Summary of

WTC Health Program Research

NIOSH Research Compendium

2022
AUGUST

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9/11 WTC Health Program

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HTTPS://WWW.CDC.GOV/WTC/RESEARCHCOMPENDIUM.HTML

UPDATE: August 2022

| LIST OF COMMON ABBREVIATIONS |

| *DIAGNOSTIC TERMS* |

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CVD	CARDIOVASCULAR DISEASE
CRS	CHRONIC RHINOSINUSITIS
COPC	CONTAMINANTS OF POTENTIAL CONCERN
CPAP	CONTINUOUS POSITIVE AIRWAY PRESSURE
GERS	GASTROESOPHAGEAL REFLUX SYMPTOM(S)
LRS	LOWER RESPIRATORY SYMPTOM(S)
OAD	OBSTRUCTIVE AIRWAY DISEASE
OSA	OBSTRUCTIVE SLEEP APNEA
PTSD	POSTTRAUMATIC STRESS DISORDER
SAID	SYSTEMIC AUTOIMMUNE DISEASES
UMHCN	UNMET MENTAL HEALTH CARE NEED(S)

| SCIENTIFIC AND TECHNICAL TERMS |

AOR	ADJUSTED ODDS RATIO
ARR	ADJUSTED RATE RATIO
CBT	COGNITIVE BEHAVIORAL THERAPY
CI	CONFIDENCE INTERVAL

DIAGNOSTIC TERMS

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ERI	EXPOSURE RANKING INDEX
MOCA	MONTREAL COGNITIVE ASSESSMENT
NPV	NEGATIVE PREDICTIVE VALUE
PPV	POSITIVE PREDICTIVE VALUE
PCL	POSTTRAUMATIC STRESS DISORDER CHECKLIST
RCT	RANDOMIZED CONTROL TRIAL
RDOC	RESEARCH DOMAIN CRITERIA
SDQ	STRENGTHS AND DIFFICULTIES QUESTIONNAIRE
W1	WAVE 1 OF WORLD TRADE CENTER HEALTH REGISTRY ENROLLEES (2003 TO 2004)
W2	WAVE 2 OF WORLD TRADE CENTER HEALTH REGISTRY ENROLLEES (2006 TO 2007)
W3	WAVE 3 OF WORLD TRADE CENTER HEALTH REGISTRY ENROLLEES (2011 TO 2012)
W4	WAVE 4 OF WORLD TRADE CENTER HEALTH REGISTRY ENROLLEES (2015 TO 2016)

INSTITUTIONS AND LOCATIONS

ATSDR	AGENCY FOR TOXIC SUBSTANCES AND DISEASE REGISTRY
FDNY	FIRE DEPARTMENT OF THE CITY OF NEW YORK
MSSMI	CAHN SCHOOL OF MEDICINE AT MOUNT SINAI

DIAGNOSTIC TERMS

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IARC	INTERNATIONAL AGENCY FOR RESEARCH ON CANCER
NIOSH	NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH
NYC	NEW YORK CITY
NYC DOHMH	NEW YORK CITY DEPARTMENT OF HEALTH AND MENTAL HYGIENE
NYC HH	NEW YORK CITY HEALTH + HOSPITALS
OEP	OFFICE OF EXTRAMURAL PROGRAMS (NIOSH)
SPARCS	STATEWIDE PLANNING AND RESEARCH COOPERATIVE SYSTEM
TRP	TREATMENT REFERRAL PROGRAM (WTCHR)

WTC WORLD TRADE CENTER

WTC CCE(S)	WORLD TRADE CENTER CLINICAL CENTERS OF EXCELLENCE
WTC EHC	WORLD TRADE CENTER ENVIRONMENTAL HEALTH CENTER
WTCHR	WORLD TRADE CENTER HEALTH REGISTRY
WTC MMTP	WORLD TRADE CENTER MEDICAL MONITORING AND TREATMENT PROGRAM
WTC MWG	WORLD TRADE CENTER MEDICAL WORKING GROUP
WTC STAC	WORLD TRADE CENTER SCIENTIFIC AND TECHNICAL ADVISORY COMMITTEE
WTC SSC	WORLD TRADE CENTER SURVIVOR STEERING COMMITTEE

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SUMMARY OF WTC HEALTH PROGRAM RESEARCH

The terrorist attacks of September 11, 2001 (9/11) caused several diverse acute and chronic adverse physical and mental ***HEALTH CONDITIONS***[1] linked to exposures. In all, nearly 400,000 exposed persons may at increased health risk from their exposures to physical, psychological, and emotional stressors from 9/11 ***[MURPHY ET AL. 2007]***

The James Zadroga **9/11** Health and Compensation Act of **2010** established the World Trade Center ***(WTC)*** Health Program ***(Program)*** to provide medical evaluation and monitoring of eligible *responders, recovery workers, and survivors*[2] ,*conduct health effects research*[3] , and to support the continuation of the ***WTC*** *Health Registry*[4] maintained by New York City ***(NYC)*** Department of Health and Mental Hygiene ***(DOHMH)***. The Program is managed by the National Institute for Occupational Safety and Health ***(NIOSH)*** within the Centers for Disease Control and Prevention ***(CDC).*** Additional information on the WTC Health Program can be found at ***WWW.CDC.GOV/WTC/ATAGLANCE.HTML***.

SUMMARY OF WTC DISEASES AND DISORDERS

The **WTC** Health Program provides treatment for several *covered conditions*[5] associated with exposures to the 9/11 disaster. For example, WTC-related diseases and disorders reported soon after the disaster were health conditions involving:

- **Lower airway (e.g., asthma/bronchitis and GERD);**
- **Upper airway (e.g., rhinosinusitis, vocal cord dysfunction);**
- **Mental health (e.g., PTSD, depression, and anxiety); and**
- **Injuries and musculoskeletal disorders (e.g., carpal tunnel, joints/fractures, low back pain).**

In addition, long-term health effects can include:

- **increased incidence of some cancers (e.g., prostate, lymphoma, thyroid, melanoma-skin, and tonsil); and**

1 ***HTTPS://WWW.CDC.GOV/WTC/CONDITIONS.HTML***
2 ***HTTPS://WWW.CDC.GOV/WTC/ELIGIBLEGROUPS.HTML***
3 ***HTTPS://WWW.CDC.GOV/WTC/RESEARCH.HTML***
4 ***HTTPS://WWW1.NYC.GOV/SITE/911HEALTH/ABOUT/WTC-HEALTH-REGISTRY.PAGE***
5 ***HTTPS://WWW.CDC.GOV/WTC/CONDITIONS.HTML***

- **obstructive sleep apnea; and,**
- **additional respiratory illnesses (e.g., sarcoidosis, pulmonary fibrosis, persistent lower respiratory symptoms).**

Although treatment has been effective for many 9/11-exposed persons, some health conditions have persisted or have manifested years after 9/11. Additionally, there is increasing interest in health conditions emerging from ongoing research and surveillance (i.e., emerging conditions), such as cognitive decline, autoimmune diseases (e.g., rheumatoid arthritis, Sjogren's Syndrome, lupus, and psoriatic arthritis), hearing loss, and cardiovascular disease, which are being investigated as possible long-term consequences of exposure to the WTC disaster.

EXAMPLES OF RECENT RESEARCH FINDINGS

RESPIRATORY DISEASE: A limited number of studies have reported on the relationship between obstructive sleep apnea ***(OSA)*** and left ventricular diastolic dysfunction ***(LVDD)***. In this study, researchers found a strong association of these conditions among **1,007 WTC** responders. The results from this large, middle-aged population may inform future guidelines regarding potential screening for **LVDD** in high-risk asymptomatic patients with **OSA**.

Iyengar-Kapuganti RL, Maceda CS, Croft LB, et al. 2022. *HTTPS://DOI.ORG/10.1136/BMJOPEN-2021-058366*

MENTAL HEALTH: Suicidal ideation is an early risk factor for suicide. Researchers found that among **WTC** disaster responders, guilt, shame, hopelessness, and functional impairment were strongly linked to suicidal ideation . Findings suggest that interventions targeting these actors may help mitigate suicide risk in this population.

Gibson R, Whealin JM, Dasaro CR, et al. 2022. *HTTPS://DOI.ORG/10.1016/J.JAD.2022.03.011*

CANCER: In the largest cohort of **9/11** rescue and recovery workers, overall cancer incidence was lower than expected over the **14** years following **9/11** compared to New York State cancer incidence rates . Howeverthe intensity of **WTC** exposure was associated with increased risk for specific cancer sites (melanoma-skin, prostate, thyroid, and tonsil). Findings support the value of long-term follow-up studies after environmental disasters.

Li J, Yung J, Qiao B, et al. 2022. *HTTPS://DOI.ORG/10.1093/JNCI/DJAB165*

LUNG CANCER: This study described the characteristics of **WTC** survivor women with lung adenocarcinoma who were enrolled in the WTC Environmental Health Center ***(WTC EHC)*** between **May 2002** and **July 2021**. The finding of a relatively high proportion of women never-smokers with lung cancer warrants further investigation into the role of **WTC** dust exposure on lung cancer.

Shum E, Durmus N, Pehlivan S, et al. 2022. *HTTPS://DOI.ORG/10.3390/IJERPH19137618*

WTC YOUTH: Researchers examined the impact of **9/11** on student performance in math and English language arts exam scores. To do this, they observed third grade student data across five years prior and two years following **9/11.** In this period, they found modest improvements in test scores following **9/11**. Authors recommended that future studies evaluate long-term impacts of the **9/11** disaster on education , as outcomes may differ compared to the short-term effects.

Takemoto E, Locke S, Goin DE, et al. 2022. *HTTPS://DOI.ORG/10.1016/J.SSMMH.2022.100096*

EMERGING CONDITIONS: This review examines neurological outcomes as emerging areas of study in **WTC**-affected individuals. Researchers concluded with recommendations to monitor neurological health for this population.

Clouston SAP, Hall CB, Kritikos M, et al. 2022. *HTTPS://DOI.ORG/10.1038/S41582-021-00576-8*

WTC RESEARCH COMPENDIUM OVERVIEW AND ORGANIZATION

This research compendium describes the World Trade Center Research Program and the extraordinary contribution of researchers, responders, and survivors and the research information they provide to ensure excellence in the clinical care for the **9/11** affected population. It is intended as a resource to assist the **WTC Health Program** staff with planning future research directions, assessing the impact of current studies, identifying gaps in the research, and coordinating external program reviews.

THE COMPENDIUM—WHICH IS UPDATED REGULARLY—IS ORGANIZED INTO FIVE SECTIONS THAT INCLUDE:

I. **WTC HEALTH PROGRAM OVERVIEW:** This section provides a summary of the WTC Health Program authorizing legislation and a description of WTC Health Program enrollees, Data Centers, and Clinical Centers of Excellence.

II. **WTC HEALTH PROGRAM RESEARCH PORTFOLIO OVERVIEW:** This section includes research funded by the WTC Health Program by year since the creation of the WTC Health Program, research projects awarded by focus area, and the number of scientific publications for each focus area.

III. **WTC HEALTH REGISTRY OVERVIEW:** This section includes a brief background description of the Registry and a listing of scientific outputs.

IV. **RESEARCH ADVISORY GROUPS:** This section comprises a list of the advisory groups that provide research recommendations to the WTC Health Program.

V. **APPENDICES:** Documents contained in each of the three appendices provide additional detailed information regarding the WTC Health Program research portfolio.

1. **APPENDIX I:** Includes a table listing research projects by focus area, brief descriptions of all portfolio studies, publications by study project, and a listing of the WTC Health Registry accomplishments.

2. **APPENDIX II:** Includes publication bibliographies for all portfolio research projects, the WTC Health Registry, and each of the three WTC Health Program Data Centers: Fire Department of New York (FDNY Responders), Icahn School of Medicine at Mount Sinai (General Responders), and NYC Health + Hospitals Corporation (NYC H+H) (Survivors). Publications prior to 2011 are included for the WTC Health Registry (8%), the General Responder Data Center (28%), the FDNY Data Center (28%), and NYC H+H (18%).

3. **APPENDIX III:** Includes research recommendations from the WTC Health Program Scientific and Technical Advisory Committee (STAC), and the WTC Medical Working Group (WTC MWG).

SECTION I. WORLD TRADE CENTER HEALTH PROGRAM OVERVIEW

Congress created the World Trade Center (WTC) Health Program with passing the ***James Zadroga 9/11 Health and Compensation Act of 2010***. The **WTC Health Program** provides medical monitoring and treatment of eligible responders, initial health evaluations for eligible survivors, and medical monitoring treatment for survivors who have health conditions certified by the Program.

The **Zadroga Act** also authorized ongoing research activities and the maintenance of the **WTC Health Registry**. This research compendium documents program-funded disaster activities and published research beginning shortly after **9/11.**

AUTHORIZING LEGISLATION

On **January 2, 2011,** President Barack Obama signed ***Public Law No. 111-347,*** the ***James Zadroga 9/11 Health and Compensation Act (Zadroga Act).*** Title I of the Zadroga Act amended the **Public Health Service Act** to add ***Title XXXIII,*** which established a new federal health care program—the "World Trade Center Health Program"—within the **Department of Health and Human Services**.

On **December 18, 2015**, ***the Zadroga Act*** was amended to provide the authority and funding for continued operation of the **WTC Health Program** through ***2090. See Pub. L. 114–113 (Dec. 18, 2015), "Consolidated Appropriations Act, 2016," Div. O, Title III (James Zadroga 9/11 Health and Compensation Reauthorization Act)***.

For the complete text of the ***James Zadroga 9/11 Health*** and ***Compensation Act (2010)*** and the ***James Zadroga 9/11 Health*** and ***Compensation Reauthorization Act (2015)***, please visit ***HTTP://WWW.CDC.GOV/WTC/LAWS.HTML***

SPECIFIC SECTIONS OF THE ZADROGA ACT MOST RELEVANT TO WTC HEALTH PROGRAM RESEARCH ACTIVITIES

SUBTITLE A: ESTABLISHMENT OF PROGRAM; ADVISORY COMMITTEE

SECTION 3302. Authorizes the establishment of the **WTC Health Program Scientific and Technical Advisory Committee *(STAC)*, and both a Responder and Survivor Steering Committee.** Research recommendations provided by the STAC and are provided in **APPENDIX III** .

SECTION 3304. Authorizes the establishment of Clinical Centers of Excellence (CCEs) and Data Centers (DCs). Data Center research publications based on Data Centers' information are provided in **Appendix II.**

SUBTITLE C: RESEARCH INTO CONDITIONS

SECTION 3341. Authorizes research activities regarding certain health conditions related to ***9/11.***

SECTION 3342. Authorizes the WTC Health Registry and ensures its ongoing maintenance.

PROGRAM POPULATION (ENROLLEES)

As of **June 30, 2022**, the **WTC Health Program** had **118,474** members enrolled, including **90,770** residing in the NYC area *(***16,394 FDNY** *responders,* **51,854** *general responders, and* **22,522** *survivors)* and **27,704** responders and/or survivors in the Nationwide Provider Network.

The Program delivered monitoring or screening exams to an estimated 48,225 members, diagnostic services to approximately **20,228** members, and treatment services to **39,319** members between **July 1, 2021**, and **June 30, 2022**.

For current WTC Health Program statistics and quarterly reports, please visit ***HTTPS://WWW.CDC.GOV/WTC/REPORTS.HTML***

▶ **NOTE:** DATA PROVIDED BY THE WTC HEALTH PROGRAM STAFF.

CLINICAL CENTERS OF EXCELLENCE AND WTC HEALTH PROGRAM DATA CENTERS

The **Clinical Centers of Excellence** *(CCEs)* are authorized to provide medical monitoring evaluations, diagnostic and treatment services for qualifying conditions, social benefits counseling, and limited outreach activities. The three **WTC Health Program Data Centers —which collect and store de-identified data from the CCEs—** are of primary importance to **WTC Health Program** research activities, providing researchers with approved datasets with information collected from the **Clinical Centers of Excellence** ***(CCEs).*** To date, **Data Center** affiliated researchers have published **313 WTC-related articles** in scientific journals ***(24% were published prior to 2011)***.

For an overview of the World Trade Center Health Program, including **Data Centers** and **Clinical Centers of Excellence**, please visit ***HTTP://WWW.CDC.GOV/WTC/PPM.HTML***

WTC HEALTH PROGRAM DATA CENTERS AND ASSOCIATED CLINICAL CENTERS OF EXCELLENCE

The **FDNY Data Center** serves **FDNY** responders and has produced **124** scientific publications. Associated Clinical Centers: **FDNY** ***(Fire Department of New York)*** headquarters in Brooklyn with satellite centers at **Brentwood**, **Fort Totten**, **Orange County,** and **Staten Island**.

The **General Responder Data Center** serves non-**FDNY** responders and has produced **159** scientific publications. **Associated Clinical Centers**: **MSSM** ***(Icahn School of Medicine at Mount Sinai);*** **Northwell Health System**; **New York University**, **Bellevue Hospital Center**; **State University of New York**, **Stony Brook**; **Environmental and Occupational Health Sciences Institute at Rutgers University**.

The **Survivor Data Center** serves **WTC survivors** and has produced **43** scientific publications. **Associated Clinical Centers**: **New York City Health + Hospitals** ***(NYC H+H)*** **Bellevue Hospital Center**, **Gouverneur Healthcare Services**, and **Elmhurst Hospital Center**.

▶ **NOTE: Appendix II** INCLUDES A PUBLICATION BIBLIOGRAPHY FOR EACH DATA CENTER.

SECTION II. WTC HEALTH PROGRAM RESEARCH PORTFOLIO OVERVIEW

NIOSH OFFICE OF EXTRAMURAL PROGRAMS

NIOSH established the Office of Extramural Programs ***(OEP)*** to facilitate stewardship for, and management of, extramural grants and cooperative agreements. **OEP** is located within the **NIOSH** Office of the Director. The **NIOSH** extramural research and training programs include diverse portfolios of investigator-initiated research, mentored research scientist awards, academic training programs, and small business innovation research ***(SBIR)*** projects. Multidisciplinary education and research centers, state surveillance programs, and focused worker training programs in mining and commercial fishing complement the breadth and depth of the extramural research and training portfolio. Peer review of applications is managed by ***OEP*** scientific review officers. ***OEP*** scientific program officials oversee and manage program management. The ***OEP*** also manages the extramural portfolio of cooperative agreements for the **WTC Health Program**. This portfolio includes the **WTC Health Program Registry** research and individual cooperative research agreements

▶ FOR INFORMATION ABOUT THE NIOSH EXTRAMURAL RESEARCH AND TRAINING PROGRAM PLEASE VISIT: *HTTPS://WWW.CDC.GOV/NIOSH/OEP/*

WTC HEALTH PROGRAM RESEARCH SOLICITATION AND FUNDING

Each year since late **2011**, the **World Trade Center *(WTC)*** Health Program has solicited applications for scientifically rigorous research to help answer critical questions about physical and mental health conditions related to the September 2001 disaster. From **2011** to **2022**, a total of **342** research proposals (not including the renewal of the **WTC Health Registry**) were reviewed and **102 (29.8%)** projects were awarded funding by ***OEP*.**

The **WTC Health Program Research-to-Care** model, the strategic framework for prioritizing research, conducts and assesses research that informs clinical care for the population of responders and survivors affected by the **9/11** disaster.

To review the current WTC Health Program research agenda, ***please visit: HTTPS://WWW.CDC.GOV/WTC/RESEARCH.HTML***

From **2011–2022**, the **WTC Health Program** funded **111** research projects (excluding the WTC Health Registry and four projects funded by **The National Institute on Aging *[NIA])*** for an awarded total of ***$148.2 million*.** From **July 2011–2022**, the **WTC Health Program** continued to fund the **WTC Health Registry** project for a total of ***$84.4 million***. Prior to **July 2011**, the **Agency for Toxic Substances and Disease Registry *(ATSDR),*** the **National Center for Environmental Health *(NCEH)***, and the **New York City Department of Health and Mental Hygiene *(NYC DOHMH)***

funded the **Registry.**

Total research funding from **2011** through **2022** for the **111** research projects and the **WTC Health Registry** is shown below in **FIGURE 1**.

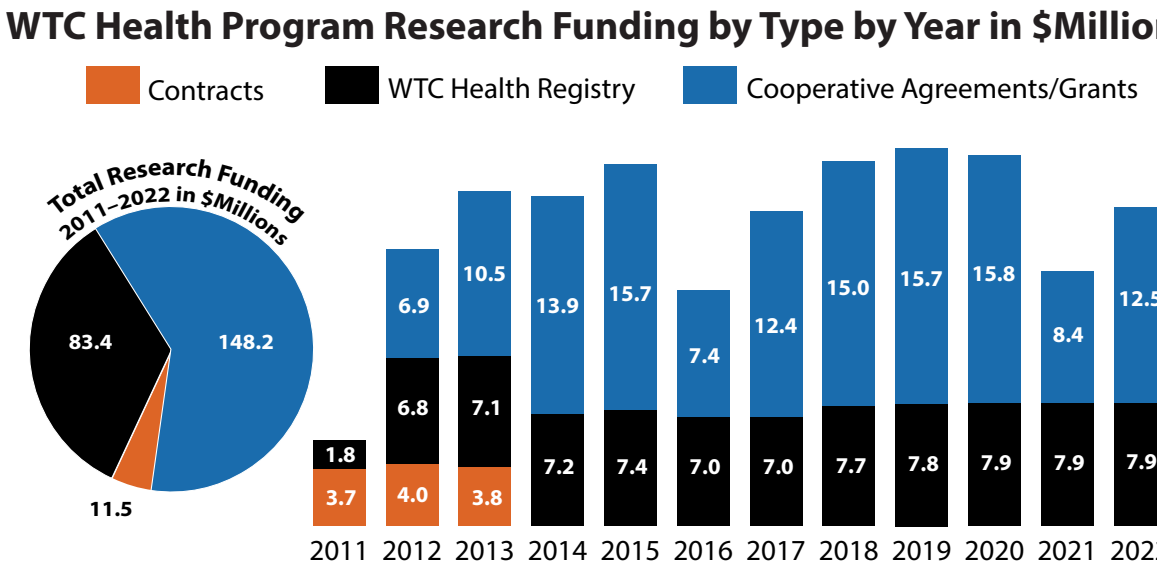

FIGURE 1: RESEARCH FUNDING FOR 2011–2022 RESEARCH CONTRACTS, WTC HEALTH REGISTRY, AND THE RESEARCH COOPERATIVE AGREEMENTS AND OTHER GRANTS, IN $MILLIONS.

▶ **Emerging Conditions: Autoimmune Disease, Assessment of Bias in WTC Studies, Cognitive Function, Neuropathic Symptoms, Kidney Disease, General Responder Mortality, WTC Exposure Assessment-Global DNA Methylation, Trace Elements in Autopsy Tissues from WTC Decedents, Development of a Comparison WTC Occupational Cohort, and Hepatitis C.**

▶ **NOTE: APPENDIX I** PROVIDES A LISTING OF ALL FUNDED PROJECTS THAT WERE AWARDED AS OF **2022.**

CURRENT STATUS OF FUNDED PROJECTS 2011–2022 (WTC HEALTH REGISTRY EXCLUDED)

Of the **115** projects awarded since **2011** (***including four funded through NIA***), **50** ***(43%)*** are active and **65** ***(57%)*** are completed (closed or ended). Of the **65** completed projects, **49** ***(75%)*** have produced publications.

For descriptions of all **World Trade Center** research projects, a listing of investigators, the current research agenda, the **WTC Research-to-Care** Logic Model, and the current funding opportunity announcements, please visit ***HTTPS://WWW.CDC.GOV/WTC/RESEARCH.HTML***

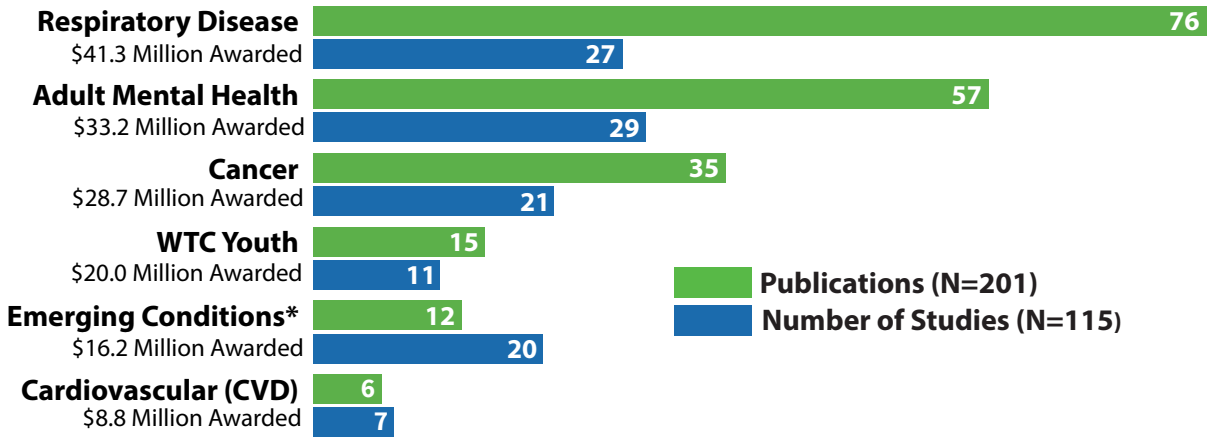

FIGURE 2: RESEARCH STUDIES AND PUBLICATIONS BY PRIMARY FOCUS AREA

▶**Emerging Conditions: Autoimmune Disease, Assessment of Bias in WTC Studies, Cognitive Function, Neuropathic Symptoms, Kidney Disease, General Responder Mortality, WTC Exposure Assessment-Global DNA Methylation, Trace Elements in Autopsy Tissues from WTC Decedents, Development of a Comparison WTC Occupational Cohort, and Hepatitis C.**

SOME PROJECTS INVOLVE MORE THAN ONE FOCUS AREA

▶ NOTE: APPENDIX I INCLUDES A TABLE LISTING OF ALL FUNDED PROJECTS, AND A LISTING OF THOSE STUDIES WITH PUBLICATIONS. APPENDIX II INCLUDES A BIBLIOGRAPHY OF ALL RESEARCH PORTFOLIO PUBLICATIONS (EXCLUDING WTC HEALTH REGISTRY PUBLICATIONS).

WTC Health Program Research by Study Population and Focus Area Of the **115** projects funded to-date, **88** ***(77%)*** focus exclusively on responder populations, **21** ***(18%)*** include survivor populations, and **6** projects ***(5%)*** involve animal and other subjects. See **FIGURE 3 [ON NEXT PAGE 11]**

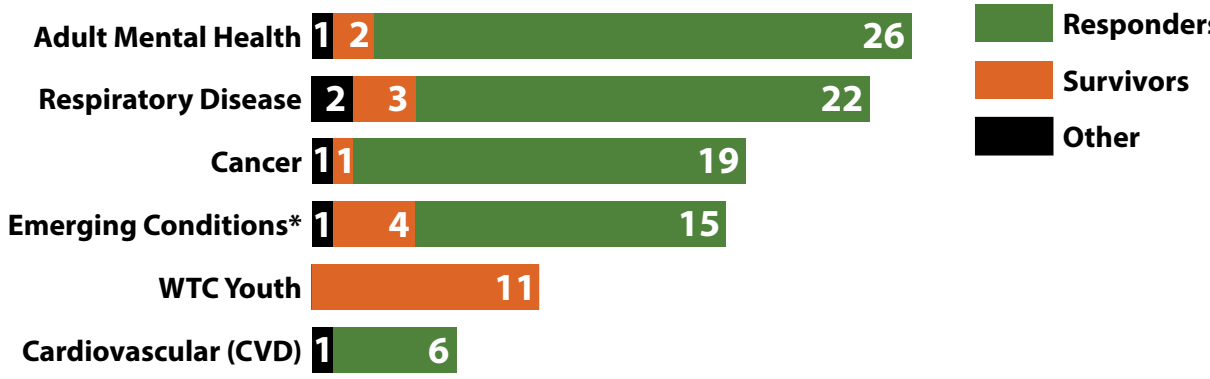

FIGURE 3: NUMBER OF PROJECTS BY STUDY POPULATION (RESPONDER, SURVIVOR, AND OTHER) AND PRIMARY FOCUS AREA

SOME PROJECTS INVOLVE MORE THAN ONE FOCUS AREA

▶ **Emerging Conditions: Autoimmune Disease, Assessment of Bias in WTC Studies, Cognitive Function, Neuropathic Symptoms, Kidney Disease, General Responder Mortality, WTC Exposure Assessment-Global DNA Methylation, Trace Elements in Autopsy Tissues from WTC Decedents, Development of a Comparison WTC Occupational Cohort, and Hepatitis C.**

SECTION III. WORLD TRADE CENTER HEALTH REGISTRY

MISSION AND SERVICES

Between **2003–2004,** the **WTC Health Registry** enrolled more than **71,000** persons of all ages who experienced a range of direct exposures the during **9/11** attacks and aftermath. It is one of the longest running post-disaster registries worldwide. **The WTC Registry**, based in the **New York City Department of Health and Mental Hygiene**, is an essential public health resource for understanding the long-term **(20+ years)** physical and mental health effects from **9/11**.

Current health information about the impact of the **9/11** disaster helps those affected by the disaster make informed decisions about their health. Health resource information is disseminated by **Registry** staff via multiple channels, including a comprehensive website, annual reports, e-newsletters, brief research summaries, testimonials from responders and survivors, informational videos, social media, targeted mailings, health information sheets, press announcements, and stakeholder meetings.

Communications with enrollees are designed to keep them engaged with the **Registry** for the long term and to obtain enrollees' updated contact information. This enhances enrollees' participation in periodical follow-up health surveys and nested studies to track and understand long-term changes in physical and mental health, quality of life, and gaps in care. The **Registry** staff also helps link enrollees and their families with the **WTC Health Program**, where they can receive needed health care.

The **Registry** staff works with community, labor, and other stakeholders to keep them informed and to receive input on various research studies, surveys, other activities related to the ***9/11*** community. **Registry** researchers disseminate findings at scientific conferences, meetings, through peer-reviewed journals. More information about the **Registry** can be found at ***HTTPS://WWW1.NYC.GOV/SITE/911HEALTH/ABOUT/WTC-HEALTH-REGISTRY.PAGE***

ENROLLMENT

The Registry enrollment is now closed, but currently includes more than **30,000** rescue and recovery workers and nearly **50,000** survivors who lived, worked, attended school, or were present in lower Manhattan on 9/11. Nearly **3,000** enrollees were under the age of **18** during the attacks.

SCIENTIFIC OUTPUTS

As of **July 1, 2022**, the **WTC Health Registry** has a total of **613** scientific outputs *(publications, presentations, published guidelines, etc.)*. The distribution of outputs by type is presented in **Figure 4: See Next Page**

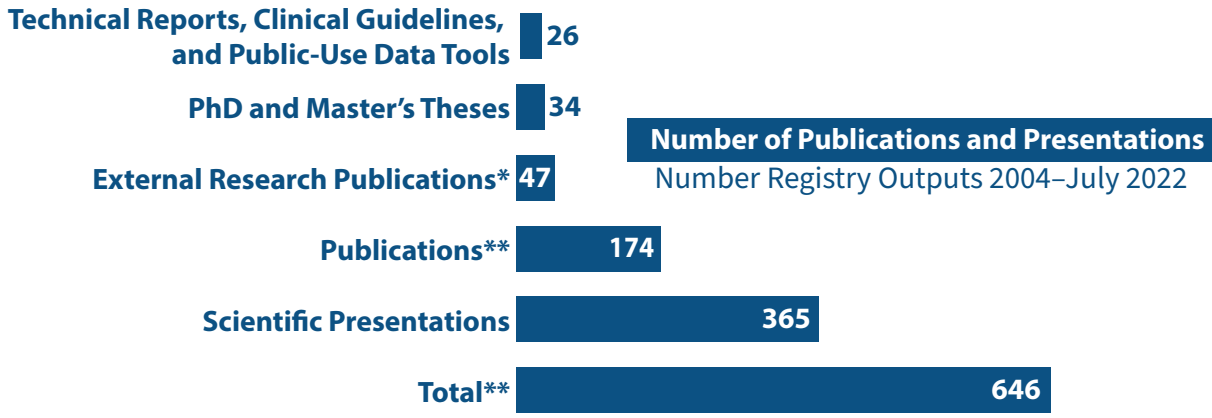

FIGURE 4: WTC HEALTH REGISTRY KEY SCIENTIFIC OUTPUTS AS OF JUNE 2021

▶*****TOTAL DOES NOT INCLUDE MANUSCRIPTS IN PRESS*****

** Publications resulting from Registry-facilitated recruitment into external research studies or Registry provided de-identified data*

▶ NOTE: APPENDIX I CONTAINS A LISTING OF THE WTC HEALTH REGISTRY KEY ACCOMPLISHMENTS AND APPENDIX II INCLUDES A BIBLIOGRAPHY OF REGISTRY PUBLICATIONS. INFORMATION AVAILABLE ON THE REGISTRY WEBSITE

REGISTRY WEBSITE

For summaries of the Registry Annual Reports, peer-reviewed scientific publications, technical reports, and clinical guidelines, please visit ***HTTPS://WWW1.NYC.GOV/SITE/911HEALTH/RESEARCHERS/WTC-SCIENTIFIC-BIBLIOGRAPHY.PAGE*** The listing on this site will be updated periodically by the Registry staff.

FOR THE GENERAL REGISTRY BIBLIOGRAPHY LIST, PLEASE VISIT:

HTTPS://WWW1.NYC.GOV/SITE/911HEALTH/RESEARCHERS/WTC-SCIENTIFIC-BIBLIOGRAPHY.PAGE

FOR REGISTRY HIGHLIGHTS AND OTHER 9/11 HEALTH INFORMATION, PLEASE VISIT

HTTP://WWW1.NYC.GOV/SITE/911HEALTH/INDEX.PAGE

SECTION IV. WTC HEALTH PROGRAM RESEARCH ADVISORY GROUPS

The **World Trade Center Scientific** and **Technical Advisory Committee** ***(STAC)***

When requested by the Administrator of the **WTC Health Program**, the **WTC Scientific** and **Technical Advisory Committee** ***(STAC)*** reviews the scientific and medical evidence and makes recommendations on additional program eligibility criteria or additional health conditions to be included in the program. The Administrator may consult with the **STAC** on research regarding certain health conditions related to ***9/11***. In addition, the **STAC** may be asked to review and provide recommendations on other matters at the request of the Administrator.

The Administrator of the **WTC Health Program** determines when the **STAC** meetings will occur. For meeting agendas, presentation materials, and meeting archives, please visit ***HTTPS://WWW.CDC.GOV/WTC/STAC.HTML***

RECOMMENDATIONS: The **STAC** provided research recommendations in 2012, 2014, and 2019. The **STAC** recommendations are provided in **Appendix III.**

The **World Trade Center Medical Working Group** of **New York City** ***(WTC MWG)*** was appointed by the Honorable ***Michael Bloomberg, Mayor of New York City***, in **June 2007.** ***WTC MWG*** members reviewed clinical and research findings on the health effects of ***WTC*** exposure, published annual reports, and reviewed the adequacy of physical and mental health services available to ***WTC-exposed*** individuals. The ***WTC MWG*** also advised city government on approaches to most effectively communicate the health risk related to **WTC exposure**. The group disbanded in **2011** due to the establishment of the **WTC Health Program**.

RECOMMENDATIONS: The **WTC Medical Working Group** ***(WTC MWG)*** made a series of recommendations related to 9/11 health treatment and services between 2007 and 2011. The recommendations fall into three broad categories: funding, research and evaluation, and education. The recommendations are outlined in the group's final Annual Report released in **2011**. The report **"2011 Annual Report on 9/11 Health"** is provided in **Appendix III**

SECTION V. DOCUMENTS INCLUDED IN THE APPENDICES

Appendix I: Research Portfolio Overview

- Table Listing of Projects
- Research Study Descriptions
- Publications by Project
- World Trade Center Health Registry Key Accomplishments (NIOSH grant years 2012 –June 2016)
- World Trade Center Health Registry Key Accomplishments (NIOSH grant years July 2016 –June 2022)

Appendix II: Publication Bibliographies

- WTC Health Program Research Cooperative Agreement Publications (2011–2022) (WTC Health Registry Publications not included)
- World Trade Center Health Registry Publications (2006 – July 2022)
- WTC Health Program Data Center Publications
- FDNY Data Center Bibliography
- General Responder Data Center Bibliography
- Survivor Data Center Bibliography

Appendix III: WTC Researcher Recommendations

- 2012 WTC STAC Research Recommendations
- 2014 WTC STAC Research Recommendations
- 2019 WTC STAC Children's Research Feasibility Recommendations
- 2014 WTC MWG Research Recommendations

SUMMARY OF USEFUL LINKS [continued on page 17]

HTTPS://WWW.CDC.GOV/WTC/PPM.HTML

Overview of the World Trade Center Health Program, including Data Centers and Clinical Centers of Excellence

HTTPS://WWWN.CDC.GOV/RESEARCHGATEWAY/

World Trade Center research projects, a listing of investigators, the current research agenda, the ***HTTPS://WWW.CDC.GOV/WTC/RESEARCH.HTML****, and the current funding opportunity announcement*

HTTPS://WWW.CDC.GOV/WTC/REPORTS.HTML

Current World Trade Center Health Program statistics and reports

HTTPS://WWW.CDC.GOV/NIOSH/OEP/

Information about NIOSH extramural research and training programs

HTTPS://WWW.CDC.GOV/WTC/STAC.HTML

Scientific Technical Advisory Committee meeting agendas, presentation materials, and meeting archives

HTTPS://WWW.CDC.GOV/WTC/LAWS.HTML

The complete text of the James Zadroga 9/11 Health and Compensation Act (2010) and the Zadroga Reauthorization Act (2015)

HTTPS://WWW1.NYC.GOV/SITE/911HEALTH/RESEARCHERS/PUBLISHED-RESEARCH-PUBLICATIONS.PAGE

Summaries of the Registry peer-reviewed scientific publications, annual re-ports, technical report, and clinical guidelines.

SUMMARY OF USEFUL LINKS [continued from PREVIOUS page 16]

HTTPS://WWW1.NYC.GOV/SITE/911HEALTH/RESEARCHERS/WTC-SCIENTIFIC-BIBLIOGRAPHY.PAGE

The general World Trade Center Health Registry Bibliography List

HTTPS://WWW1.NYC.GOV/SITE/911HEALTH/INDEX.PAGE

World Trade Center Health Registry Highlights and Home Page

Appendix One • WTC Health Program Research Project Table • 2022

Projects are grouped by study focus area and fiscal year initiated. 111 are WTCHP funded, and 4 are NIA funded (see footnote)

Study Focus	Principal Investigator (Project Number)	Title	Institution	Year Initiated	Project Duration (Years)	WTC Population Studied	Status	# Publications
Adult Mental Health	BROMET (39410)	Burden of Mental-Physical Comorbidity in World Trade Center Responders	STATE UNIVERSITY NEW YORK STONY BROOK	FY 11	3 years	Responders	Completed	10
Adult Mental Health	BROMET (42057)	Enhanced Smoking Cessation Intervention for WTC Responders[1]	STATE UNIVERSITY NEW YORK STONY BROOK	FY 11	3 years	Responders	Completed	8
Adult Mental Health	FEDER (41919)	Trajectories of Psychological Risk and Resilience in World Trade Center Responders	MOUNT SINAI SCHOOL OF MEDICINE	FY 11	3 years	Responders	Completed	8
Adult Mental Health	FEDER (10407)	Biomarkers of Psychological Risk and Resilience in World Trade Center Responders	MOUNT SINAI SCHOOL OF MEDICINE	FY 12	4 years	Responders	Completed	0
Adult Mental Health	KIM (10399)	Health and Socioeconomic Sequelae of the WTC Disaster Among Responders	FEINSTEIN INSTITUTE FOR MEDICAL RESEARCH [NORTH SHORE-LONG ISLAND JEWISH MEDICAL (LIJ)]	FY 12	2 years	Responders	Completed	4
Adult Mental Health	GONZALEZ (10524)	Mind Body Treatment for WTC Responders with Comorbid PTSD and Respiratory Illness[1]	STATE UNIVERSITY NEW YORK STONY BROOK	FY 13	3 years	Responders	Completed	0
Adult Mental Health	KOTOV (10712)	The Daily Burden of PTSD and Respiratory Problems in World Trade Center Responders	STATE UNIVERSITY NEW YORK STONY BROOK	FY 14	2 years	Responders	Completed	2
Adult Mental Health	KUNG (10516)	Mental Health Impact and Service Use among Asian Survivors and Rescuers Exposed to the WTC Attack[2]	FORDHAM UNIVERSITY	FY 14	2 years	Responders & Survivors	Completed	5
Adult Mental Health	FEDER (10986)	Gene Expression Profiles as Markers of PTSD Risk and Resilience in WTC Responders	ICAHN SCHOOL OF MEDICINE AT MOUNT SINAI	FY 15	1 years	Responders	Completed	0
Adult Mental Health	FERRI (10996)	A Pilot Test of the Relaxation Response Resiliency Program (3RP) in Spanish Speaking World Trade Center Disaster Survivors with PTSD	NEW YORK UNIVERSITY SCHOOL OF MEDICINE	FY 15	1 years	Survivors	Completed	0

[1]Registry facilitated recruitment [2]Registry provided de-identified data [3]Registry co-investigator collaboration [4]funded by the National Institute on Aging (NIA)

Study Focus	Principal Investigator (Project Number)	Title	Institution	Year Initiated	Project Duration (Years)	WTC Population Studied	Status	# Publications
Adult Mental Health	FEDER (10729)	Internet-Based Psychotherapies for PTSD Symptoms in WTC Responders	ICAHN SCHOOL OF MEDICINE AT MOUNT SINAI	FY 16	3 years	Responders	Completed	0
Adult Mental Health	KOTOV (11321)	Personality-Informed Care Model for 9/11-Related Comorbid Conditions	STATE UNIVERSITY NEW YORK STONY BROOK	FY 16	5 years	Responders	Active	5
Adult Mental Health	LUCCHINI (11314)	Structural and Functional Neuroimaging of Post Traumatic Stress Disorder and Cognitive Impairment in World Trade Center Responders	ICAHN SCHOOL OF MEDICINE AT MOUNT SINAI	FY 16	4 years	Responders	Completed	6
Adult Mental Health	FEDER (11473)	Neuroimaging of Resilience in World Trade Center Responders: A Focus on Emotional Processing, Reward and Social Cognition	ICAHN SCHOOL OF MEDICINE AT MOUNT SINAI	FY 17	4 years	Responders	Active	0
Adult Mental Health	KUAN (11478)	Longitudinal Genome-wide Transcriptome Study of PTSD Symptom Change in WTC Responders	THE RESEARCH FOUNDATION FOR THE STATE UNIVERSITY OF NEW YORK	FY 17	3 years	Responders	Completed	7
Adult Mental Health	WASZCZUK/ KOTOV (11864)	Polygenic prediction of PTSD trajectories and inflammation in 9/11 responders	STATE UNIVERSITY NEW YORK STONY BROOK	FY 19	2 years	Responders	Completed	1
Adult Mental Health	CYCOWICZ (12065)	Intergenerational Transmission of Trauma in WTC Responders with PTSD	NEW YORK STATE PSYCHIATRIC INSTITUTE	FY 20	1 years	Other	Active	0
Adult Mental Health	ARCAN (12057)	Lifestyle intervention to reduce body weight and systemic inflammation among World Trade Center responders with PTSD: Pilot Randomized Control Trial	STATE UNIVERSITY NEW YORK STONY BROOK	FY 21	1 years	Responders	Active	0
Adult Mental Health	AYAPPA (11852)	Role of Sleep Apnea in Cognition and Alzheimers Disease Biomarkers in WTC Responders	ICAHN SCHOOL OF MEDICINE AT MOUNT SINAI (NEW YORK, NY)	FY 21	5 years	Responders	Active	0
Adult Mental Health	CLOUSTON (12258)	Cognition and neuropathology in World Trade Center-exposed FDNY, NYPD, and construction worker responders	STATE UNIVERSITY NEW YORK STONY BROOK (STONY BROOK, NY)	FY 21	5 years	Responders	Active	0

[1]Registry facilitated recruitment [2]Registry provided de-identified data [3]Registry co-investigator collaboration [4]funded by the National Institute on Aging (NIA)

Study Focus	Principal Investigator (Project Number)	Title	Institution	Year Initiated	Project Duration (Years)	WTC Population Studied	Status	# Publications
Adult Mental Health	CYCOWITZ (12272)	Neuropsychological Profile and Neurocognitive Biomarkers of Attention and Memory in Trauma-Exposed Responders at Risk of Premature Cognitive Decline	NEW YORK STATE PSYCHIATRIC INSTITUTE (NEW YORK, NY)	FY 21	5 years	Responders	Active	0
Adult Mental Health	KORAISHY (12237)	Investigating the association of posttraumatic stress disorder (PTSD) with chronic kidney disease (CKD) in World Trade Center (WTC) responders	STATE UNIVERSITY NEW YORK STONY BROOK	FY 21	2 years	Responders	Active	0
Adult Mental Health	KUAN (12257)	Changes in monocyte transcriptome as a predictor of cognitive decline in WTC responders: a longitudinal study	STATE UNIVERSITY NEW YORK STONY BROOK (STONY BROOK, NY)	FY 21	3 years	Responders	Active	0
Adult Mental Health	MANN (74705)[4]	Trauma Exposure and Cognitive Impairment: Understanding Polygenic Liability and the Causative and Moderating Effects of Exposure, PTSD, and Psychiatric Comorbidity in WTC Responders	STATE UNIVERSITY NEW YORK STONY BROOK	FY 21	2 years	Responders	Active	0
Adult Mental Health	MUJICA-PARODI (74706)[4]	Using Artificial Intelligence to Identify Accelerated Brain Aging in World Trade Center Responders	STATE UNIVERSITY NEW YORK STONY BROOK	FY 21	2 years	Responders	Active	0
Adult Mental Health	SCHWARTZ (12050)	Assessing the feasibility and acceptability of using non-invasive transcutaneous auricular vagus nerve stimulation (taVNS) to reduce PTSD symptoms in WTC responders	FEINSTEIN INSTITUTE FOR MEDICAL RESEARCH (MANHASSET, NY)	FY 21	2 years	Responders	Active	1
Adult Mental Health	WEISENBACH (74707)[4]	Using Resting State Functional MRI to Predict Cognitive Decline among World Trade Center Responders	STATE UNIVERSITY NEW YORK STONY BROOK	FY 21	2 years	Responders	Active	0
Adult Mental Health	ZAMMIT (74708)[4]	Physical and Mental Health Pathways to Cognitive Decline in World Trade Center Responders: The Roles of Pulmonary Function and Post-Traumatic Stress Disorder	RUSH UNIVERSITY MEDICAL CENTER	FY 21	2 years	Responders	Active	0
Adult Mental Health	SCHWARTZ (12476)	Developing and Evaluating Artificial Intelligence-based Longitudinal Assessments of PTSD in 9/11 Responders	STATE UNIVERSITY NEW YORK STONY BROOK	FY 22	4 years	Responders	Active	0

[1]Registry facilitated recruitment [2]Registry provided de-identified data [3]Registry co-investigator collaboration [4]funded by the National Institute on Aging (NIA)

Study Focus	Principal Investigator (Project Number)	Title	Institution	Year Initiated	Project Duration (Years)	WTC Population Studied	Status	# Publications
Cancer	BOFFETTA (41815)	Cancer Among WTC Responders: Enhanced Surveillance, Exposure Assessment, and Cancer Specific Risks[3]	MOUNT SINAI SCHOOL OF MEDICINE	FY 11	3 years	Responders	Completed	2
Cancer	PREZANT (39489)	Cohort Studies of Incident Cancers in the FDNY WTC Responder Population	ALBERT EINSTEIN COLLEGE OF MEDICINE	FY 11	3 years	Responders	Completed	1
Cancer	TAIOLI (10396)	Prostate Cancer Risk and Outcome in WTC Respondents	MOUNT SINAI SCHOOL OF MEDICINE	FY 13	2 years	Responders	Completed	2
Cancer	TAIOLI (10512)	Biorepository of Cancer Tissue Samples from WTC Responders	FEINSTEIN INSTITUTE FOR MEDICAL RESEARCH	FY 14	2 years	Responders	Completed	1
Cancer	WEBBER (10728)	Post-9/11 Cancer Incidence in FDNY Firefighters	ALBERT EINSTEIN COL OF MED YESHIVA UNIV	FY 14	2 years	Responders	Completed	3
Cancer	AARONSON (11328)	Impact of WTC Dust on Immune Functions and Prostate Cancer Promotion	ICAHN SCHOOL OF MEDICINE AT MOUNT SINAI	FY 16	5 years	Other	Active	1
Cancer	GRABER (11322)	Head and Neck Cancer in the World Trade Center Health Program Cohort; Elucidating Risk Factors to Reduce Incidence and Morbidity	RUTGERS, THE STATE UNIVERSITY OF NEW JERSEY	FY 16	2 years	Responders	Completed	4
Cancer	HALL (11932) (Previously 11315)	Incidence, Latency, and Survival of Cancer Following World Trade Center Exposure (2,3)	ALBERT EINSTEIN COLLEGE OF MEDICINE, INC	FY 16	4 years	Responders	Active	4
Cancer	TAIOLI (10984)	Thyroid Cancer Risk in WTC Responders	ICAHN SCHOOL OF MEDICINE AT MOUNT SINAI	FY 16	3 years	Responders	Completed	2
Cancer	WEBBER (11934) (Previously 11309)	Maintenance and Extension of a Cohort of Career Firefighters as a Non-WTC Exposed Comparison for the FDNY Firefighter Cohort	ALBERT EINSTEIN COLLEGE OF MEDICINE, INC	FY 16	5 years	Responders	Active	3
Cancer	BRANCH (11489)	Hepatotoxic Exposures, Progressive Fatty Liver Disease (NASH), and Liver Cancer Risk in the World Trade Center Health Program General Responder Cohort	ICAHN SCHOOL OF MEDICINE AT MOUNT SINAI	FY 17	4 years	Responders	Completed	3

[1]Registry facilitated recruitment [2]Registry provided de-identified data [3]Registry co-investigator collaboration [4]funded by the National Institute on Aging (NIA)

Study Focus	Principal Investigator (Project Number)	Title	Institution	Year Initiated	Project Duration (Years)	WTC Population Studied	Status	# Publications
Cancer	VERMA (11933) (Previously 11475)	Early Detection of Hematologic Malignancies in New York City Firefighters Exposed To World Trade Center Dust After The 9/11 Attacks	ALBERT EINSTEIN COLLEGE OF MEDICINE, INC	FY 17	3 years	Responders	Completed	2
Cancer	DIEFENBACH (11690)	Informed/Shared Decision Making for Prostate Cancer Screening Among Members of the World Trade Center Health Program	FEINSTEIN INSTITUTE FOR MEDICAL RESEARCH	FY 18	3 years	Responders	Completed	0
Cancer	SIGEL (11479)	Optimizing Lung Cancer Screening in World Trade Center Rescue and Recovery Workers	ICAHN SCHOOL OF MEDICINE AT MOUNT SINAI	FY 18	3 years	Responders	Completed	1
Cancer	TAIOLI (11704)	World Trade Center Tissue Biobank	ICAHN SCHOOL OF MEDICINE AT MOUNT SINAI	FY 18	3 years	Responders	Active	1
Cancer	ZEIG-OWENS (11931) (Previously 11681)	Detection and Incidence of Thyroid Cancer among Three Cohorts of WTC Exposed Rescue and Recovery Workers	ALBERT EINSTEIN COL OF MED YESHIVA UNIV	FY 18	2 years	Responders	Completed	3
Cancer	TAIOLI (11849)	Thyroid cancer aggressiveness in WTC responders	ICAHN SCHOOL OF MEDICINE AT MOUNT SINAI	FY 19	2 years	Responders	Active	1
Cancer	ZEIG-OWENS (11869)	Myeloma Precursor Disease among WTC responders	ALBERT EINSTEIN COLLEGE OF MEDICINE	FY 20	1 years	Responders	Active	0
Cancer	ARSLAN (12238)	DNA Methylation Profiles and Breast Cancer among WTC Survivors	NEW YORK UNIVERSITY SCHOOL OF MEDICINE	FY 21	2 years	Survivors	Active	1
Cancer	VANGERWIN (12249)	WTC-Related Pollutants in Thyroid Cancer Tissue	ICAHN SCHOOL OF MEDICINE AT MOUNT SINAI	FY 21	2 years	Responders	Active	0
Cancer	VERMA (12271)	Early Detection of Clonal Hematopoiesis and Leukemia Associated Mutations in WTC Exposed Firefighters after the 9/11 Attacks	ALBERT EINSTEIN COLLEGE OF MEDICINE (BRONX, NY)	FY 21	3 years	Responders	Active	0
Cardiovascular (CVD)	McLAUGHLIN (39405)	Pulmonary Function Abnormalities, Diastolic Dysfunction and World Trade Center Exposure: Implications for Diagnosis and Treatment	MOUNT SINAI SCHOOL OF MEDICINE	FY 11	3 years	Responders	Completed	1

[1]Registry facilitated recruitment [2]Registry provided de-identified data [3]Registry co-investigator collaboration [4]funded by the National Institute on Aging (NIA)

Study Focus	Principal Investigator (Project Number)	Title	Institution	Year Initiated	Project Duration (Years)	WTC Population Studied	Status	# Publications
Cardiovascular (CVD)	MORABIA (41826)	Cardiovascular Health Impact and Prediction of Incident (primary and subsequent) Cardiovascular Events among WTC Responders	CITY UNIVERSITY OF NEW YORK QUEENS (CUNY-QUEENS)	FY 11	3 years	Responders	Completed	0
Cardiovascular (CVD)	McLAUGHLIN (10716)	Renal and Cardiovascular Impairment in WTC Responders: Implications for Diagnosis and Treatment	MOUNT SINAI SCHOOL OF MEDICINE	FY 14	2 years	Responders	Completed	0
Cardiovascular (CVD)	MORABIA (10722)	WTC-Heart: A Cohort Study of Heart Diseases in World Trade Center Responders	CITY UNIVERSITY OF NEW YORK QUEENS (CUNY-QUEENS)	FY 14	2 years	Responders	Completed	1
Cardiovascular (CVD)	COHEN (10921)	Role for WTC Dust and DEP Co-pollutant in First Responder Cardiovascular Ailments	NEW YORK UNIVERSITY SCHOOL OF MEDICINE	FY 16	4 years	Other	Completed	4
Cardiovascular (CVD)	JIRAPATNAKUL (12244)	Long-term effects of WTC exposure on respiratory and cardiovascular diseases using automated CT image analysis	ICAHN SCHOOL OF MEDICINE AT MOUNT SINAI	FY 21	2 years	Responders	Active	0
Cardiovascular (CVD)	MORABIA (12265)	Association of PTSD Dose with Cardiovascular Disease Risk in Multi-ethnic WTC Heart Cohort: 13 Year Follow Up	QUEENS COLLEGE	FY 22	4 years	Responders	Active	0
Emerging Conditions	MARMOR (10395)	Trace Elements in Autopsy Tissues from World Trade Center Decedents (2,3)	NEW YORK UNIVERSITY SCHOOL OF MEDICINE	FY 13	2 years	Responders & Survivors	Completed	3
Emerging Conditions	WEBBER (10513)	Post-9/11 Incidence of Systemic Autoimmune Diseases in the FDNY Cohort	ALBERT EINSTEIN COL OF MED YESHIVA UNIV	FY 13	2 years	Responders	Completed	3
Emerging Conditions	KIM (10730)	Assessing the Impacts of Epidemiologic Biases in WTC Health Studies	FEINSTEIN INSTITUTE FOR MEDICAL RESEARCH	FY 14	2 years	Responders	Completed	1
Emerging Conditions	BOFFETTA (10987)	Enhanced Assessment of WTC Exposure and Global DNA Methylation	ICAHN SCHOOL OF MEDICINE AT MOUNT SINAI	FY 15	1 years	Responders	Completed	1
Emerging Conditions	STEIN/LUCCHINI (10988)	Cognitive Function among World Trade Center Rescue and Recovery Workers-Direct Effect or Mediation through Comorbidities	ICAHN SCHOOL OF MEDICINE AT MOUNT SINAI	FY 15	1 years	Responders	Completed	0
Emerging Conditions	FACTOR (11307)	Hepatitis C Virus Infection in WTC Responders	ICAHN SCHOOL OF MEDICINE AT MOUNT SINAI	FY 16	2 years	Responders	Completed	0

[1]Registry facilitated recruitment [2]Registry provided de-identified data [3]Registry co-investigator collaboration [4]funded by the National Institute on Aging (NIA)

Study Focus	Principal Investigator (Project Number)	Title	Institution	Year Initiated	Project Duration (Years)	WTC Population Studied	Status	# Publications
Emerging Conditions	MARMOR (11305)	World Trade Center Exposures, Neuropathic Symptoms and Nervous System Injury	NEW YORK UNIVERSITY SCHOOL OF MEDICINE	FY 16	2 years	Survivors	Completed	1
Emerging Conditions	BOFFETTA (12235) (Previously 11480)	Mortality among WTC Rescue and Recovery Workers (2,3)	ICAHN SCHOOL OF MEDICINE AT MOUNT SINAI	FY 17	4 years	Responders	Active	1
Emerging Conditions	McLAUGHLIN (11326)	Linking the Effects of 9/11 to Kidney Disease	ICAHN SCHOOL OF MEDICINE AT MOUNT SINAI	FY 17	3 years	Responders	Completed	0
Emerging Conditions	TEITELBAUM (11487)	Development and implementation of a comparison occupational cohort for the WTC General Responder Cohort (GRC)	ICAHN SCHOOL OF MEDICINE AT MOUNT SINAI	FY 18	3 years	Responders	Active	0
Emerging Conditions	BOFFETTA (12187) (Previously 12071)	Prevalence of Chronic Hematopoiesis of Indeterminate Potential Among WTC Responders	ICAHN SCHOOL OF MEDICINE AT MOUNT SINAI	FY 20	1 years	Responders	Active	0
Emerging Conditions	HORTON (12075)	Risk and resilience factors for adverse mental and physical health outcomes related to WTC exposure	ICAHN SCHOOL OF MEDICINE AT MOUNT SINAI	FY 20	1 years	Responders	Completed	0
Emerging Conditions	ORNSTEIN (12068)	The Aging Process of WTC Responders: Assessment and Consequences of Frailty	ICAHN SCHOOL OF MEDICINE AT MOUNT SINAI	FY 20	1 years	Responders	Completed	1
Emerging Conditions	WOLD (12056)	Effects of WTC Dust Exposure on Cardiac and Cognitive Functions	OHIO STATE UNIVERSITY	FY 20	1 years	Other	Completed	1
Emerging Conditions	BRANCH (12263)	Evidence of Toxicant-associated Fatty Liver Disease in WTC Responders	ICAHN SCHOOL OF MEDICINE AT MOUNT SINAI (NEW YORK, NY)	FY 21	3 years	Responders	Active	0
Emerging Conditions	MOROZOVA (12275)	Severity and long-term health effects of COVID-19 among World Trade Center responders	STATE UNIVERSITY NEW YORK STONY BROOK (STONY BROOK, NY)	FY 21	5 years	Responders	Active	0
Emerging Conditions	SENAY (12247)	Implementing a Lifestyle Medicine Program via Telehealth to Optimize GERD Management in WTC First Responders	ICAHN SCHOOL OF MEDICINE AT MOUNT SINAI	FY 21	2 years	Responders	Active	0

[1]Registry facilitated recruitment [2]Registry provided de-identified data [3]Registry co-investigator collaboration [4]funded by the National Institute on Aging (NIA)

Study Focus	Principal Investigator (Project Number)	Title	Institution	Year Initiated	Project Duration (Years)	WTC Population Studied	Status	# Publications
Emerging Conditions	COZZA (12485)	Grief and Health-related Quality of Life in WTCHR Survivors: Associations with Bereavement, Trauma Exposures, and Mental and Physical Health Conditions	HENRY M. JACKSON FDN FOR THE ADV MIL/MED	FY 22	3 years	Survivors	Active	0
Emerging Conditions	KO (12473)	Promoting Healthy Aging among WTC Responders: Frailty Trajectories and Intervention Strategies	ICAHN SCHOOL OF MEDICINE AT MOUNT SINAI	FY 22	4 years	Responders	Active	0
Emerging Conditions	SHAO (12486)	Cognitive Decline among WTC Survivors with Chronic Mental and Physical Disorders	NEW YORK UNIVERSITY SCHOOL OF MEDICINE	FY 22	4 years	Survivors	Active	0
Respiratory Disease	BERGER (39413)	Evaluation of Distal Airway Injury Following Exposure to World Trade Center Dust (2,3)	NEW YORK UNIVERSITY SCHOOL OF MEDICINE	FY 11	3 years	Survivors	Completed	9
Respiratory Disease	ALDRICH (10411)	Bronchial Reactivity And The Course of Lung Function after WTC Exposure	ALBERT EINSTEIN COL OF MED YESHIVA UNIV	FY 12	2 years	Responders	Completed	1
Respiratory Disease	DE LA HOZ (10401)	Pulmonary Diseases in WTC Workers: Symptoms, Function, and Chest CT Correlates	MOUNT SINAI SCHOOL OF MEDICINE	FY 12	4 years	Responders	Completed	4
Respiratory Disease	HALL (10412)	For how long is WTC exposure associated with incident airway obstruction	ALBERT EINSTEIN COL OF MED YESHIVA UNIV	FY 12	2 years	Responders	Completed	2
Respiratory Disease	LUFT (10416)	Epigenetic Linkage Between PTSD and Respiratory Disease in WTC Responders	STATE UNIVERSITY NEW YORK STONY BROOK	FY 12	2 years	Responders	Completed	3
Respiratory Disease	SUNDERRAM (10415)	Obstructive Sleep Apnea in WTC Responders: Role of Nasal Pathology	UNIV OF MED/DENT NJ-R W JOHNSON MED SCH	FY 12	4 years	Responders	Completed	7
Respiratory Disease	WISNIVESKY (10405)	Prognosis and Determinants of Asthma Morbidity in World Trade Center Rescue and Recovery Workers	MOUNT SINAI SCHOOL OF MEDICINE	FY 12	4 years	Responders	Completed	5
Respiratory Disease	REIBMAN (10404)	Uncontrolled Lower Respiratory Symptoms in the WTC Survivor Program	NEW YORK UNIVERSITY SCHOOL OF MEDICINE	FY 13	3 years	Survivors	Completed	5

[1]Registry facilitated recruitment [2]Registry provided de-identified data [3]Registry co-investigator collaboration [4]funded by the National Institute on Aging (NIA)

Study Focus	Principal Investigator (Project Number)	Title	Institution	Year Initiated	Project Duration (Years)	WTC Population Studied	Status	# Publications
Respiratory Disease	HALL (10711)	For How Long is WTC Exposure Associated with Chronic Rhinosinusitis	ALBERT EINSTEIN COL OF MED	FY 14	2 years	Responders	Completed	2
Respiratory Disease	LUFT (10718)	Deciphering Biological Linkages between PTSD and Respiratory Disease in WTC Responders	STATE UNIVERSITY NEW YORK STONY BROOK	FY 14	2 years	Responders	Completed	0
Respiratory Disease	WEIDEN (10726)	Evolution of Risk Factors for Sinusitis in WTC Exposed Firefighters	NEW YORK UNIVERSITY SCHOOL OF MEDICINE	FY 14	2 years	Responders	Completed	5
Respiratory Disease	ALDRICH/ SPIVACK (10993)	Clinical characteristics and outcomes of WTC-associated Sarcoidosis	ALBERT EINSTEIN COLLEGE OF MEDICINE	FY 15	1 years	Responders	Completed	2
Respiratory Disease	BERGER (11317)	Small Airway Chronic Obstructive Disease Syndrome Following Exposure to WTC Dust	NEW YORK UNIVERSITY SCHOOL OF MEDICINE	FY 16	3 years	Survivors	Completed	0
Respiratory Disease	WEIDEN (11302)	Evolution of Risk Factors for Lung Function Decline in WTC Exposed Firefighters	NEW YORK UNIVERSITY SCHOOL OF MEDICINE	FY 16	3 years	Responders	Completed	5
Respiratory Disease	WISNIVESKY (11312)	Assessing Inflammatory and Behavioral Pathways Linking PTSD to Increased Asthma Morbidity in WTC Workers	ICAHN SCHOOL OF MEDICINE AT MOUNT SINAI	FY 16	5 years	Responders	Active	2
Respiratory Disease	DE LA HOZ (10401-05)	Pulmonary Diseases in WTC Workers: Symptoms, Function, and Chest CT Correlates	ICAHN SCHOOL OF MEDICINE AT MOUNT SINAI	FY 17	4 years	Responders	Active	0
Respiratory Disease	NOLAN (11300)	Metabolomics of World Trade Center-Lung Injury: Biomarker Validation, Longitudinal Assessment and Dietary Intervention	NEW YORK UNIVERSITY SCHOOL OF MEDICINE	FY 17	4 years	Responders	Completed	19
Respiratory Disease	AYAPPA (11481)	Exploring Mechanisms of Obstructive Sleep Apnea (OSA) in WTC Responders	ICAHN SCHOOL OF MEDICINE AT MOUNT SINAI	FY 18	3 years	Responders	Completed	1
Respiratory Disease	DE LA HOZ (11697)	Chronic Obstructive Pulmonary Disease in WTC Workers - Diagnoses and Transitions	ICAHN SCHOOL OF MEDICINE AT MOUNT SINAI	FY 18	3 years	Responders	Completed	2
Respiratory Disease	WEIDEN (11682)	Treatment response of WTC related airway injury	NEW YORK UNIVERSITY SCHOOL OF MEDICINE	FY 19	2 years	Responders	Active	2

[1]Registry facilitated recruitment [2]Registry provided de-identified data [3]Registry co-investigator collaboration [4]funded by the National Institute on Aging (NIA)

Study Focus	Principal Investigator (Project Number)	Title	Institution	Year Initiated	Project Duration (Years)	WTC Population Studied	Status	# Publications
Respiratory Disease	CAMERON (12054)	Validation of non-electrophile Nrf2 activators for WTC relevant pulmonary indications	SCRIPPS FLORIDA	FY 20	1 years	Other	Completed	0
Respiratory Disease	NOLAN (11855)	World Trade Center Particulate Matter Induced Cardiorespiratory and Vascular Dysfunction: a MultiOmic Approach	NEW YORK UNIVERSITY SCHOOL OF MEDICINE (NEW YORK, NY)	FY 21	5 years	Responders	Active	0
Respiratory Disease	NOLAN (12069)	Aerodigestive Disease in the World Trade Center Exposed FDNY Cohort: Validation of Biomarkers and Defining Risk to Tailor Therapy	NEW YORK UNIVERSITY SCHOOL OF MEDICINE (NEW YORK, NY)	FY 21	3 years	Responders	Active	0
Respiratory Disease	SUNDERRAM (12072)	Obstructive Sleep Apnea and WTC dust: Does Chronic Intermittent Hypoxia exacerbate WTC dust induced lung injury	RBHS-ROBERT WOOD JOHNSON MEDICAL SCHOOL (PISCATAWAY, NJ)	FY 21	3 years	Other	Active	0
Respiratory Disease	THANIK (12253)	An Innovative Approach to Improving Asthma Control for World Trade Center Rescue and Recovery Workers through Telehealth Enriched Asthma Management (WTC-TEAM)	ICAHN SCHOOL OF MEDICINE AT MOUNT SINAI	FY 21	2 years	Responders	Active	0
Respiratory Disease	DE LA HOZ (10401-09)	Pulmonary Diseases in WTC Workers: Symptoms, Function, and Chest CT Correlates	ICAHN SCHOOL OF MEDICINE AT MOUNT SINAI	FY 22	4 years	Responders	Active	0
Respiratory Disease	NOLAN (11300-05)	Metabolomics of World Trade Center-Lung Injury: Biomarker Validation, Longitudinal Assessment and Dietary Intervention	NEW YORK UNIVERSITY SCHOOL OF MEDICINE	FY 22	4 years	Responders	Active	0
WTC Youth	TRASANDE (10394)	Early Identification of World Trade Center Conditions in Adolescents (1,2)	NEW YORK UNIVERSITY SCHOOL OF MEDICINE	FY 13	3 years	Survivors (Youth)	Completed	3
WTC Youth	HOVEN (10721)	Context and Ethnic Diversity: Children's Responses to 9/11	NEW YORK STATE PSYCHIATRIC INSTITUTE	FY 15	1 years	Survivors (Youth)	Completed	5
WTC Youth	TRASANDE (10714)	Childhood Exposure to Persistent Organic Pollutants in the World Trade Center and Cardiovascular Consequences	NEW YORK UNIVERSITY SCHOOL OF MEDICINE	FY 15	1 years	Survivors (Youth)	Completed	3
WTC Youth	HOVEN (11308)	9/11 Trauma and Toxicity in Childhood: Longitudinal Health and Behavioral Outcomes	NEW YORK STATE PSYCHIATRIC INSTITUTE	FY 16	5 years	Survivors (Youth)	Active	0

[1]Registry facilitated recruitment [2]Registry provided de-identified data [3]Registry co-investigator collaboration [4]funded by the National Institute on Aging (NIA)

Study Focus	Principal Investigator (Project Number)	Title	Institution	Year Initiated	Project Duration (Years)	WTC Population Studied	Status	# Publications
WTC Youth	HOVEN (11327)	Research Domain Criteria (RDoC) Domains Underlying Emotional Health and Trajectories of Psychopathology in Families of WTC First Responders and Evacuees: A Genome-Wide Gene Environment Interaction (Gx E) Study	NEW YORK STATE PSYCHIATRIC INSTITUTE	FY 16	5 years	Survivors (Youth)	Active	0
WTC Youth	TRASANDE (11299)	Prenatal WTC Chemical Exposures, Birth Outcomes and Cardiometabolic Risks	NEW YORK UNIVERSITY SCHOOL OF MEDICINE	FY 17	4 years	Survivors (Youth)	Active	4
WTC Youth	CYCOWICZ (11694)	Multimodal Neuroimaging of Cognitive and Emotional Networks in Young Adults Exposed to 9/11 as Children	NEW YORK STATE PSYCHIATRIC INSTITUTE	FY 18	3 years	Survivors (Youth)	Active	0
WTC Youth	HOVEN (12264)	Longitudinal Follow-Up of 9/11 Directly Exposed Children in their Age of Transition: Independence, Occupation and Morbidity	NEW YORK STATE PSYCHIATRIC INSTITUTE (NEW YORK, NY)	FY 21	5 years	Survivors (Youth)	Active	0
WTC Youth	HOVEN (12264)	Longitudinal Follow-Up of 9/11 Directly Exposed Children in their Age of Transition: Independence, Occupation and Morbidity	NEW YORK STATE PSYCHIATRIC INSTITUTE (NEW YORK, NY)	FY 21	5 years	Survivors (Youth)	Active	0
WTC Youth	HERBSTMAN (12472)	Exposomic Approach to Identifying WTC Exposures and Effects in Survivor Youth	COLUMBIA UNIVERSITY HEALTH SCIENCES	FY 22	4 years	Survivors (Youth)	Active	0
WTC Youth	HERBSTMAN (12472)	Exposomic Approach to Identifying WTC Exposures and Effects in Survivor Youth	COLUMBIA UNIVERSITY HEALTH SCIENCES	FY 22	4 years	WTC Youth	Active	0

[1]Registry facilitated recruitment [2]Registry provided de-identified data [3]Registry co-investigator collaboration [4]funded by the National Institute on Aging (NIA)

WTC Health Program Research Portfolio Study Descriptions

WTC Health Program Research Contracts Awarded in FY 2011

Pulmonary Function Abnormalities, Diastolic Dysfunction and World Trade Center Exposure: Implications for Diagnosis and Treatment

CONTRACT NUMBER: 200-2011-39405

INSTITUTION: Icahn School of Medicine at Mount Sinai

PRINCIPAL INVESTIGATOR: Maryann McLaughlin, *MD, MPH*

PHONE NUMBER: *(866) 537-7107*

EMAIL: *CYNARA.MACEDA@MSSM.EDU*

PROJECT DURATION: 3 years (Project Completed)

DESCRIPTION: The present proposal seeks to determine the significance of the long-term effect of particulate matter (PM) on pulmonary and cardiovascular risk, and to fully evaluate the relationship between PM exposure, pulmonary function, and cardiovascular health. We will evaluate the clinical and pathophysiologic outcomes of exposure including pulmonary function abnormalities, obstructive sleep apnea, imaging abnormalities, and risk factors for cardiopulmonary disease. This study will provide critical information regarding risk of exposure to PM, risk factors for disease and potential for improvements in diagnosis and treatment.

Burden of Mental-Physical Comorbidity in World Trade Center Responders

CONTRACT NUMBER: 200-2011-39410

INSTITUTION: State University of New York at Stony Brook

PRINCIPAL INVESTIGATOR: Evelyn Bromet, *PhD*

PHONE NUMBER: *(631) 632-8853*

EMAIL: *EVELYN.BROMET@STONYBROOK.EDU*

PROJECT DURATION: 3 years (Project Completed)

DESCRIPTION: The study objective is to test mechanisms thought to be responsible for the comorbidity between psychiatric and medical sequelae of WTC exposures. We propose to study responders participating in the WTC Health Program. Of the entire cohort, approximately 16,000 completed the first two monitoring visits, about two years apart. In addition to routine questionnaires completed by responders at their

monitoring visits, we conduct standard interviews designed to diagnose WTC-related PTSD. The longitudinal data will allow us to evaluate potential mechanisms underlying the links between mental and physical disorders.

Evaluation of Distal Airway Injury Following Exposure to World Trade Center Dust

CONTRACT NUMBER: 200-2011-39413

INSTITUTION: New York University School of Medicine

PRINCIPAL INVESTIGATOR: Kenneth Berger, MD

PHONE NUMBER: (212) 263-6407, (212) 562-3752

EMAIL: *KENNETH.BERGER@NYUMC.ORG*

PROJECT DURATION: 3 years (Project Completed)

DESCRIPTION: The goal of the present proposal is to enhance characterization of WTC-related lung disease using lung function measurements that can detect lung injury in addition to abnormalities identified in standard spirometry. The proposed studies are based on the concept that spirometry may identify airway injury as a reduction in lung volume or air flow; however, spirometry can often be normal even in symptomatic patients, particularly when injury is located in the distal airways.

Cohort Studies of Incident Cancers in the FDNY WTC Responder Population

CONTRACT NUMBER: 200-2011-39489

INSTITUTION: Fire Department of New York

PRINCIPAL INVESTIGATOR: David Prezant, MD

PHONE NUMBER: (718) 999-2696

EMAIL: *PREZAND@FDNY.NYC.GOV*

PROJECT DURATION: 3 years (Project Completed)

DESCRIPTION: The main objective of this three-year research project is to analyze the cohorts of FDNY firefighters and EMS workers, both WTC-exposed and non-WTC exposed in order to compare cancer incidence by WTC-exposure status during the early post-9/11 years. To achieve this objective, we intend to conduct longitudinal surveillance of cancer diagnoses in WTC-exposed and non-WTC-exposed individuals through 2008 and later, as data become available.

Trajectories of Psychological Risk and Resilience in World Trade Center Responders

CONTRACT NUMBER: 200-2011-41919

INSTITUTIONS: Icahn School of Medicine at Mount Sinai School of Medicine and the Yale School of Medicine

PRINCIPAL INVESTIGATORS: **Adriana Feder, *MD*, Robert Pietrzak, *PhD*, Steven Southwick, *MD***

PHONE NUMBER: (212) 659-9145

EMAIL: *ADRIANA.FEDER@MSSM.EDU*

PROJECT DURATION: 3 years *(Project Completed)*

DESCRIPTION: The objectives of this study are to (1) characterize longitudinal trajectories of WTC-related PTSD and depressive symptoms in WTC responders; (2) examine specific risk and protective determinants of these trajectories; and (3) identify personal and psychosocial factors associated with resilience and recovery trajectories, with the ultimate goal of maximizing preparedness and improving mental health outcomes in disaster responders. The study shall make use of the unique dataset collected prospectively at the WTC Health Program, beginning in 2002, to study longitudinal trajectories of WTC-related PTSD and depressive symptoms in 10,800 cohort members who completed three monitoring visits at the WTC Health Program, each approximately two years apart.

Enhanced Smoking Cessation for WTC Responders

CONTRACT NUMBER: 200-2011-42057

INSTITUTION: State University of New York at Stony Brook

PRINCIPAL INVESTIGATOR: **Evelyn Bromet,** ***PhD***

PHONE NUMBER: *(631) 632-8853*

EMAIL: *EVELYN.BROMET@STONYBROOK.EDU*

PROJECT DURATION: 3 years (Project Completed)

DESCRIPTION: The objective of this study is to adapt and test an enhanced smoking cessation treatment for WTC responders burdened with PTSD symptoms. We will recruit 100 smokers who have significant PTSD symptoms from the population monitored at the Long Island site of the WTC Health Program and other responders in the New York metropolitan area with PTSD symptoms. We will over-sample patients with lower respiratory illness to ensure that at least two-thirds have these symptoms. Participants are randomly assigned to either: (1) standard smoking cessation or (2) enhanced smoking cessation that addresses PTSD and other anxiety symptoms. Nicotine replacement therapy is administered to both groups.

Cancer among WTC Responders: Enhanced Surveillance, Exposure Assessment, and Cancer-Specific Risks

CONTRACT NUMBER: 200-2011-41815

INSTITUTION: Icahn School of Medicine at Mount Sinai

PRINCIPAL INVESTIGATOR: **Paolo Boffetta,** ***MD***

PHONE NUMBER: (212) 659-1474

EMAIL: *PAOLO.BOFFETTA@MSSM.EDU*

PROJECT DURATION: 3 years (Project Completed)

DESCRIPTION: The overarching objective of the project is to define whether WTC responders included in the WTC Health Program experienced an increased risk of

cancer, and whether or not such increase can be associated with WTC-related exposures. The specific aims of the project are to: 1) identify and confirm all cases of cancer occurring among WTC responders included in WTC Health Program, using multiple sources of information and developing algorithms for confirmation of cancer diagnosis; 2) develop and apply an exposure assessment procedure to estimate ERIs for selected known and suspected carcinogens for all WTC Health Program responders, and to conduct a systematic analysis of exposure-cancer associations, based on ERIs; and 3) conduct in-depth analyses of exposure-cancer associations.

Cardiovascular Health Impact and Prediction of Incident (Primary and Subsequent) Cardiovascular Events

CONTRACT NUMBER: 200-2011-41826

INSTITUTION: Center for the Biology of Natural Systems (CBNS) CUNY-Queens College

PRINCIPAL INVESTIGATOR: **Alfredo Morabia,** ***MD***

PHONE NUMBER: ***(718) 670-4182***

EMAIL: ***ALFREDO.MORABIA@QC.CUNY.EDU***

PROJECT DURATION: 3 years (Project Completed)

DESCRIPTION: This cohort study will assess the conventional CVD determinants, 9/11-related dust exposure, and PTSD, of 6,503 participants (of the Mt. Sinai and Northwell Health WTC Health Program) recruited between January 2012, and June 2013. We will follow the cohort for incident CVD during the subsequent two years, 2013 and 2014. Cardiovascular risk has been obtained from questionnaires and clinical exams. The on-going follow-up will track all incident events over two years by direct contact with the participants. Validation of events will be performed by obtaining hospital discharge and outpatient medical records, patient electronic databases (SPARCS), and death certificates. In addition to its direct relevance for the health surveillance of WTC workers, this project will accrue new knowledge on the long-term effects of a major environmental disaster on the cardiovascular health of rescue, recovery, and clean-up workers.

WTC Health Program Research Cooperative Agreements Awarded in FY 2012

Health and Socioeconomic Sequelae of the WTC Disaster Among Responders

PROJECT NUMBER: U01 OH010399

INSTITUTION: Northwell Health

PRINCIPAL INVESTIGATOR: **Hyun Kim,** ***ScD***

PHONE NUMBER: ***(516) 465-2517***

EMAIL: ***HKIM8@NSHS.EDU***

PROJECT DURATION: Two years (Project Completed)

DESCRIPTION: This study will comprehensively describe the overall physical, mental,

and socioeconomic impact of the WTC disaster on responders, as well as identify the linkage between socioeconomic sequelae and health among WTC responders.

RESULTS:from this study have the potential to make a significant public health impact through the identification of new diseases and high-risk groups within the WTC cohort, and aid future development of new guidelines for the implementation of an occupational health surveillance system for disasters, which is essential for disaster preparedness

Pulmonary Diseases in WTC Workers: Symptoms, Function, and Chest CT Correlates

PROJECT NUMBER: U01 OH010401

INSTITUTION: Icahn School of Medicine at Mount Sinai

PRINCIPAL INVESTIGATOR: **Rafael E. de la Hoz, *MD***

PHONE NUMBER: ***(212) 241-8871***

EMAIL: ***LILLIAM.MEDINA@MSSM.EDU***

PROJECT DURATION: Four years (Project Completed)

DESCRIPTION: The overall goal of this study is to identify the early manifestations of lung disease among the WTC workers and volunteers, as well as investigate their risk factors. The study team will perform standardized and computer-assisted readings of all chest CT scans received by WTC workers and volunteers at the Mount Sinai Medical Center since January 2003; assess the findings in a systematic way; evaluate the correlation of findings with clinical, functional, and exposure indicators; and develop a protocol for continued radiological surveillance of this cohort.

Prognosis and Determinants of Asthma Morbidity in WTC Rescue and Recovery Workers

PROJECT NUMBER: U01 OH010405

INSTITUTION: Icahn School of Medicine at Mount Sinai

PRINCIPAL INVESTIGATOR: **Juan Wisnivesky, *MD, DrPH***

PHONE NUMBER: (212) 824-7567

EMAIL: ***JUAN.WISNIVESKY@MSSM.EDU***

PROJECT DURATION: Four years (Project Completed)

DESCRIPTION: Asthma is a common illness among WTC workers (nine-year cumulative incidence is about 28%) and is responsible for a high rate of morbidity and diminished quality of life in this population. However, there is limited data regarding the natural history or factors that contribute to asthma morbidity among WTC workers.

THE OBJECTIVE OF THIS STUDY: is to examine the natural history, self-management, and impact of physical and mental health comorbidities on asthma morbidity among WTC rescue and recovery workers.

Biomarkers of Psychological Risk and Resilience in World Trade Center Responders

PROJECT NUMBER: U01 OH010407

INSTITUTION: Icahn School of Medicine at Mount Sinai

PRINCIPAL INVESTIGATORS: Adriana Feder, MD; Robert Pietrzak, PhD; Steven Southwick, MD

PHONE NUMBER: (212) 659-9145

EMAIL: *ADRIANA.FEDER@MSSM.EDU*

PROJECT DURATION: Four years (Project Completed)

DESCRIPTION: This study will employ a multi-level approach to study clinical, psychosocial, neuroendocrine, genotypic, gene-environment interaction, and molecular factors associated with PTSD risk and resilience in a sample of 500 WTC responders. The study will provide important information about the risk and resilience factors for PTSD in disaster responders and make possible the development of improved preventive and treatment interventions for this disorder in disaster responders and trauma-exposed individuals in general.

Bronchial Reactivity and the Course of Lung Function

PROJECT NUMBER: U01 OH010411

INSTITUTION: Albert Einstein College of Medicine

PRINCIPAL INVESTIGATOR: **Thomas Aldrich, *MD***

PHONE NUMBER: ***(718) 999-0734*** (office)

EMAIL: *RACHEL.ZEIG-OWENS@FDNY.NYC.GOV*

PROJECT DURATION: Two years (Project Completed)

DESCRIPTION: Persistent obstructive airways disease (an asthma-like condition) is common among WTC exposed firefighters, though rare in this population before September 11, 2001. In about 30%, there is accompanying bronchial hyperreactivity (easily triggered airway narrowing). This study will re-examine a large number of firefighters who had bronchial reactivity soon after 9/11 to determine whether those with bronchial hyper-reactivity at onset have persistent hyperactivity more than ten years later, whether they have accelerated lung function decline, and whether those treated with anti-asthma medications were more likely to show resolution of bronchial hyperactivity and/or show less rapid decline in lung function.

For How Long is WTC Exposure Associated with Incident Airway Obstruction

PROJECT NUMBER: U01 OH010412

INSTITUTION: Albert Einstein College of Medicine

PRINCIPAL INVESTIGATOR: **Charles Hall, *PhD***

PHONE NUMBER: ***(917) 974-4009***

EMAIL: *CHARLES.HALL@EINSTEIN.YU.EDU*

PROJECT DURATION: Two years (Project Completed)

DESCRIPTION: The study uses innovative statistical methods (parametric survival models with change points) to study the incidence of new onset OAD diagnoses and symptoms over the first ten years following WTC exposure, with the goal of determining the length of time that exposure response gradients are observed among exposed FDNY firefighters. This study will allow estimation of the length of time that a relatively short-term, high intensity exposure may be associated with incident respiratory illness.

Service Need and Use Among Youth Exposed to the WTC Attack

PROJECT NUMBER: U01 OH010413

INSTITUTION: New York State Psychiatric Institute at Columbia University

PRINCIPAL INVESTIGATOR: **Christina W. Hoven**, ***DrPH, MPH***

PHONE NUMBER: ***(646) 774-5800***

EMAIL: ***CH42@COLUMBIA.EDU***

PROJECT DURATION: Two years ((Project Completed)

DESCRIPTION: This study will examine patterns of mental health service utilization, barriers to mental health treatment services, and the factors associated with such use by youth who were exposed to the WTC attack. The study findings will provide guidance to the improvement of mental health intervention for these youth and will help in preparedness efforts for future terrorist attacks.

The Impact of 9/11 on Youth: Mental Health, Substance Use & Other Risk Behaviors

PROJECT NUMBER: U01 OH010414

INSTITUTION: New York State Psychiatric Institute at Columbia University

PRINCIPAL INVESTIGATOR: **Christina W. Hoven**, ***DrPH, MPH***

PHONE NUMBER: ***(646) 774-5800***

EMAIL: ***CH42@COLUMBIA.EDU***

PROJECT DURATION: Four years (Project Completed)

DESCRIPTION: Worldwide Public Health concern about disaster and its long-term consequences on mental health remains an important but inadequately addressed issue. This study examines the mental health, substance use and other risky behaviors, among children directly exposed to the 9/11 attack—current ages 12-24. The study is designed to obtain an-in depth assessment of these adolescents' and emerging adults' current level of need, with the intention of facilitating treatment, diagnosis and intervention, as well as to inform public policy.

Obstructive Sleep Apnea in WTC Responders; Role of Nasal Pathology

PROJECT NUMBER: U01 OH010415

INSTITUTION: Robert Wood Johnson Medical School at Rutgers University and NYU

School of Medicine

PRINCIPAL INVESTIGATORS: **Jag Sunderram,*MD*** and **Indu Ayappa, *PhD***

PHONE NUMBER: ***(732) 235-7038***

EMAIL: ***SUNDERJA@RWJMS.RUTGERS.EDU***

PROJECT DURATION: Four years (Project Completed)

DESCRIPTION: Obstructive sleep apnea (OSA) is a highly prevalent disorder with significant morbidity and impact on quality of life that can be improved by treatment with CPAP. This study will examine the role of nasal pathology in WTC responders in the development of OSA and its impact on their ability to use CPAP. The present study contributes to understanding the relationship of nasal /upper airway mechanisms to the development of sleep apnea in this population and explores the possibility of improving comfort and adherence to CPAP treatment by modifying how CPAP is delivered.

Epigenetic Linkage between PTSD and Respiratory Disease in WTC Responders

PROJECT NUMBER: U01 OH010416

INSTITUTION: State University of New York at Stony Brook

PRINCIPAL INVESTIGATOR: ***Benjamin Luft, MD***

PHONE NUMBER: ***(631) 855-1200***

EMAIL: ***BENJAMIN.LUFT@STONYBROOKMEDICINE.EDU***

PROJECT DURATION: Two years (Project Completed)

DESCRIPTION: WTC disaster responders exhibit persistent symptoms of PTSD and respiratory illness linked to the severity of their exposures. One-quarter of responders affected by these conditions suffer from both, resulting in increased disability and utilization of medical services. This study will examine the potential mechanisms underlying PTSD/respiratory co-morbidity that may facilitate the development of more effective, theory-driven interventions for these difficult to treat patients.

Extension of the World Trade Center Health Registry

PROJECT NUMBER: U50-OH009739

INSTITUTION: New York City Department of Health and Mental Hygiene

PRINCIPAL INVESTIGATOR: **Mark Farfel, *ScD***

PHONE NUMBER: ***(646) 632-6649***

EMAIL: ***MFARFEL@HEALTH.NYC.GOV***

PROJECT DURATION: Four years (Project Completed)

DESCRIPTION: During the funding period, Registry staff will conduct priority epidemiological analyses using data from the Wave 1 (2003-04), Wave 2 (2006-08), and Wave 3 (2011-12) surveys, including analyses to assess risk factors for the development or persistence of serious respiratory and mental health conditions over time. A Wave 4 survey will be conducted using multiple survey modes to ascertain the health status and 9/11-related healthcare needs of the cohort 13-14 years after 9/11. The Registry

will also extend the assessment of cancer and mortality incidence through 10 years post-9/11, investigate potential emerging health conditions through public health surveillance and follow-up studies (including collaborations with the WTC Health Program and other external researchers), and continue outreach to encourage enrollees to access monitoring and treatment through the WTC Health ProgramWTC Health Program

Research Cooperative Agreements Awarded in FY 2013

Early Identification of World Trade Center Conditions in Adolescents

PROJECT NUMBER: U01 OH010394

INSTITUTION: New York University School of Medicine

PRINCIPAL INVESTIGATOR: **Leonardo Trasande, *MD, MPP***

PHONE NUMBER: (646) 501-2520

EMAIL: ***LEONARDO.TRASANDE@NYUMC.ORG***

PROJECT DURATION: Three years (Project Completed)

DESCRIPTION: This study builds on preliminary studies in self-selected populations to identify opportunities for early identification of WTC-related health consequences in adolescents. If adverse health consequences are identified, proactive cardiometabolic and pulmonary screening of exposed children may be indicated, with targeted interventions intended to prevent development of chronic obstructive pulmonary disease, and adverse cardiometabolic outcomes in adulthood.

Trace Elements in Autopsy Tissue from World Trade Center Decedents

PROJECT NUMBER: U01 OH010395

INSTITUTION: New York University School of Medicine

PRINCIPAL INVESTIGATOR: **Michael Marmor, *PhD***

PHONE NUMBER: ***(212) 263-6667***

EMAIL: ***MICHAEL.MARMOR@NYUMC.ORG***

PROJECT DURATION: Two years (Project Completed)

DESCRIPTION: This study will determine if WTC-related trace elements can be identified in tissues of individuals at their times of death in 2007–2012. If signature trace elements can be identified, this project will lay the foundation for future development of biomarkers indicative of cumulative exposure to WTC contaminants among living individuals. Biomarkers reflective of WTC exposures would be of value to research on the health effects of WTC exposures among first responders, residents and workers, including members of the WTC Health Program. They would also be helpful for the investigation and attribution of diseases among WTC-exposed individuals and may aid in the treatment of WTC-associated diseases.

Prostate Cancer Risk and Outcome in WTC Respondents

PROJECT NUMBER: U01 OH010396

INSTITUTION: Icahn School of Medicine at Mount Sinai

PRINCIPAL INVESTIGATOR: **Emanuela Taioli,** ***MD, PhD***

PHONE NUMBER: ***(516) 465-3093***

EMAIL: ***EMANUELA.TAIOLI@MSSM.EDU***

PROJECT DURATION: Two years (Project Completed)

DESCRIPTION: This study represents the first in-depth analysis of prostate cancer among WTC rescue and recovery workers. The study results will have practical implications on the surveillance and clinical management of prostate cancer, which is the most common cancer among male WTC Health Program members. The study will generate novel data on biomarkers of prostate cancer aggressiveness that could be used to make decisions on clinical treatment.

Uncontrolled Lower Respiratory Symptoms in the WTC Survivor Program

PROJECT NUMBER: U01 OH010404

INSTITUTION: New York University School of Medicine

PRINCIPAL INVESTIGATOR: **Joan Reibman,** ***MD***

PHONE NUMBER: (212) 263-6479

EMAIL: ***JOAN.REIBMAN@NYUMC.ORG***

PROJECT DURATION: Three years (Project Completed)

DESCRIPTION: Many "survivors" (community members) in the WTC clinical treatment program have persistent LRS, despite treatment. This study will test the hypothesis that patients with uncontrolled LRS have (despite aggressive medical therapy) increased rates of abnormal airway physiology, airway inflammation and co-morbid conditions when compared to those with controlled symptoms. Identifying these mechanisms for uncontrolled LRS is imperative to guide therapy with the important potential to reduce secondary adverse health outcomes.

Post-9/11 Incidence of Systemic Autoimmune Diseases in the FDNY Cohort

PROJECT NUMBER: U01 OH010513

INSTITUTION: Albert Einstein College of Medicine

PRINCIPAL INVESTIGATOR: **Mayris Webber,** ***DrPH***

PHONE NUMBER: ***(718) 999-2665***

EMAIL: ***WEBBERM@FDNY.NYC.GOV***

PROJECT DURATION: Two years (Project Completed)

DESCRIPTION: The overall goal of this two-year study is to calculate in 21,786 WTC-exposed and unexposed firefighters and emergency medical service workers and to estimate the association between intense WTC exposure and SAID. If results suggest that SAID are increased in relation

to WTC exposure, FDNY and other centers of excellence could then incorporate active case finding into routine monitoring visits, facilitating early detection and treatment, which has been shown to reduce end-organ damage and improve quality of life.

Mind-Body Treatment for WTC Responders with Comorbid PTSD and Respiratory Illness

PROJECT NUMBER: U01 OH010524

INSTITUTION: State University of New York at Stony Brook

PRINCIPAL INVESTIGATOR: Adam Gonzalez, PhD

PHONE NUMBER: *(631) 855-1233*

EMAIL: *ADAM.GONZALEZ@STONYBROOK.EDU*

PROJECT DURATION: Three years (Project Completed)

DESCRIPTION: Comorbid PTSD and respiratory illness continue to burden WTC responders over a decade post disaster, despite pharmaceutical and psychotherapeutic treatment efforts. Mind-body treatments have demonstrated promise for reducing both PTSD and respiratory symptoms, and potential biological markers underlying these conditions; however no RCT has evaluated this treatment approach among patients with comorbid PTSD and respiratory illness. This study will be the first RCT to evaluate a novel mind-body treatment among WTC responders with these comorbidities and could have important implications for health care costs, quality of life and functioning, morbidity and possibly mortality.

WTC Health Program Research Cooperative Agreements Awarded in FY 2014

Biorepository of Cancer Tissue Samples from WTC Responders

PROJECT NUMBER: U01 OH010512

INSTITUTION: Feinstein Institute for Medical Research

PRINCIPAL INVESTIGATOR: **Emanuela Taioli,** ***MD, PhD***

PHONE NUMBER: *(516) 465-3093*

EMAIL: *ETAIOLI@NSHS.EDU*

PROJECT DURATION: Two years (Project Completed)

DESCRIPTION: The current project aims to establish a biorepository of cancer tissue samples from WTC responders. This biorepository will consolidate tissue samples from all those in the WTC cohort that consent to participate. These samples will be stored in a centralized location, de-identified, and cataloged. This will allow for future research into WTC-specific mechanisms involved in cancer development, and will result in improved treatment options for WTC responders. Procedures will be implemented to review and grant/deny requests for use of samples in biomedical research based on a rigorous review.

Mental Health Impact and Service Use among Asian Survivors and Rescuers Exposed to the WTC Attack

PROJECT NUMBER: U01 OH010516

INSTITUTION: Fordham University

PRINCIPAL INVESTIGATOR: **Winnie Kung, *PhD***

PHONE NUMBER: ***(347) 239-1717***

EMAIL: ***KUNG@FORDHAM.EDU***

PROJECT DURATION: Two years (Project Completed)

DESCRIPTION: This study attempts to assess the short-, medium-, and long-term mental health impact of the WTC attack on Asian Americans. The course of the psychological distress and its related risk factors will be explored, and the pattern is compared to that of whites. It also examines Asians' mental health service use patterns and the facilitating factors and barriers to help seeking. It has important policy implications in improving treatment access to this sizable but understudied subgroup affected by the attack, which has a history of being the lowest mental health service users compared to other races.

For How Long is the WTC Exposure Associated with Chronic Rhinosinusitis

PROJECT NUMBER: U01 OH010711

INSTITUTION: Albert Einstein College of Medicine

PRINCIPAL INVESTIGATOR: **Charles B. Hall, *PhD***

PHONE NUMBER: (917) 803-5470

EMAIL: ***CHARLES.HALL@EINSTEIN.YU.EDU***

PROJECT DURATION: Two years (Project Completed)

DESCRIPTION: This study will use innovative statistical methods to examine the temporal patterns in the association between the effects of rescue/recovery work at the WTC by FDNY firefighters on the incidence of physician-diagnosed CRS and on self-reported persistent rhinosinusitis symptoms. Specifically, we will use parametric survival models with change points to determine whether the exposure-response relationship persists for years after exposure or becomes attenuated after some time.

The Daily Burden of PTSD and Respiratory Problems in World Trade Center Responders

PROJECT NUMBER: U01 OH010712

INSTITUTION: State University of New York at Stony Brook

PRINCIPAL INVESTIGATOR: **Roman Kotov, *PhD***

PHONE NUMBER: ***(631) 632-7763***

EMAIL: ***ROMAN.KOTOV@STONYBROOK.EDU***

PROJECT DURATION: Two years (Project Completed)

DESCRIPTION: Comorbid PTSD and LRS are

among the most common and persistent health burdens faced by WTC responders following the attacks on 9/11. For the first time, the proposed study will use ecological momentary assessment approach to survey WTC responders in real time about the prevalence, burden and the sequence of PTSD and LRS, and to test biological processes involved.

Renal and Cardiovascular Impairment in WTC Responders: Implications for Diagnosis and Treatment

CONTRACT NUMBER: U01 OH010716

INSTITUTION: Icahn School of Medicine at Mount Sinai

PRINCIPAL INVESTIGATOR: **Maryann McLaughlin, *MD, MPH***

PHONE NUMBER: ***1-(866) 537-7107***

EMAIL: ***CYNARA.MACEDA@MSSM.EDU***

PROJECT DURATION: Two years *(Project Completed)*

DESCRIPTION: Environmental toxins exert damaging health effects in workers. Volunteers of the WTC rescue and recovery effort following WTC attacks may be at increased risk for worsening health. The goal of this proposal is to quantify the risk of kidney damage among first responders to the WTC attack and determine its relationship to particulate matter exposure. We hypothesize that exposure to inhaled particulate matter causes systemic inflammation and endothelial dysfunction that result in chronic kidney and cardiovascular damage. Knowledge to be gained from this proposal can influence strategies to minimize the risk of chronic kidney and cardiovascular disease among first responders

WTC-Heart: A Cohort Study of Heart Diseases in Word Trade Center Responders

PROJECT NUMBER: U01 OH010722

INSTITUTION: Center for the Biology of Natural Systems (CBNS) CUNY-Queens College

PRINCIPAL INVESTIGATOR: **Alfredo Morabia, *MD***

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PROJECT DURATION: Two years (Project Completed)

DESCRIPTION: Several research studies indicate that people working or residing near Ground Zero in 2001-2002 are at increased risk of CVD. It is hypothesized that this increased risk is a result of exposure to the dust and gases liberated by the destruction of the twin towers and/or the psychological stress of working in such a dramatic human and environmental disaster. WTC-Heart (n=6,481) is a rigorous cohort study comprised of responders and volunteers recruited at the WTC Health Program. WTC-Heart will provide unique evidence of observed CVD risk and predicted CVD risk in WTC responders to guide the implementation of preventive interventions.

Evolution of Risk Factors for Sinusitis in WTC Exposed Firefighters

PROJECT NUMBER: U01 OH010726

INSTITUTION: New York University School of Medicine

PRINCIPAL INVESTIGATOR: **Michael Weiden,** ***MD***

PHONE NUMBER: (212) 263-6479

EMAIL: ***MICHAEL.WEIDEN@NYUMC.ORG***

PROJECT DURATION: Two years (Project Completed)

DESCRIPTION: Early neutrophil concentrations in blood drawn within 6 months of exposure were a risk factor for progressive sinusitis. Despite treatment, those affected continue to experience morbidity and reduced quality of life, while screening continues to identify new cases. Development of models, using an inexpensive, biomarker (complete blood count or CBC) that predicts disease severity and progression may enable earlier and more aggressive interventions to improve the health of WTC-exposed subjects. This may improve the quality of life of those with high risk of proceeding to sinus surgery. This may also avoid radiation exposure to those at low risk.

Post-9/11 Cancer Incidence in FDNY Firefighters

PROJECT NUMBER: U01 OH010728

INSTITUTION: Albert Einstein College of Medicine

PRINCIPAL INVESTIGATOR: **Mayris Webber,** ***DrPH***

PHONE NUMBER: ***(718) 999-2665***

EMAIL: ***WEBBERM@FDNY.NYC.GOV***

PROJECT DURATION: Two years (Project Completed)

DESCRIPTION: Modest elevations in cancer rates post-exposure to the WTC site have been reported in all three cohorts of rescue/recovery workers. The overarching goal of this proposal is to improve understanding of the association between WTC exposure and cancer risk. We will: 1) Compare cancer rates in WTC-exposed NYC firefighters to rates in non-WTC-exposed firefighters; 2) develop a new exposure measure based on work records and model cancer incidence rates as a function of both time of first arrival at the WTC site and the new duration measure; and, 3) estimate the future cancer burden of WTC-exposed firefighters.

Assessing the Impacts of Epidemiologic Biases in WTC Health Studies

PROJECT NUMBER: U01 OH010730

INSTITUTION: Feinstein Institute for Medical Research

PRINCIPAL INVESTIGATOR: Hyun Kim, ScD

PHONE NUMBER: ***(516) 465-2517***

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PROJECT DURATION: Two years (Project Completed)

DESCRIPTION: The main goal of the proposed study is to assess the impacts of epidemiologic biases in WTC health studies

by identifying the presence of bias and then by quantifying and adjusting for the bias effects. The successful completion of the proposed bias analysis will assist other researchers to draw plausible inference of WTC health effects and other future disaster studies by adjusting for bias.

WTC Health Program Research Cooperative Agreements Awarded in FY 2015

Childhood Exposures to Persistent Organic Pollutants in the World Trade Center Disaster and Cardiovascular Consequences

PROJECT NUMBER: U01 OH010714

INSTITUTION: New York University School of Medicine

PRINCIPAL INVESTIGATOR: Leonardo Trasande, *MD, MPP*

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PROJECT DURATION: 1 year (Project Completed)

DESCRIPTION: The study builds upon a NIOSH-supported study of WTC-exposed adolescents to assess whether persistent organic pollutant exposures are potentially contributors to cardiometabolic conditions in adolescents. If these exposures are associated with cardiometabolic consequences and with reported exposure to the disaster, these findings will enhance understanding of WTC-associated conditions and guide proactive screening and management of future disasters.

A Pilot Test of the Relaxation Response Resiliency Program (3RP) Context and Ethnic Diversity: Children's Responses to 9/11

PROJECT NUMBER: U01 OH0 10721

INSTITUTION: New York State Psychiatric Institute at Columbia University

PRINCIPAL INVESTIGATOR: *Christina W. Hoven, DrPH, MPH*

PHONE NUMBER: *(646) 774-5800*

EMAIL: *CH42@COLUMBIA.EDU*

PROJECT DURATION: 1 year *(Project Completed)*

DESCRIPTION: The Trauma, Context and Outcome (TCO) study will identify the role that race/ethnicity, interacting with family and neighborhood contextual factors, had on the mental health outcomes of youth exposed to 9/11 and will contribute to the NIOSH WTC Health Program. This study will clarify the role that children's context played in determining if they had a resilient, versus an adverse response to 9/11. This understanding is key to the development of improved and targeted prevention and treatment strategies, as well as public policies, for all children exposed to mass trauma, but especially minority populations.

Gene Expression Profiles as Markers of PTSD Risk and Resilience in WTC Responders

PROJECT NUMBER: U01 OH010986

INSTITUTION: Icahn School of Medicine at Mount Sinai

PRINCIPAL INVESTIGATOR: *Adriana Feder, MD*

PHONE NUMBER: (212) 659-9145

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PROJECT DURATION: 1 year (project completed)

DESCRIPTION: PTSD arising in response to the WTC disaster is one of the most prevalent and persistent psychiatric disorders among workers involved in rescue, recovery, and clean-up efforts, even over a decade after 9/11. This study involves a comprehensive, multi-modal, and integrative assessment of biomarkers implicated in the pathophysiology of PTSD, including measuring differences in whole-blood gene expression and other blood biomarkers of key neurobiological systems, an approach critical to informing risk and resilience prediction algorithms for PTSD, and to develop novel psychopharmacologic approaches for the treatment of this disabling condition in disaster responders and other trauma survivors.

Enhanced Assessment of WTC Exposure and Global DNA Methylation

PROJECT NUMBER: U01 OH 010987

INSTITUTION: Icahn School of Medicine at Mount Sinai

PRINCIPAL INVESTIGATOR: **Paolo Boffetta,** *MD*

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EMAIL: *PAOLO.BOFFETTA@MSSM.EDU*

PROJECT DURATION: 1 year (Project Completed)

DESCRIPTION: The project aims at correlating a detailed assessment of exposure of WTC responders enrolled at program at Stony Brook with alterations the mechanism of regulation of DNA called methylation, which may be relevant to cancer risk. The project is expected to contribute to understanding of the possible role of DNA methylation as marker of exposure to carcinogenic exposure among WTC responders. If the results confirm a correlation between WTC exposures, assessed through a high-quality methodology, and altered DNA methylation, they might lead to the development of strategies to identify WTC responders at increased risk of cancer and other chronic diseases.

Cognitive Function among World Trade Center Rescue and Recovery Workers—Direct Effect or Mediation through Comorbidities

PROJECT NUMBER: U01 OH0 10988

INSTITUTION: New York University School of Medicine

PRINCIPAL INVESTIGATOR: **Cheryl Stein,** *MD*

PHONE NUMBER: *(646) 754-4886*

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PROJECT DURATION: 1 year (Project Completed)

DESCRIPTION: The main goal of the study is to use existing, longitudinal data from the New York City Region Clinical Centers of Excellence to examine the association between WTC exposure and cognitive function among the nearly 25,000 rescue and recovery workers participating in the WTC Health Program. First we want to determine whether there is evidence of cognitive dysfunction among rescue and recovery workers. Then if there is evidence of cognitive dysfunction, we will try to tease apart whether the dysfunction is due to WTC exposure (e.g., dust, chemicals), WTC-related illness (e.g., CVD, depression), or both.

Clinical Characteristics and Outcomes of WTC-Associated Sarcoidosis

PROJECT NUMBER: U01 OH0 10993

INSTITUTION: Albert Einstein College of Medicine

PRINCIPAL INVESTIGATOR: **Simon Spivack**, *MD, MPH* (**Thomas Aldrich**, *MD*)

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PROJECT DURATION: 1 year (Project Completed)

DESCRIPTION: Sarcoidosis, an inflammatory disease of unknown cause that can affect almost any organ, has been noted in unexpectedly large numbers of WTC-exposed persons, including 76 FDNY firefighters. This project is a detailed re-examination of this group, to define their clinical patterns and genetic markers and compare them with those of previously reported non-WTC-exposed sarcoidosis patients. We will also assess genetic differences with similarly WTC-exposed firefighters who did not develop sarcoidosis. The results should help to determine the extent and severity of sarcoidosis triggered by a unique occupational exposure.

A Pilot Test of the Relaxation Response Resiliency Program (3RP) in Spanish Speaking World Trade Center Disaster Survivors with PTSD

PROJECT NUMBER: U01 OH0 10996

INSTITUTION: New York University School of Medicine

PRINCIPAL INVESTIGATOR: Lucia Ferri, PhD

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PROJECT DURATION: 1 year (Project Completed)

DESCRIPTION: Individuals directly exposed to 9/11 WTC disaster, including community members who lived or worked in the area, continue to experience significant psychiatric and physical health symptoms. At the WTC EHC, at least one-third of patients serviced are Hispanic with Spanish as their primary language. Unfortunately, there are limited, empirically-supported treatment protocols that are translated and available in Spanish for this population. This study will adapt and translate the

Relaxation Response Resiliency Program (3RP), a comprehensive mind-body treatment, for Spanish-speaking WTC survivors. We will evaluate whether the treatment is acceptable and feasible for this population.

WTC Health Program Research Cooperative Agreements Awarded in FY 2016

Extension of the World Trade Center Health Registry (U50)

PROJECT NUMBER: U50 OH009739-08

INSTITUTION: New York City Department of Health and Mental Hygiene

PRINCIPAL INVESTIGATOR: **Mark Farfel, *ScD***

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PROJECT DURATION: Five years

DESCRIPTION: The WTC Health Registry contributes to public health by identifying the longterm physical and mental health effects and health care needs of persons directly affected by the WTC disaster. The Registry follows a diverse cohort of over 71,000 persons who performed 9/11-related rescue/recovery work, or who lived, worked or attended school in lower Manhattan on September 11, 2001. The Registry shares its health findings and recommendations with enrollees, the public, health care providers, scientists, policy makers, and the WTC Health Program. The Registry also provides information about 9/11-related services and offers enrollee referrals to the WTC Health Program.

Internet-Based Psychotherapies for PTSD Symptoms in WTC Responders

PROJECT NUMBER: U01 OH010729

INSTITUTION: Icahn School of Medicine at Mount Sinai

PRINCIPAL INVESTIGATOR: **Adriana Feder, *MD***

PHONE NUMBER: ***(212) 659-9145***

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PROJECT DURATION: Three years

DESCRIPTION: While CBT is the most effective and empirically supported of PTSD treatments, its provision to WTC workers who still suffer from clinically significant WTC-related PTSD is often limited by geographical distance, reduced availability of expertly trained therapists, and stigma associated with seeking mental health treatment. We will conduct a randomized controlled trial to assess the efficacy of Internet-based, therapist-assisted CBT in WTC rescue and recovery workers with clinically-significant PTSD symptoms, compared to a control intervention of Internet-based, therapist-assisted supportive counseling, and will evaluate genetic and epigenetic biomarker predictors and correlates of treatment response.

Roles for WTC Dust and DEP Co-pollutant in First Responder Cardiovascular Ailments

PROJECT NUMBER: R01 OH010921

INSTITUTION: New York University School of Medicine

PRINCIPAL INVESTIGATOR: **Mitchell Cohen**, ***PhD***

PHONE NUMBER: ***(845) 731 3527***

E-MAIL: ***COHENM01@NYUMC.ORG***

PROJECT DURATION: Four years

DESCRIPTION: There is an elevated risk for development of atherosclerosis/CVD among first responders who were present at Ground Zero over the first 72 hours. It has yet to be established if WTC dusts were causative agents to alter heart/vascular functions or caused damage in situ, modulating the impact of other pollutants that were also present at high levels at Ground Zero. These rodent model studies — using relevant exposure scenarios mimicking mouth-breathing exposures/pollutant levels in that critical period — will help us better understand the bases for the still-increasing incidence of cardiovascular anomalies reported in first responders

Thyroid Cancer Risk in WTC Responders

PROJECT NUMBER: U01 OH010984

INSTITUTIONS: Icahn School of Medicine at Mount Sinai, Johns Hopkins School of Medicine

PRINCIPAL INVESTIGATORS: **Emanuela Taioli**, ***MD***, ***PhD*** and **Gregory Riggins**, ***MD***, ***PhD***

PHONE NUMBER: ***(212) 659-9590***

EMAIL: ***EMANUELA.TAIOLI@MOUNTSINAI.ORG***

PROJECT DURATION: 3 years (project completed)

DESCRIPTION: A statistically significant excess of thyroid cancer has been identified among WTC rescue and recovery workers included in the WTC Health Program at Mount Sinai in New York, and in two other cohorts, the WTC-exposed firefighters and the NYC Department of Health exposed residents. The objectives of this project are to elucidate the reasons for the increased incidence of thyroid cancer among WTC Health Program participants, and to explore the behavior of these cancers. This project will investigate whether thyroid cancers among WTC Health Program participants differ from a clinical, epidemiologic and molecular viewpoint from thyroid cancers in WTC-unrelated patients.

Evolution of Risk Factors for Lung Function Decline in WTC Exposed Firefighters

PROJECT NUMBER: U01 OH011302

INSTITUTION: New York University School of Medicine

PRINCIPAL INVESTIGATOR: Michael Weiden, MD

PHONE NUMBER: ***(212) 263-6479***

EMAIL: *WEIDEM01@NYUMC.ORG*

PROJECT DURATION: Three years

DESCRIPTION: The study will utilize recently obtained serum to test if biomarkers such as IgE are persistently associated with enhanced-FEV1-decline testing the hypothesis that Eos, PMN, IgE are risk factors for enhanced-FEV1 decline using serum collected from 10/2001-2/2002 and serum collected 2013-2015. This will allow for more intensive monitoring and early treatment to be directed toward high risk individuals; meanwhile, avoided devoting costly resources to intensive screening individuals at low risk for severe disease. This investigation could rationalize anti-IgE in patients with enhanced-FEV1-decline refractory to standard therapy even when there is no other evidence of atopy.

World Trade Center Exposures, Neuropathic Symptoms and Nervous System Injury Symptoms, and Nervous System Injury

PROJECT NUMBER: U01 OH0 11305

INSTITUTION: New York University School of Medicine

PRINCIPAL INVESTIGATOR: Michael Marmor, PhD

PHONE NUMBER: *(212) 263-6667*

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PROJECT DURATION: Two years (project completed)

DESCRIPTION: Many survivors and first responders have complained of neuropathic symptoms following exposure to the WTC attacks of September 11, 2001, or the subsequent clean-up activities. This study will investigate neuropathy among WTC survivors using interview data, neurologic examinations, skin biopsies to measure small fiber nerve densities, electromyograms and nerve conduction velocity studies. Findings of associations between WTC exposures and neuropathic symptoms would advance the field of toxic neuropathies and provide data that might affect the decision to include or exclude neuropathies in the list of WTC-Related Health Conditions covered in the WTC Health Program.

Hepatitis C Virus Infection in WTC Responders

PROJECT NUMBER: U01 OH011307

INSTITUTION: Icahn School of Medicine at Mount Sinai

PRINCIPAL INVESTIGATORS: **Stephanie Factor**, ***MD,MPH***; **Paolo Boffetta**, ***MD, MPH***

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PROJECT DURATION: Two years (project completed)

DESCRIPTION: This study provides hepatitis C virus (HCV) screening to members of the WTC cohort followed at the Icahn School of Medicine at Mount Sinai (WTC Health Program) born during 1945–1965, and linkage to care for those found infected. In addition to identifying and treating HCV-infected individuals within the WTC Health Program, the study aims to identify undetermined

risk factors for HCV infection experienced by WTC Health Program members, and factors associated with improved linkage to HCV care. These findings would be relevant to the larger US population, especially to persons born during 1945–1965 who are at high risk of HCV infection.

9/11 Trauma and Toxicity in Childhood: Longitudinal Health and Behavioral Outcomes

PROJECT NUMBER: U01 OH011308

INSTITUTION: New York State Psychiatric Institute at Columbia University

PRINCIPAL INVESTIGATOR: **Christine Hoven,** ***DrPH***

PHONE NUMBER: ***(646) 774-6068***

EMAIL: ***HOVEN@NYSPI.COLUMBIA.EDU***

PROJECT DURATION: Five years

DESCRIPTION: The 9/11 Trauma and Toxicity in Childhood: Longitudinal Health and Behavioral Outcomes Study aims to understand the longitudinal, lifetime effects of 9/11 traumatic and toxic exposures on children's physical health and behavioral development, as they grow into adulthood. This study follows a cohort of children exposed to 9/11 and assesses the longitudinal health effects of their toxic and traumatic exposures, and examines the interactions of these factors in their development. This will generate valuable information to guide both psychiatric and general medical care for children exposed to 9/11 while providing information relevant for youth

Head and Neck Cancer in the World Trade Center Health Program Cohort; Elucidating Risk Factors to Reduce Incidence and Morbidity

PROJECT NUMBER: U01 OH011322

INSTITUTION: Rutgers, The State University of New Jersey

PRINCIPAL INVESTIGATOR: ***Judith Graber, PhD***

PHONE NUMBER: ***(848) 445-0190***

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PROJECT DURATION: Two years

DESCRIPTION: The study will investigate whether exposure to pollution from the WTC 9/11 attacks is associated with increased risk of head and neck cancer among WTC responders and remediation workers. It will further explore whether that exposure adds to known causes of head and neck cancer including tobacco and alcohol. The findings from this study will help to build the evidence base for developing recommendations for modifying risk factors for these devastating cancers among WTC responders, including tobacco and alcohol use.

Assessing Inflammatory and Behavioral Pathways Linking PTSD to Increased Asthma Morbidity in WTC Workers

PROJECT NUMBER: U01 OH0 11312

INSTITUTION: Icahn School of Medicine at Mount Sinai

PRINCIPAL INVESTIGATOR: **Juan Wisnivesky, *MD, DrPH***

PHONE NUMBER: ***(212) 824-7567***

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PROJECT DURATION: Five years

DESCRIPTION: Asthma and PTSD are the most common conditions in WTC rescue and recovery workers. In this study, we will evaluate the interplay of biological and behavioral mechanisms explaining the relationship of PTSD with increase asthma morbidity and adapt and pilot test a novel intervention to improve outcomes of WTC workers.

Structural and Functional Neuroimaging of Post-Traumatic Stress Disorder and Cognitive Impairment in World Trade Center Responders

PROJECT NUMBER: U01 OH011314

INSTITUTION: Icahn School of Medicine at Mount Sinai

PRINCIPAL INVESTIGATOR: Roberto Lucchini, MD

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PROJECT DURATION: Four years

DESCRIPTION: The Stony Brook arm of the WTC Health Program screened 2,400 responders with the MoCA, observing a 2.6% moderate-to-severe Cognitive Impairment (scores <20), with significant association with WTC-PTSD. We will use functional MRI and PET/MRI imaging to examine these brain patterns among 120 SBU-WTC responders, including 30 with CI (MoCA <20, and PTSD; 30 with Cognitive Impairment without PTSD; 30 with normal cognitive functioning (MoCA>26) and PTSD; and 30 with normal cognitive functioning without PTSD. All responders will be matched on age and occupation as well as 30 non-WTC exposed, matched controls.

Small Airway Chronic Obstructive Disease Syndrome Following Exposure to WTC Dust

PROJECT NUMBER: U01 OH011317

INSTITUTION: New York University School of Medicine

PRINCIPAL INVESTIGATOR: Kenneth Berger, MD

PHONE NUMBER: ***(212) 263-6407***

EMAIL: ***BERGEK01@NYUMC.ORG***

PROJECT DURATION: 3 years (project completed)

DESCRIPTION: Many "survivors" in the WTC clinical program have a clinical syndrome characterized by chronic obstruction in small airways and persistence of LRS despite therapy. This study will test the hypothesis that persistent symptoms in WTC "survivors" are associated with abnormal small airways whose dysfunction is amplified during exercise and is associated with biologic evidence of inflammation and remodeling. The results from this study will have important treatment implications for our WTC population with potential applicability to larger populations with inhalational lung injury and/or airway diseases such as asthma and chronic obstructive pulmonary disease.

Personality-Informed Care Model for 9/11-Related Comorbid Conditions

PROJECT NUMBER: U01 OH011321

INSTITUTION: State University of New York at Stony Brook

PRINCIPAL INVESTIGATOR: Roman Kotov, PhD

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EMAIL: *ROMAN.KOTOV@STONYBROOKMEDICINE.EDU*

PROJECT DURATION: Five years

DESCRIPTION: Co-occurrence of medical and psychiatric illness is very persistent and prevalent in WTC responders following the attacks of 9/11, impairing their daily functioning and treatment outcomes. For the first time, the proposed study will identify modifiable personality-informed risk factors, resilience characteristics, and mechanisms for maintenance of comorbid conditions, as well as propose, and test, using a proof-of-concept randomized control trial, a system of personality-informed interventions to improve care of vulnerable individuals. This study will inform planning of WTC Health Program services and patient care, and will advance science by helping to illuminate the etiology of complex comorbidities.

RDoC Domains Underlying Emotional Health and Trajectories of Psychopathology in Families of WTC First Responders and Evacuees: A Genome-Wide GxE Study

PROJECT NUMBER: U01 OH011327

INSTITUTION: New York State Psychiatric Institute at Columbia University

PRINCIPAL INVESTIGATOR: **Christine Hoven,** ***DrPH***

PHONE NUMBER: *(646) 774-6068*

EMAIL: *HOVEN@NYSPI.COLUMBIA.EDU*

PROJECT DURATION: Five years

DESCRIPTION: The Wave 3 WTC Family Study examines prospectively the consequences of parental 9/11 exposure to children and parents in a sample of first responders and WTC evacuees previously assessed in two waves of data collection, with non-exposed control families. The study examines the link between WTC exposure and a range of psychiatric disorders and explores the RDoC constructs of mental function and the gene-environment interactions that underlie them. The overall aim is to understand post-9/11 long-term psychiatric

outcomes and emotional health through an examination of their associated RDoC dimensions and underlying interactions among genome-wide genetic variation and direct/indirect WTC exposus.

Impact of WTC Dust on Immune Functions and Prostate Cancer Promotion

PROJECT NUMBER: U01 OH011328

INSTITUTION: Icahn School of Medicine at Mount Sinai

PRINCIPAL INVESTIGATOR: **Stuart Aaronson**, ***MD***

PHONE NUMBER: ***(212) 659-5400***

EMAIL: ***STUART.AARONSON@MSSM.EDU***

PROJECT DURATION: Five years

DESCRIPTION: This project addresses adverse health effects to WTC rescue and recovery workers of exposure to dust containing asbestos and other toxic components. Proposed studies would test mechanisms that may be responsible for the increased incidence of prostate cancer in exposed individuals using mouse genetic models. Immune and/ or other biomarkers identified would also be applied in correlative studies with prostate tumors from WTC workers.

Incidence, Latency, and Survival of Cancer Following World Trade Center Exposure

PROJECT NUMBER: U01 OH011932 (formerly U01 OH011315)

INSTITUTIONS: Albert Einstein College of Medicine, Icahn School of Medicine at Mount Sinai, New York City Department of Health, New York State Cancer Registry

PRINCIPAL INVESTIGATORS: **Charles B. Hall**, ***Ph.D.***; **Paolo Boffetta**, ***M.D.***, ***M.P.H.***

PHONE NUMBERS: ***(917)-974-4009*** (Dr. Hall); ***(212) 824-7378*** (Dr. Boffetta)

EMAIL: ***CHARLES.HALL@EINSTEIN.YU.EDU***

PROJECT DURATION: Four years

DESCRIPTION: Combining follow-up from all three cohorts of WTC rescue/recovery workers, this study will update estimates of the effect of WTC-exposure on cancer incidence, study in detail the latency period between exposure and cancer incidence, and study the effect of WTC-exposure and other prognostic factors on survival after cancer diagnosis in this population. This research will add to the understanding of long-term consequences of WTC-exposure, inform surveillance efforts in future environmental disasters, will stimulate further research into environmental risk factors for cancer in this and other cohorts, and will stimulate future work that would maximize survival of cancer patients among WTC-exposed workers.

Maintenance and Extension of a Cohort of Career Firefighters as a Non-WTC Exposed Comparison for the FDNY Firefighter Cohort

PROJECT NUMBER: U01 OH011934(formerly U01 OH011309)

INSTITUTION: Albert Einstein College of Medicine

PRINCIPAL INVESTIGATOR: Mayris Webber, *DrPH*

PHONE NUMBER: *(718) 999-2665*

EMAIL: *MWEBBER@MONTEFIORE.ORG*

PROJECT DURATION: Five years

DESCRIPTION: Most studies of WTC-exposed populations have reported the occurrence of various conditions thought to present more commonly as a consequence of exposure to the WTC disaster site. Because a non-WTC-exposed comparison group has not yet been identified, the most critical question remains unanswered: to what extent are apparent disease and symptom excesses associated with WTC exposure? This 5-year project will address this question through the ongoing study inclusion of an established comparison cohort of non-NYC-based urban firefighters who were not exposed to the disaster site to estimate disease risk in WTC-exposed compared with risk in unexposed firefighters.

WTC Health Program Research Cooperative Agreements Awarded in FY 2017

Pulmonary Diseases in WTC Workers: Symptoms, Function, and Chest CT Correlates

PROJECT NUMBER: U01 OH010401

INSTITUTION: Icahn School of Medicine at Mount Sinai

PRINCIPAL INVESTIGATOR: Rafael de la Hoz, MD

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PROJECT DURATION: Four years (project completed)

DESCRIPTION: The overall goal of this ongoing study is to characterize the WTC-related lower airway disorders, to investigate newly developed obesity-related imaging markers that may be associated with unfavorable disease expression and functional outcomes, and assess their interaction with WTC occupational exposure level. The WTC Pulmonary Evaluation Unit Chest CT Imaging Archive, a large database with more than 3000 chest CT images on 1700 WTC workers, operational since February 2016, will be utilized for this study. This study will characterize the WTC-related lower airway diseases and their most important adverse prognostic risk factors, and evaluate lung function and imaging longitudinal trajectories. WTC Health Program Research Cooperative Agreements

Prenatal WTC Chemical Exposures, Birth Outcomes and Cardiometabolic Risks

PROJECT NUMBER: U01 OH011299

INSTITUTION: New York University School of Medicine

PRINCIPAL INVESTIGATOR: Leonardo Trasande, MD

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PROJECT DURATION: Four years

DESCRIPTION: Effects of perinatal exposures to the World Trade Center (WTC) disaster have identified increases in adverse birth outcomes. The disaster also released large amounts of particulate matter, heavy metals and persistent organic pollutants, which have been associated with adverse birth outcomes and cardiometabolic risks later in life. If WTC exposures, chemical and psychological, are associated with these outcomes, the study findings could facilitate proactive interventions such as treatment with antihypertensive medications, which have been documented to prolong survival among adults with suboptimal cardiovascular profile.

Metabolomics of World Trade Center-Lung Injury: Biomarker Validation, Longitudinal Assessment and Dietary Intervention

PROJECT NUMBER: U01 OH011300

INSTITUTION: New York University School of Medicine

PRINCIPAL INVESTIGATOR: Anna Nolan, MD, MS

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PROJECT DURATION: Four years

DESCRIPTION: The adverse impact on quality of life and sizable cost of WTC-lung injury (WTC-LI) are public health concerns. We propose to Identify and Validate metabolic contributors of WTC-LI through comprehensive metabolomics profiling and integration of relevant clinical, environmental, and serum biomarkers. We propose to investigate targeted behavioral dietary modification to alter modifiable risk factors and metabolomic (scientific study of chemical processes involving metabolites) biomarkers that may mitigate disease severity and improve the health and well-being of WTC exposed patients.

Linking the Effects of 9/11 to Kidney Disease

PROJECT NUMBER: U01 OH011326

INSTITUTION: Icahn School of Medicine at Mount Sinai

PRINCIPAL INVESTIGATOR: **Mary Ann McLaughlin**, *MD, MPH*

PHONE NUMBER: (212) 241-3340

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PROJECT DURATION: Three years

DESCRIPTION: This study focuses on the prevalence and identification of kidney disease among WTC Health Program patients and assessment of kidney disease in a multi-factorial manner. The first aim is to correlate kidney dysfunction with 9/11 exposure. Secondly, we propose that a well-established WTC-related condition, obstructive sleep apnea, is independently associated with kidney disease. Lastly, we would explore potential mechanisms and phenotypes of kidney disease in WTC

Health program participants. Successful completion of the research would address a critical knowledge gap regarding risk of kidney damage among this group, and would inform future mechanistic studies with the potential to impact prevention.

Neuroimaging of Resilience in World Trade Center Responders: A Focus on Emotional Processing, Reward and Social Cognition

PROJECT NUMBER: U01 OH011473

INSTITUTION: Icahn School of Medicine at Mount Sinai

PRINCIPAL INVESTIGATOR: Adriana Feder, MD

PHONE NUMBER: (212)659-9145

EMAIL: *ADRIANA.FEDER@MSSM.EDU*

PROJECT DURATION: Four years

DESCRIPTION: The ultimate goal of this study is to develop an integrative, data-driven model to examine how patterns of brain activation across functional domains give rise to distinct mechanisms underlying resilience, and how these neural mechanisms interrelate with behavioral (e.g., emotion regulation, reward responses, social cognition) and psychosocial (e.g., coping self-efficacy, positive emotions, social connectedness) factors implicated in resilience. Results of this study will be used to inform personalized and targeted prevention and treatment approaches that bolster function of specific neural circuits and help promote psychological resilience in WTC and other disaster responders, as well as other populations of trauma survivors.

Longitudinal Genome-wide Transcriptome Study of PTSD Symptom Change in WTC Responders

PROJECT NUMBER: U01 OH011478

INSTITUTION: The Research Foundation for the State University of New York

PRINCIPAL INVESTIGATOR: **Pei Fen Kuan**, ***PhD***

PHONE NUMBER: ***(631) 632-1419***

EMAIL: *PEIFEN.KUAN@STONYBROOK.EDU*

PROJECT DURATION: Three years

DESCRIPTION: The 9/11 World Trade Center terrorist attack was a massive disaster, resulting in long-term physical and psychological symptoms among responders,in particular PTSD and lower respiratory symptoms (LRS). The proposed study builds on an extensive pilot study by evaluating the association between change in gene expression and changes in PTSD and LRS symptom severity across an 18-month period, using cutting edge RNA-sequencing. By characterizing the transcriptome patterns and pathways for these symptoms, our goal is to shed light on the biological mechanisms underlying this comorbidity, which can help prevent the exacerbation of physical symptoms by intervening at the level of etiological pathway.

Mortality among WTC Rescue and Recovery Workers

PROJECT NUMBER: U01 OH011480

INSTITUTION: Icahn School of Medicine at Mount Sinai

PRINCIPAL INVESTIGATOR: Paolo Boffetta, MD

PHONE NUMBER: *(212) 824-7378*

EMAIL: *PAOLO.BOFFETTA@MSSM.EDU*

PROJECT DURATION: Four years

DESCRIPTION: Preliminary analyses based on comparisons with the general population showed a reduced mortality among WTC rescue and recovery workers, which may be due to selection of healthy workers in the cohorts. We plan to perform a number of analyses of a combined database comprising three WTC cohorts to address the possible 'healthy worker effect' and to investigate whether there is any indication of a possible effect of WTC exposure on mortality of these workers. The proposed research will provide strong evidence on the presence or absence of an association of WTC exposure and mortality among WTC workers, and will inform on the best methodology to quantitative assess the effects of disasters on mortality of exposed individuals.

Hepatotoxic Exposures, Progressive Fatty Liver Disease (NASH), and Liver Cancer Risk in the World Trade Center Health Program General Responder Cohort

PROJECT NUMBER: U01 OH011489

INSTITUTION: Icahn School of Medicine at Mount Sinai

PRINCIPAL INVESTIGATOR: Andrea Branch, PhD

PHONE NUMBER: *(212) 659-8371*

EMAIL: *MANDREA.BRANCH@MSSM.EDU*

PROJECT DURATION: Four years

DESCRIPTION: This project will develop and use innovative and enabling digital technologies to provide the first systematic investigation of liver disease in a large cohort of WTC responders. WTC responders were exposed to many substances known to cause serious progressive liver disease in other populations and in animal models; and it is thus highly likely that the WTC attack exposed responders to hepatotoxins that caused liver damage. By uncovering previously unrecognized liver disease and by introducing new digital technology, this project is expected to improve the health of WTC responders and rescue workers and to advance computational methods for analyzing medical data.

Early Detection of Hematologic Malignancies in New York City Firefighters Exposed To World Trade Center Dust after the 9/11 Attacks

PROJECT NUMBER: UU01 OH011933 (formerly U01 OH011475)

INSTITUTION: Albert Einstein College of Medicine, INC.

PRINCIPAL INVESTIGATOR: Amit Verma, *MD*

PHONE NUMBER: (718) 430-8761

EMAIL: *AMIT.VERMA@EINSTEIN.YU.EDU*

PROJECT DURATION: Three years

DESCRIPTION: The overall goal of this project is early detection of blood cancers using a large repository of blood and serum samples from firefighters exposed to WTC disaster. Specifically, we will use proteomic analysis, flow cytometry and genomic sequencing to detect early signs of myeloma, chronic lymphocytic leukemia and myelodysplastic syndromes in these cases, toenable potentially disease altering therapeutic interventions for these cancers.

Research Cooperative Agreements Awarded in FY 2018

Optimizing Lung Cancer Screening in World Trade Center Rescue and Recovery Workers

PROJECT NUMBER: U01 OH011479

INSTITUTION: Icahn School of Medicine at Mount Sinai

PRINCIPAL INVESTIGATORS: Keith Sigel, MD, PhD, and Juan Wisnivesky, MD, DrPH

PHONE NUMBER: (212) 824-7558

EMAIL: *KEITH.SIGEL@MSSM.EDU*

PROJECT DURATION: Three years

DESCRIPTION: The goal of this study is to use simulation modeling to determine the best and most cost-effective screening and work-up regimens implementing low-dose computed tomography screening for lung cancer in WTC responders. The study findings will have direct implications on the adoption and implementation of this potentially lifesaving intervention in a population exposed to multiple carcinogens during the recovery efforts following the WTC attack.

Exploring Mechanisms of Obstructive Sleep Apnea (OSA) in WTC Responders

PROJECT NUMBER: U01 OH011481

INSTITUTION: Icahn School of Medicine at Mount Sinai

PRINCIPAL INVESTIGATORS: **Indu Ayappa,** ***PhD*** and **Jag Sunderram,** ***MD***

PHONE NUMBER: (212) 241-1967

CONTACT PI EMAIL: *INDU.AYAPPA@MSSM.EDU*

PROJECT DURATION: Three years

DESCRIPTION: There is a high prevalence of obstructive sleep apnea (OSA) in the WTC responder population with an increased risk for OSA in subjects with chronic rhinosinusitis. This study will examine the impact of upper airway sensory impairment from chronic rhinosinusitis as a potential mechanism for development of OSA in WTC responders. The study will also examine the contribution of other pathophysiologic mechanisms (impaired upper airway muscle responsiveness, low arousal threshold and loop gain) in the development of OSA that may be used to target therapeutic interventions in the future in this population

Development and Implementation of a Comparison Occupational Cohort for the WTC GRC

PROJECT NUMBER: U01 OH011487

INSTITUTION: Icahn School of Medicine at Mount Sinai

PRINCIPAL INVESTIGATOR: Susan Teitelbaum, PhD

PHONE NUMBER: *(212)824-7105*

EMAIL: *SUSAN.TEITELBAUM@MSSM.EDU*

PROJECT DURATION: 3 years

DESCRIPTION: This project arises from the need to have a valid occupational comparator cohort against which the health data from the WTC first responders might be measured. To date, very few analyses have utilized occupational cohorts as comparison groups when estimating the risk of exposure to 9/11 toxins and stressors. The goal is to create a cohort that is as similar as possible to the first responders with the exception of 9/11 exposure. At a minimum, the similarities would include occupation, age, sex, and race/ethnicity that will result in more accurate and valid estimates of disease risk amongst the first responders

Informed/Shared Decision Making for Prostate Cancer Screening Among Members of the World Trade Center Health Program

PROJECT NUMBER: U01 OH011690

INSTITUTION: Feinstein Institute for Medical Research

PRINCIPAL INVESTIGATOR: Michael Diefenbach, PhD

PHONE NUMBER: (516) 600-1440

EMAIL: *MDIEFENBACH@NORTHWELL.EDU*

PROJECT DURATION: Three years

DESCRIPTION: Members of the WTCHP program are characterized by multiple physical and psychiatric comorbidities and are at an increased risk for cancer, especially for prostate cancer. Screening for prostate cancer is not part of the routine annual monitoring visit and thus the current study proposes to a) explore and develop a stepped approach to informed/shared decision making (SDM) about prostate cancer screening; b) evaluate the uptake of screening after informed/shared decision making during members' annual monitoring visits; c) evaluate factors related to uptake/rejection of screening and d) evaluate costs associated with screening.

RESULTS FROM THIS STUDY: have the potential to change clinical care for all members of the WTC Health Program by introducing and evaluating an informed/shared approach to decision making for cancer screening and to ultimately reduce the cancer burden of this vulnerable population.

Multimodal Neuroimaging of Cognitive and Emotional Networks in Young Adults Exposed to 9/11 as Children

PROJECT NUMBER: 1 U01 OH011694

INSTITUTION: New York State Psychiatric Institute

PRINCIPAL INVESTIGATOR: Yael Cycowicz, PhD

PHONE NUMBER: *(646)-774-5837*

EMAIL: *YAEL.CYCOWICZ@NYSPI.COLUMBIA.EDU*

PROJECT DURATION: Three years

DESCRIPTION: Understanding the patterns of brain functioning of individuals exposed to 9/11 as children is essential to safeguarding their mental health. This study will assess brain structure and function in 3 adult groups who were children at 9/11: 1) Highly Exposed to 9/11 with Anxiety Disorders; 2) Highly Exposed to 9/11 without Anxiety Disorders; 3) No Exposed and No Mental Disorders. These findings will improve our understanding of emotional, memory and cognitive systems, which are sensitive to traumatic stress during development, and will inform the trajectory of psychiatric disorders and could guide preventative and treatment strategies for children exposed to trauma.

Chronic Obstructive Pulmonary Disease in WTC Workers – Diagnoses and Transitions

PROJECT NUMBER: U01 OH011697

INSTITUTION: Icahn School of Medicine at Mount Sinai

PRINCIPAL INVESTIGATOR: Rafael de la Hoz, MD

PHONE NUMBER: (212) 241-7996

EMAIL: *RAFAEL.DELAHOZ@MSSM.EDU*

PROJECT DURATION: Three years

DESCRIPTION: Utilizing an extensive amount of qualitative and quantitative imaging, clinical, and functional data, the overall goal of this study is to characterize the transitions over time into chronic obstructive pulmonary disease (COPD) among former workers and volunteers at the WTC disaster site, and examine the progression of the diagnosis, their radiographic imaging correlates, and the contribution of work-related exposures to disease causation.

World Trade Center issue Biobank

PROJECT NUMBER: U01 OH011704

INSTITUTION: Icahn School of Medicine at Mount Sinai

PRINCIPAL INVESTIGATOR: Emanuela Taioli, MD, PhD

PHONE NUMBER: (212)659-9590

EMAIL: *EMANUELA.TAIOLI@MOUNTSINAI.ORG*

PROJECT DURATION: 3 years

DESCRIPTION: There has been concern about the increase cancer incidence among the World Trade Center (WTC) responders; this project will update the WTC tissue bank system with the newly diagnosed cancers (2010-2014), and to add the banking of organs and tissues from animal studies exposed to the WTC dust. The biobank will provide the necessary infrastructure for addressing questions such as the link between specific carcinogens exposures and certain cancer sites, molecular signatures of exposure that could be linked to cancer, specific markers of tumor aggressiveness among WTC responders

Detection and Incidence of Thyroid Cancer among Three Cohorts of WTC Exposed Rescue and Recovery Workers

PROJECT NUMBER: U01 OH011931 (formerly U01 OH011681)

INSTITUTION: Albert Einstein College of Medicine, INC.

PRINCIPAL INVESTIGATOR: Rachel Zeig-Owens, DrPH

PHONE NUMBER: (718) 999-0734

EMAIL: *RACHEL.ZEIG-OWENS@FDNY.NYC.GOV*

PROJECT DURATION: Two years

DESCRIPTION: World Trade Center (WTC)-exposed rescue/recovery workers have an elevated risk of thyroid cancer compared with the general United States population but to-date none of the compounds found at the WTC disaster site has been proven to be associated with thyroid cancer. Instead the elevated rate might be the result of incidental detection due to increased medical surveillance provided to the WTC-exposed rescue/recovery workers. This study will investigate the method of detection of thyroid cancer among WTC-exposed rescue/recovery workers and a non-WTC exposed reference population to determine the rate of thyroid cancer cases diagnosed incidentally and to identify reasons for the elevated risk of thyroid cancer among WTC-exposed populations.

WTC Health Program Research Cooperative Agreements Awarded in FY 2019

Treatment Response of WTC Related Airway Injury

PROJECT NUMBER: 1 U01 OH011682

INSTITUTION: New York University School of Medicine

PRINCIPAL INVESTIGATOR: Michael D. Weiden, MD

PHONE NUMBER: *(212)263-6479*

EMAIL: *MICHAEL.WEIDEN@NYULANGONE.ORG*

PROJECT DURATION: Two years

DESCRIPTION: Exposure to dust and smoke at the WTC collapse site has caused ongoing loss of lung function and reduced quality of life. The effectiveness of medications in treating accelerated decline in lung function is unclear. This grant will define how effective current treatments are, information essential to direct future therapy.

Thyroid Cancer Aggressiveness in WTC Responders

PROJECT NUMBER: 1 U01 OH011849

INSTITUTION: ICAHN School of Medicine at Mount Sinai

PRINCIPAL INVESTIGATOR: Emanuela Taioli, MD, PhD

PHONE NUMBER: *(212)824-7077*

EMAIL: *EMANUELA.TAIOLI@MOUNTSINAI.ORG*

PROJECT DURATION: Two years

DESCRIPTION: There is an excess of thyroid cancer risk in World Trade Center first responders that our previous research has confirmed to be true malignancies and not the result of over diagnosis from heightened screening. Understanding the aggressiveness of these cancers has implications for treatment; if these tumors arise from a micro environment characterized by high inflammation and immune depression, and have a higher mutational burden and/or mutations known to be associated with poor prognostic outcomes, then it may be that more aggressive treatments such as total thyroidectomy are most appropriate. Additionally, whole exome sequencing of these tumors may illuminate novel mutations that are useful targets for immunotherapy or chemotherapy.

Polygenic Prediction of PTSD Trajectories and Inflammation in 9/11 Responders

PROJECT NUMBER: 1 U01 OH011864

INSTITUTION: State University of New York Stony Brook

PRINCIPAL INVESTIGATOR: Monika Aldona Waszczuk, PhD

PHONE NUMBER: *(631)-638-1921*

EMAIL: *MONIKA.WASZCZUK@STONYBROOKMEDICINE.EDU*

PROJECT DURATION: Two years

DESCRIPTION: Recent discoveries in genetics promise to revolutionize our understanding of posttraumatic stress disorder. We will test whether these genetic vulnerabilities can predict course of this disorder in 8,000 responders to World Trade Center disaster. We also will use powerful genetic models to investigate whether systemic inflammation is responsible for worsening of posttraumatic stress symptoms, knowledge that can lead to development of new treatments.

WTC Health Program Research Cooperative Agreements Awarded in FY 2020

Myeloma Precursor Disease among WTC responders

PROJECT NUMBER: 1 U01 OH011869-01A1

PRINCIPAL INVESTIGATOR: Rachel Zeig-Owens (Albert Einstein College of Medicine)

CO-PIS: David Prezant (FDNY) and Carl Landgren (Sloan-Kettering Institute for Cancer Research)

PHONE NUMBER: *(718)- 403-4416*

EMAIL: *RACHEL.ZEIG-OWENS@FDNY.NYC.GOV*

PROJECT DURATION: 7/1/2020-6/30/2021

DESCRIPTION: The proposed study will investigate the association between World Trade Center exposure and precursor

disease for multiple myeloma, monoclonal gammopathy of undetermined significance (MGUS), among WTC Health Program rescue/recovery workers. We demonstrated a significantly higher rate of MGUS in a subset of this population, thus providing a rationale for a comprehensive study in other WTC-exposed rescue/recovery workers. Assessing this association in a heterogeneous cohort will improve the understanding of relationship between WTC exposure and the clinical course of multiple myeloma.

Validation of non-electrophile Nrf2 activators for WTC relevant pulmonary indications

PROJECT NUMBER: 1 U01 OH012054

PRINCIPAL INVESTIGATOR: Michael Cameron (Scripps Florida)

PHONE NUMBER: *561-228-2223*

EMAIL: *CAMERON@SCRIPPS.EDU*

PROJECT DURATION: 1 Years

DESCRIPTION: The incidence of pulmonary fibrosis in World Trade Center responders is significantly increased and tracks with duration of exposure. Current therapy options are limited and have not been demonstrated to increase life expectancy. We plan to test an exciting lead compound in World Trade Center relevant models of pulmonary fibrosis.

Effects of WTC Dust Exposure on Cardiac and Cognitive Functions

PROJECT NUMBER: 1 U01 OH012056

PRINCIPAL INVESTIGATOR: Loren Wold (Ohio State University)

CO-PRINCIPAL INVESTIGATOR: Mitchell Cohen (New York University School of Medicine)

PHONE NUMBER: (614) 292-0627

EMAIL: *LOREN.WOLD@OSUMC.EDU*

PROJECT DURATION: 1 Years

DESCRIPTION: We seek to understand the bases for the still-increasing incidence of cardiovascular (CV)/neurodegenerative anomalies of 9/11 First Responders (FR). These studies will be performed in a rat model exposed to WTC dusts obtained within 72 hr after the buildings collapsed, using exposures that mimic exposures and dust levels faced by FR. These results will: clarify whether exposure to WTC dust exacerbates CV/neurologic phenotypes (effects that have led to changes in CV and brain health of exposed FR); ascertain if the dusts induce an Alzheimer Disease/PTSD phenotype in exposed hosts; obtain biochemical/molecular clues to the CV/neurologic problems of exposed FR.

Intergenerational Tranmission of Trauma in WTC Responders with PTSD

PROJECT NUMBER: 1 U01 OH012065

PRINCIPAL INVESTIGATOR: Yael Cycowicz (Research Foundation for Mental Hygiene, Inc)

CO-PRINCIPAL INVESTIGATOR: Diana Rodriguez Moreno and Keely Cheslack-Postava

(NYSPI, Columbia University)

PHONE NUMBER: (646) 774-5837

EMAIL: *YAEL.CYCOWICZ@NYSPI.COLUMBIA.EDU*

PROJECT DURATION: 1 Years

DESCRIPTION: Parental traumatic exposure has persistent impacts on children's psychological well-being, even when they were not directly exposed. Two to four years following the 9/11 WTC attack, over 20% of police officers and over 30% of relief workers reported behavioral issue(s) with their children. Yet this affected group has not been directly assessed. This study will: establish a cohort of those under age 18 during 9/11 and that their parents developed PTSD through their occupation as responders to the WTC aftermath; assess their mental well-being using an online battery; examine intergenerational trauma transmission pathway using existing data on the parents' health.

The Aging Process of WTC Responders: Assessment and Consequences of Frailty

PROJECT NUMBER: 1 U01 OH012068

PRINCIPAL INVESTIGATOR: Katherine Ornstein (Icahn School of Medicine at Mount Sinai)

CO-PRINCIPAL INVESTIGATOR: Roberto Lucchini (Icahn School of Medicine at Mount Sinai)

PHONE NUMBER: *(917) 518-2250*

EMAIL: *KATHERINE.ORNSTEIN@MSSM.EDU*

PROJECT DURATION: 1 Years

DESCRIPTION: As the WTC responder cohort ages (current median age is 56), the assessment of age-related syndromes becomes increasingly important. The goal of this study is to develop a frailty index among the WTC general responders cohort that will allow us to: i) identify individuals with a higher degree of age-related vulnerability; ii) evaluate trajectories of decline among WTC respondents over time; and iii) assess key age-related syndromes (falls, functional decline) and their consequences (hospitalizations). This development will facilitate monitoring for frailty in this cohort and timely implementation of interventions to prevent further clinical deterioration in this high-risk population.

Prevalence of Chronic Hematopoiesis of Indeterminate Potential Among WTC Responders

PROJECT NUMBER: 1 U01 OH012071

PRINCIPAL INVESTIGATOR: Paolo Boffetta (now Stony Brook; was Mount Sinai)

CO-PRINCIPAL INVESTIGATOR: John Mascarenhas (Icahn School of Medicine at Mount Sinai)

PHONE NUMBER:*(212) 659-1474* (may need update to Stony Brook phone #)

EMAIL: *PAOLO.BOFFETTA@STONYBROOKMEDICINE.EDU*

PROJECT DURATION: 1 Years

DESCRIPTION: World Trade Center (WTC) responders experienced an increased risk of leukemia and cardiovascular disease. We plan to study the prevalence of clonal hematopoiesis of indeterminate potential (CHIP), an asymptomatic condition entailing an increased risk of leukemia and

cardiovascular disease, among 350 healthy WTC responders and a group of controls. These results will lead to strategies to prevent leukemia and cardiovascular disease in WTC responders

Risk and resilience factors for adverse mental and physical health outcomes related to WTC exposure

PROJECT NUMBER: 1 U01 OH012075

PRINCIPAL INVESTIGATOR: Megan Horton (Icahn School of Medicine at Mount Sinai)

PHONE NUMBER: *(212) 824-7038*

EMAIL: *MEGAN.HORTON@MSSM.EDU*

PROJECT DURATION: 1 Years

DESCRIPTION: This study comprehensively examines WTC experience during rescue and recovery efforts including baseline sociodemographic and health status are associated with adverse health outcomes. We address a critical gap in our understanding of risk and protective factors for WTC-related diseases that will help identify vulnerable responders and determine factors that may protect against the development or progression of disease.

WTC Health Program Research Cooperative Agreements and Other Grants Awarded in FY 2021

Extension of the World Trade Center Health Registry

PROJECT NUMBER: 2 U50 OH009739-13

INSTITUTION: New York City Department of Health and Mental Hygiene

PRINCIPAL INVESTIGATOR: Mark Farfel, ScD

PHONE NUMBER: *(718) 786-4551*

EMAIL: *mfarfel@health.nyc.gov*

PROJECT DURATION: Five years

DESCRIPTION: The World Trade Center Health Registry contributes to public health by identifying the long-term physical and mental health effects and health care needs of persons directly affected by the World Trade Center disaster. The Registry shares its health findings and recommendations with enrollees, the public, health care providers, scientists, policy makers, and the World Trade Center Health Program. The Registry also provides information about 9/11-related services and offers treatment referral and health promotion opportunities for enrollees.

Role of Sleep Apnea in Cognition and Alzheimer's Disease Biomarkers in WTC Responders

PROJECT NUMBER: 1 U01 OH011852-01 A1

INSTITUTION: Icahn School of Medicine at Mount Sinai

PRINCIPAL INVESTIGATOR: Indu Ayappa, PhD

PHONE NUMBER: *(212) 241-1967*

EMAIL: *INDU.AYAPPA@MSSM.EDU*

PROJECT DURATION: Five years

DESCRIPTION: Common sleep disorders like obstructive sleep apnea (OSA) may represent risk factors for cognitive decline. We have found a very high prevalence of OSA in the World Trade Center responder population, and the present work will evaluate the impact of OSA on early markers of Alzheimer 's Disease using plasma biomarkers, PET/MR and cognition using a visual-spatial memory test. This study has the potential to identify the mechanisms by which sleep disruption contributes to Alzheimer's Disease neurodegeneration and guide therapeutic interventions in the future in the aging WTC responder population. World Trade Center Particulate Matter Induced

CARDIORESPIRATORY AND VASCULAR DYSFUNCTION: a MultiOmic Approach

World Trade Center Particulate Matter Induced Cardiorespiratory And VascuLar Dysfunction: A Multiomic Approach

PROJECT NUMBER: 1 U01 OH011855-01 A1

INSTITUTION: New York University School of Medicine (NYU Grossman School of Medicine)

PRINCIPAL INVESTIGATOR: Anna Nolan, MD (PI of a current/funded WTCHP project FY17 OH11300A1)

PHONE NUMBER: *(212) 263-6459*

EMAIL: *Anna.Nolan@nyulangone.org*

PROJECT DURATION: Five years

POPULATION/DATA SOURCE: Responders (FDNY First Responders)

DESCRIPTION: World Trade Center (WTC) site destruction caused an intense particulate matter (PM) exposure. Since PM is responsible for a high percentage of cardiorespiratory disease/death we propose to investigate the development of WTC-PM induced cardiorespiratory and vascular dysfunction (WTC-CaRVD) in the FDNY cohort. Our proposal will identify biologically plausible therapeutic targets of oxidative stress and clinical phenotypes of WTC-CaRVD; which falls squarely within the purview of the James Zadroga 9/11 Health & Compensation Act.

STUDY DESIGN: Case-Control

Assessing the Feasibility and Acceptability of Using Non-invasive Transcutaneous Auricular Vagus Nerve Stimulation (taVNS) to Reduce PTSD Symptoms in WTC Responders

PROJECT NUMBER: 1 U01 OH012050-01 A1

INSTITUTION: Feinstein Institute for Medical Research

PRINCIPAL INVESTIGATORS: Rebecca Schwartz, PhD (contact PI); Theodoros Zanos

PHONE NUMBER: *(516) 465-7926*

EMAIL: *Rschwartz3@northwell.edu*

PROJECT DURATION: Two years

DESCRIPTION: World Trade Center (WTC) responders have high rates of Posttraumatic Stress Disorder (PTSD) and experience barriers to engagement in mental health care. This study aims to determine whether a novel, non-invasive form of vagus nerve stimulation (VNS), transcutaneous auricular VNS (taVNS), is acceptable and feasible for use with WTC responders who have PTSD and whether the methodology to test the efficacy of taVNS in reducing PTSD symptoms in a larger trial is acceptable and feasible. This will involve the conduct of a formative phase focus group and then a pilot feasibility study with Northwell-affiliated WTC responders who have PTSD.

STUDY DESIGN: Study design consists of a focus group (Aim 1) and a randomized, double-blind placebo-controlled feasibility trial with a parallel-design (Aim 2)

Lifestyle intervention to reduce body weight and systemic inflammation among World Trade Center responders with PTSD: Pilot Randomized Control Trial

PROJECT NUMBER: U01 OH012057

INSTITUTION: State University New York Stony Brook

PRINCIPAL INVESTIGATOR: Chrisa Arcan, PhD

PHONE NUMBER: 202-468-2447

EMAIL: hrisanti.arcan@stonybrookmedicine.edu

PROJECT DURATION: 1 year

DESCRIPTION: World Trade Center responders with post-traumatic stress disorder (PTSD) are at increased risk for overweight/obesity, metabolic syndrome and systemic inflammation. Diets rich in antioxidant and anti-inflammatory properties coupled with physical activity (PA) can positively contribute to the metabolic and oxidative milieu of mental and physical comorbidities. The Mediterranean dietary pattern (MedDiet) a heart-healthy eating plan, has been shown to also reduce chronic disease risk and related inflammatory biomarkers. This pilot study will be the first randomized controlled trial testing the feasibility and acceptability of a MedDiet protocol with PA among WTC responders with PTSD and metabolic comorbidities.

Aerodigestive Disease in the World Trade Center Exposed FDNY Cohort: Validation of Biomarkers and Defining Risk to Tailor Therapy

PROJECT NUMBER: 1 U01 OH012069-01 A1 FY17 OH11300A1)

INSTITUTION: New York University School of Medicine (NYU Grossman School of Medicine)

PRINCIPAL INVESTIGATOR: Anna Nolan, MD (PI of a current/funded WTCHP project

PHONE NUMBER: *(212) 263-6459*

EMAIL: *Anna.Nolan@nyulangone.org*

PROJECT DURATION: Three years

DESCRIPTION: World Trade Center (WTC) exposed Fire Department of New York (FDNY) rescue and recovery workers developed gastroesophageal reflux disease (GERD), a risk factor for Barrett's Esophagus (BE) and subsequent esophageal cancer. There is diminished health-related quality of life and productivity associated with aerodigestive diseases such as GERD and BE. Our research will leverage the longitudinally phenotyped WTC exposed cohort, identify/validate novel biomarkers of WTC-aerodigestive disease, develop novel, noninvasive disease phenotyping to promote early diagnosis of premalignant disease, and identify potential targeted therapeutics; goals that are in line with the James Zadroga 9/11 Health & Compensation Act.

STUDY DESIGN: Case-Control

Obstructive Sleep Apnea and WTC Dust: Does Chronic Intermittent Hypoxia Exacerbate WTC Dust Induced Lung Injury

PROJECT NUMBER: 1 U01 OH012072-01 A1

INSTITUTION: Rutgers, The State University of New Jersey (RBHS-Robert Wood Johnson Medical School)

PRINCIPAL INVESTIGATORS: Jag Sunderram, MD (contact PI; co-PI of a current/funded WTCHP project FY18 OH11481A1); Andrew Gow

PHONE NUMBER: (732) 235-7038

EMAIL: *sunderja@rwjms.rutgers.edu*

PROJECT DURATION: Three years

OUTCOME/AREA OF INTEREST: Respiratory Disease (Oxidative stress, Lung injury)

POPULATION/DATA SOURCE: Other (Animal model for responders)

DESCRIPTION: In this project, we are testing the hypothesis that chronic intermittent hypoxia exacerbates WTC dust exposure induced oxidative stress, lung injury, and alterations in lung function in a mouse model of WTC dust exposure. We will also examine alterations in the metabolomic profile and correlate them to the changes in the immunometabolic function of alveolar and interstitial lung macrophages in this mouse model of WTC dust exposure.

STUDY DESIGN: Animal Model

Changes in Monocyte Transcriptome as a Predictor of Cognitive Decline in WTC Responders: a Longitudinal Study

PROJECT NUMBER: 1 U01 OH012257-01

INSTITUTION: State University New York Stony Brook

PRINCIPAL INVESTIGATORS: Pei-Fen Kuan, PhD (contact PI; PI of a current/funded WTCHP project FY17 OH11478); Sean Clouston

PHONE NUMBER: *(631) 632-1419*

EMAIL: *peifen.kuan@stonybrook.edu*

PROJECT DURATION: Three years

DESCRIPTION: World Trade Center (WTC) responders are showing signs of mild cognitive impairment (MCI), a symptom consistent with neurodegenerative diseases earlier than general population. For the first time, we will compare the monocyte transcriptome and plasma markers of cerebral neuropathology of Stony Brook WTC Health Program responders within a longitudinal study design to identify molecular mechanisms underlying monocyte dynamics and the biological processes involved in the progression of MCI to dementia. This knowledge will help identify novel blood-based biomarkers for early detection of Alzheimer's disease, and inform development of novel treatments.

STUDY DESIGN: Longitudinal

Cognition and Neuropathology in World Trade Center-exposed FDNY, NYPD, and Construction Worker Responders

PROJECT NUMBER: 1 U01 OH012258-01

INSTITUTION: State University New York Stony Brook

PRINCIPAL INVESTIGATORS: Sean Clouston, PhD (contact PI); Charles Hall (PI of a current/funded WTCHP project FY16 OH11932/OH11315)

PHONE NUMBER: *(631) 444-6593*

EMAIL: *sean.clouston@stonybrookmedicine.edu*

PROJECT DURATION: Five years

POPULATION/DATA SOURCE: Responders (FDNY Responders)

DESCRIPTION: World Trade Center (WTC) responders were exposed to a mix of tiny dust particles and toxic gases when they participated in rescue and recovery efforts at the WTC. While all responders were exposed, the Fire Department of the City of New York (FDNY) responders were more intensely exposed to inhaled particles. Given the magnitude and scale of events surrounding 9/11 and reports of cognitive dysfunction indicative of an underlying neurodegenerative disease, we proposed to examine cognitive symptoms, blood-based biomarkers, and Beta-Amyloid and Tau on positron emission tomography in FDNY responders to compare with Police and Volunteer responders.

STUDY DESIGN: Cross-Sectional Study

Evidence of Toxicant-associated Fatty Liver Disease in WTC Responders

PROJECT NUMBER: 1 U01 OH012263-01

INSTITUTION: Icahn School of Medicine at Mount Sinai

PRINCIPAL INVESTIGATOR: Andrea Branch, PhD (PI of a current/funded WTCHP project FY17 OH11489)

PHONE NUMBER: *(212) 659-8371*

EMAIL: *andrea.branch@mssm.edu*

PROJECT DURATION: Three years

DESCRIPTION: This project will use our newly-developed and novel diagnostic tools [computer tomography (CT)-based and electronic health record (EHR)-based] to identify members of the World Trade Center (WTC) General Responder Cohort

(GRC) who have evidence of toxicant-associated fatty liver disease (TAFLD) and liver cancer. The findings will provide unprecedented detail about these occupational liver diseases, helping to inform public policy. A WTC Liver Disease registry will be established to collect data about the impact of liver disease on quality of life and other valuable information.

Longitudinal Follow-Up of 9/11 Directly Exposed Children in their Age of Transition: Independence, Occupation and Morbidity

PROJECT NUMBER: 1 U01 OH012264-01

INSTITUTION: New York State Psychiatric Institute

PRINCIPAL INVESTIGATOR: Christina Hoven, DrPH

PHONE NUMBER: *(646) 774-6068*

EMAIL: *Christina.Hoven@nyspi.columbia.edu*

PROJECT DURATION: Five years

DESCRIPTION: As we approach the 20th anniversary of 9/11, the focus of this study is to thoroughly examine the long-term consequences of being exposed to 9/11 as a child, including mental and physical health, adult development, role functioning, relationships, independence and parenting Using our thoroughly characterized ongoing longitudinal, representative cohort of 9/11 directly exposed children, we will now conduct a third wave of physical and psychological assessments and add a thorough examination of adult developmental achievements and challenges. This will result in the largest, longest and most thoroughly studied cohort of 9/11 exposed children, and will give us the knowledge to mitigate their suffering and improve their lives, as well as the lives of children exposed to mass trauma in the future.

Early Detection of Clonal Hematopoiesis and Leukemia Associated Mutations in WTC Exposed Firefighters after the 9/11 Attacks

PROJECT NUMBER: 1 U01 OH012271-01

INSTITUTION: Albert Einstein College of Medicine

PRINCIPAL INVESTIGATORS: Amit Verma, MD (Contact PI; PI of a current/funded WTCHP project FY17 OH11933/11475); Michael Savona; Rachel Zeig-Owens

PHONE NUMBER: (718) 430-8761

EMAIL: *amit.verma@einsteinmed.org*

PROJECT DURATION: Three years

POPULATION/DATA SOURCE: Responders ***(FDNY Employees; WTC-exposed firefighters, non-WTC exposed firefighters and non-firefighters)***

DESCRIPTION: Our proposal aims to detect mutations associated with early signs of clonal hematopoiesis and blood cancers in samples from firefighters who were exposed to the World Trade Center (WTC) dust after the 9/11 terrorist attack. To test how WTC exposure results in increased mutations, we will also study the effects of exposure to WTC dust in animal models. Early detection of these cases would enable clinical evaluation and potentially disease altering therapeutic interventions for firefighters.

STUDY DESIGN: Case series evaluating incidence of mutations on banked samples

Neuropsychological Profile and Neurocognitive Biomarkers of Attention and Memory in Trauma-Exposed Responders at Risk of Premature Cognitive Decline

PROJECT NUMBER: 1 U01 OH012272

INSTITUTION: New York State Psychiatric Institute

PRINCIPAL INVESTIGATOR: Yael Cycowicz, PhD (PI of current/funded ***WTCHP projects FY18 OH11694 and FY20 OH12065)***

PHONE NUMBER: ***(646) 774-5837***

EMAIL: ***Yael.Cycowicz@nyspi.columbia.edu***

PROJECT DURATION: Five years

DESCRIPTION: Exposure to trauma can lead to premature cognitive decline, as early as mid-life, and adversely affect one's quality of life. First responders who were 20-35 years old at the time of the September 11 terror attack, are at a greater risk for premature cognitive decline, especially if they have other health consequences such as respiratory disorders or depression. This proposal aims to assess cognitive decline, using a battery of neuropsychological tests and neuroimaging measures, to advance our understanding of premature cognitive decline and its neurobiological mechanisms among the youngest first-responders to hopefully contribute to the development of early interventions.

STUDY DESIGN: WTC first responders with underlying physical or a mental health condition other than PTSD and cancer will be neuropsychologically assessed twice (longitudinal) at the beginning and the end of the grant period. In addition, a subset of WTC FR will participate in the investigation of the mechanisms of premature cognitive decline compared with the community controls (cross sectional).

Severity and Long-term Health Effects of COVID-19 among World Trade Center Responders

PROJECT NUMBER: 1 U01 OH012275

INSTITUTION: State University New York Stony Brook

PRINCIPAL INVESTIGATORS: Olga Morozova, PhD (contact PI); Michael Crane; Laura Crowley; Benjamin Luft

PHONE NUMBER: ***(631) 444-9396***

EMAIL: ***olga.morozova@stonybrookmedicine.edu***

PROJECT DURATION: Five years

DESCRIPTION: SARS-CoV-2 infection causes potentially deadly disease called COVID-19, which has severely affected aging and vulnerable populations in the United States and around the world, possibly leading to serious long-term health effects among survivors. This project will evaluate risk factors for COVID-19 severity and assess the long-term health outcomes of COVID-19 among World Trade Center responders – an aging population with high prevalence of respiratory and pulmonary conditions, and occupational risk factors. The results of this study will contribute to understanding the impact of genetic factors, toxic

environmental exposures, occupational factors and preexisting conditions on the course and long-term effects of COVID-19.

STUDY DESIGN: Prospective cohort

Investigating the Association of Posttraumatic Stress Disorder (PTSD) with Chronic Kidney Disease (CKD) in World Trade Center (WTC) Responders

PROJECT NUMBER: 1 R21 OH012237-01

INSTITUTION: State University New York Stony Brook

PRINCIPAL INVESTIGATOR: Farrukh Mansoor Koraishy, MBBS, MD

PHONE NUMBER: *(631) 444-3036*

EMAIL: *farrukh.koraishy@stonybrookmedicine.edu*

PROJECT DURATION: Two years

DESCRIPTION::Chronic kidney disease (CKD) is common, costly, associated with high mortality and a promising area to identify novel risk factors is mental health disorders, specifically post-traumatic stress disorder (PTSD), a common psychiatric diagnosis in WTC responders. The objectives of this research proposal are to test the hypotheses that severity/course of PTSD can predict the risk of CKD and to identify gene/protein variants related to common pathways between PTSD and CKD/GFR decline in WTC responders. This research proposal will address a current gap in the field by contributing to the understanding of how chronic mental stress contributes to kidney disease in the WTC responders and will lead to further studies on the effects of mental trauma on the kidneys.

DNA Methylation Profiles and Breast Cancer among WTC Survivors

PROJECT NUMBER: 1 R21 OH012238

INSTITUTION: New York University School of Medicine

PRINCIPAL INVESTIGATOR: Alan Arslan, MD

PHONE NUMBER: *(212) 263-7763*

EMAIL: *Alan.Arslan@nyulangone.org*

PROJECT DURATION: Two years

DESCRIPTION:The main objective of the project is to assess and validate the role of DNA methylation as objective marker of WTC exposure-related breast cancer among general population of survivors, specifically women

Long-term Effects of WTC Exposure on Respiratory and Cardiovascular Diseases using Automated CT Image Analysis

PROJECT NUMBER: 1 R21 OH012244

INSTITUTION: Icahn School of Medicine at Mount Sinai

PRINCIPAL INVESTIGATOR: Artit Jirapatnakul, PhD

PHONE NUMBER: *(212) 241-2367*

EMAIL: *artit.jirapatnakul@mountsinai.org*

PROJECT DURATION: Two years

DESCRIPTION: Responders to the World Trade Center attack were exposed to toxic dust, which has been linked to increased incidence of respiratory and cardiovascular disease, but the relationship between the amount of exposure and the extent and progression of disease is not well understood. The proposed research uses automated image analysis software to identify and measure specific respiratory and cardiovascular diseases: emphysema, pleural thickening, interstitial lung disease, and coronary artery calcifications. This will allow for the analysis of the relationship between these diseases and WTC exposure, which may inform screening guidelines for diseases, such as lung cancer, with long latency periods for WTC responders.

Implementing a Lifestyle Medicine Program via Telehealth to Optimize GERD Management in WTC First Responders

PROJECT NUMBER: 1 R21 OH012247

INSTITUTION: Icahn School of Medicine at Mount Sinai

PRINCIPAL INVESTIGATOR: Emilie Senay, MD

PHONE NUMBER: *(212) 241-6442*

EMAIL: *emily.senay@mssm.edu*

PROJECT DURATION: Two yearsDescription: Gastroesophageal reflux disease (GERD) can increase risk of esophageal adenocarcinoma, increase need for medication, negatively impact quality of life (QOL) and is among the most common conditions in World Trade Center (WTC) first responders. Lifestyle modification is an effective first-line therapy for GERD, yet patients rarely receive adequate counseling to maximize needed behavioral change. This study will evaluate a formal evidence-based Lifestyle Medicine (LM) Program for WTC first responders interested in reducing symptoms and/or medication use related to GERD.

WTC-Related Pollutants in Thyroid Cancer Tissue

PROJECT NUMBER: 1 R21 OH012249

INSTITUTION: Icahn School of Medicine at Mount Sinai

PRINCIPAL INVESTIGATOR: Maaike van Gerwen, MD, PhD

PHONE NUMBER: *(212) 659-9620*

EMAIL: *maaike.vangerwen@mountsinai.org*

PROJECT DURATION: Two years

DESCRIPTION: There is an excess cancer risk in the World Trade Center first responders that our previous research has confirmed not to be associated with surveillance or physician bias therefore WTC dust exposure-may potentially be associated with thyroid cancer carcinogenesis although the exact carcinogenic mechanism remains unclear. Understanding the thyroid carcinogenesis associated with respiratory WTC dust exposure in this highly exposed population will shape future studies investigating other cancers with excess risk in the WTC cohorts. If WTC dust exposure is associated with the accumulation of WTC dust components and their metabolites in the thyroid gland and is potentially associated with an inflammatory microenvironment, then the same mechanism may exist for other WTC-exposed cancers as well as for cancers with excess risk in other highly environmentally exposed populations.

An Innovative Approach to Improving Asthma Control for World Trade Center Rescue and Recovery Workers through Telehealth Enriched Asthma Management (WTC-TEAM)

PROJECT NUMBER: 1 R21 OH012253

INSTITUTION: Icahn School of Medicine at Mount Sinai

PRINCIPAL INVESTIGATOR: Erin Thanik, MD

PHONE NUMBER: *(212) 241-7069*

EMAIL: *erin.thanik@mssm.edu*

PROJECT DURATION: Two years

DESCRIPTION: Exposure to airborne toxins among rescue and recovery workers who responded to the World Trade Center (WTC) disaster provoked several respiratory conditions, including asthma. This project will address the unique needs of WTC rescue and recovery workers by developing an innovative approach to optimizing asthma care, the Telehealth Enriched Asthma Management (TEAM) program, to promote self- management. We will test this intervention as well as evaluate telehealth capabilities, not only to improve asthma care and outcomes, but also to develop knowledge to optimally respond to patients during the ongoing coronavirus-19 pandemic and in the event of future public health crises.

Trauma Exposure and Cognitive Impairment: Understanding Polygenic Liability and the Causative and Moderating Effects of Exposure, PTSD, and Psychiatric Comorbidity in WTC Responders

PROJECT NUMBER: 1 R21 AG074705

INSTITUTION: State University New York Stony Brook

PRINCIPAL INVESTIGATOR: Frank Mann, PhD

PHONE NUMBER: (612) 625-2818

EMAIL: *FRANK.MANN@STONYBROOK.EDU*

PROJECT DURATION: Two years

DESCRIPTION: Incidence of cognitive impairment is higher in WTC (World Trade Center) responders than in the general population, and is accompanied by psychiatric comorbidity, including symptoms of PTSD and major depressive disorder (MDD). This proposal has a high-potential to inform health strategies that manage cognitive impairment and psychiatric comorbidity in WTC responders by illuminating the potentially causative and mechanistic roles of exposure severity, PTSD, and depressive symptoms in the emergence and progression of cognitive impairment, while also exploring the more general question of whether trauma exposure and its psychiatric sequalae are causally related to, or exacerbate underlying genetic liability for mental health problems, which is of interest to clinicians, epidemiologists, and psychiatrists alike.

Using Artificial Intelligence to Identify Accelerated Brain Aging in World Trade Center Responders

PROJECT NUMBER: 1 R21 AG074706

INSTITUTION: State University New York Stony Brook

PRINCIPAL INVESTIGATOR: Lilianne Mujica-Parodi, PhD

PHONE NUMBER: (631) 428-8461

EMAIL: *LILIANNE.STREY@STONYBROOK.EDU*

PROJECT DURATION: Two years

DESCRIPTION: The men and women who worked in rescue and recovery operations at the 9/11 World Trade Center (WTC) site are developing cognitive impairment at mid-life, decades before age-based cognitive impairment is usually detected. This study seeks to implement a novel measure of brain age, optimized to be sensitive to midlife neurological changes, and combines it with artificial intelligence to understand the mechanisms through which exposures may have affected WTC responders. We propose to complete secondary data analyses of a large scale brain MRI training data set (UK Biobank, N=19,831) to train a deep learning model for neurobiological signatures of aging and its potential mechanisms. We will then compare neurobiological features seen in WTC responders to these signatures.

Using Resting State Functional MRI to Predict Cognitive Decline among World Trade Center Responders

PROJECT NUMBER: 1 R21 AG074707

INSTITUTION: State University New York Stony Brook

PRINCIPAL INVESTIGATOR: Sara Weisenbach, PhD

PHONE NUMBER: (631) 638-2035

EMAIL: *Sara.Weisenbach@stonybrookmedicine.edu*

PROJECT DURATION: Two years

DESCRIPTION: World Trade Center (WTC) responders experience cognitive impairment at higher rates and at earlier ages than community normative samples, with underlying plasma and structural brain markers suggestive of a neurodegenerative process. Early identification of cognitive impairment and prediction of future cognitive decline is imperative for formulating accurate treatment goals and for care planning. This study aims to measure resting state networks in WTC responders with and without cognitive impairment, and associated network patterns with current and prospective cognitive performance to inform a larger study that will aim to These results will inform a study that will aim to identify (with a larger sample) how and to what extent RS fMRI metrics can be used for predicting cognitive change in WTC responders.

Physical and Mental Health Pathays to Cognitive Decline in World Trade Center Responders: The Roles of Pulmonary Function and Post-Traumatic Stress Disorder

PROJECT NUMBER: 1 R21 AG074708

INSTITUTION: Rush University Medical Center

PRINCIPAL INVESTIGATOR: Andrea Zammit, PhD

PHONE NUMBER: (312) 942-3870

EMAIL: *zammitandrea@gmail.com*

PROJECT DURATION: Two years

DESCRIPTION: Cognitive impairment is an emerging public health condition in World Trade Center (WTC) responders, and one that will become more clinically significant in the coming years. Non-cognitive symptoms, such as physical and mental health conditions, may be in the pathway leading from WTC exposure to early onset cognitive impairment and non-normative cognitive decline. We seek to explicate the individual, joint, and mediating effects of abnormal spirometry and chronic post-traumatic stress disorder (PTSD) on cognitive decline to further our understanding of non-cognitive pathways to cognitive impairment, consequently target high-risk individuals to mitigate preventable cognitive decline in years to come.

WTC Health Program Research Cooperative Agreements and Other Grants Awarded in FY 2022

PAR-20-280 COOPERATIVE RESEARCH AGREEMENTS RELATED TO THE WORLD TRADE CENTER HEALTH PROGRAM (U01)

Pulmonary Diseases in WTC Workers: Symptoms, Function, and Chest CT Correlates

PROJECT NUMBER: 2 U01 OH 010401-09

INSTITUTION: Icahn School of Medicine at Mount Sinai

PRINCIPAL INVESTIGATOR: Rafael E. de la Hoz, MD, MPH, MSc, ATSF, FACP, FCCP

PHONE NUMBER: (212) 241-7996

EMAIL: *RAFAEL.DELAHOZ@MSSM.EDU*

PROJECT DURATION: Four years

DESCRIPTION: Utilizing an extensive amount of qualitative and quantitative imaging, clinical, and functional data, we propose to investigate newly developed and novel chest CT scan imaging and spirometric markers to the investigation of lung tissue and airway injury and remodeling, and its evolution over time towards healing and recovery, or to chronic and disabling chronic lung disease. These in-

vestigations have the potential to enhance our ability for earlier and more effective detection or treatment, and to prevent disability.WTC Subpopulation(s) under

STUDY DESIGN: General Responders

PRIMARY DISEASES OR CONDITIONS: Respiratory Disease (Lower Airway Diseases)

STUDY DESIGN: Retrospective Cohort, Cross-sectional, Longitudinal Analysis

Metabolomics of World Trade Center-Lung Injury: Biomarker Validation, Longitudinal Assessment and Dietary Intervention

PROJECT NUMBER: 2 U01 OH011300-05

INSTITUTION: New York University School of Medicine

PRINCIPAL INVESTIGATOR: Anna Nolan, MD, MSc

PHONE NUMBER: (646) 501-6783

EMAIL: *ANNA.NOLAN@NYULANGONE.ORG*

PROJECT DURATION: Four years

DESCRIPTION: The adverse health effects at the intersection of metabolic syndrome, particulate matter exposure, and pulmonary disease are a global concern. In the context of our FIREHOUSE cohort, we will i. perform comprehensive/integrative multiOMIC profiling to identify metabolic contributors and biosignatures of disease and its potential therapeutic targets; ii. Determine long-term effectiveness of our multidisciplinary approach to improve health outcomes; iii. validate our observations made in the prior funding period and iv. determine feasibility and need using shared decision making of the technology supported nutritional intervention. This work falls squarely within the purview of the James Zadroga 9/11 Health & Compensation Act. WTC Subpopulation(s) under study: FDNY First Responders (90%) and WTCHP/CCE Enrollees (10%).

PRIMARY DISEASES OR CONDITIONS: Respiratory Disease

STUDY DESIGN: Randomized Controlled Clinical Trial (Data Analysis); Observational

Association of PTSD Dose with Cardiovascular Disease Risk in Multi-ethnic WTC Heart Cohort: 13-Year Follow Up

PROJECT NUMBER: 1 U01 OH012265-01A1

INSTITUTION: Queens College, CUNY

PRINCIPAL INVESTIGATOR: Alfredo Morabia, MD, PhDPhone Number: (917) 670-4180

EMAIL: *AMORABIA@QC.CUNY.EDU*

PROJECT DURATION: Four years

DESCRIPTION: The proposed study ambitions to provide guidance for whether effective treatment for posttraumatic stress disorder (PTSD) would aid in the prevention of cardiovascular disease (CVD), a leading cause of death. Its innovative aspects are a) a consideration of the influence of cumulated symptoms of PTSD over time (PTSD "dose") in relation to cardiovascular disease risk in the full cohort; b) the ability to stratify theses analyses by race/ethnicity, and c) an examination of the association between PTSD dose and behavioral

and biological, and trauma history plausibility markers of stress and CVD risk in a subsample of the cohort. WTC Subpopulation under

STUDY DESIGN: General Responders

PRIMARY DISEASES OR CONDITIONS: Cardiovascular Diseases (fatal and nonfatal coronary artery disease and cerebrovascular events); Adult Mental Health (Depression and Post-Traumatic Stress Disorder.)

STUDY DESIGN: Prospective Cohort study

Promoting Healthy Aging among WTC Responders: Frailty Trajectories and Intervention Strategies

PROJECT NUMBER: 1 U01 OH012473-01
Institution: Icahn School of Medicine at Mount Sinai

PRINCIPAL INVESTIGATORS: Fred Chau-Yang Ko, MD (contact PI); William Hung, MD; Katherine Orstein, PHD

PHONE NUMBER: (212) 241-9370

EMAIL: *FRED.KO@MSSM.EDU*

PROJECT DURATION: Four years

DESCRIPTION: As the World Trade Center general responder cohort ages, the assessment of aging-related syndromes (e.g., falls, functional decline) and implementation of healthy aging interventions become increasingly important. The goals of this study are to: (1) validate a frailty index among the general responder cohort that will allow identification of risk factors that worsen frailty trajectories and predict aging-related outcomes; and (2) implement a pilot multicomponent intervention targeting modifiable risk factors of frailty among responders. This work will enable timely monitoring for frailty and the development of interventions to promote healthy aging and to prevent clinical decline in this high-risk population.

WTC SUBPOPULATION(S) UNDER STUDY: General Responders (WTCHP/CCE Enrollees) Primary Diseases or Conditions: Emerging Conditions (Aging)

STUDY DESIGN: Prospective Cohort

Developing and Evaluating Artificial Intelligence-based Longitudinal Assessmentsof PTSD in 9/11 Responders

PROJECT NUMBER: 1 U01 OH012476-01

INSTITUTION: State University New York Stony Brook

PRINCIPAL INVESTIGATOR: Hansen Andrew Schwartz, PhD

PHONE NUMBER: (631) 632-2459

EMAIL: *HAS@CS.STONYBROOK.EDU*

PROJECT DURATION: Four years

DESCRIPTION: Two decades after the disaster, symptoms and severity of posttraumatic stress disorder (PTSD) manifest differently and fluctuate within each WTC responders' daily life, making it difficult to measure and predict. This project will leverage recent advances in artificial intelligence (AI) techniques, applied across time and natural communication, to enable

more accurate and fine-grained longitudinal assessments of PTSD symptoms and future outcome risks based on patients' own words. This work will develop a tool PTSD-STOP to aid in such assessment of PTSD symptoms over three communication modalities and determine the optimum inputs as well as generalizability across demographic and population attributes.

WTC SUBPOPULATION(S) UNDER STUDY: WTC Responders (currently residing on Long Island and serviced by the Stony Brook World Trade Center Wellness Clinic): Police (48%), Fire Fighters (33%), General Responders (19%).

PRIMARY DISEASES OR CONDITIONS: Adult Mental Health (PTSD)

STUDY DESIGN: Cross-sectional (Aim 1), Retrospective Longitudinal Cohort (Aim 2), and Prospective Longitudinal Cohort (Aim 3).

RFA-OH-22-004 WORLD TRADE CENTER HEALTH RESEARCH RELATED TO WTC SURVIVORS (U01)

Exposomic Approach to Identifying WTC Exposures and Effects in Survivor Youth

PROJECT NUMBER: 1 U01 OH012472-01

INSTITUTION: Columbia University Health Sciences

PRINCIPAL INVESTIGATORS: Julie Beth Herbstman, PhD (contact PI); Leonardo Trasande, MD

PHONE NUMBER: (212) 304-7273

EMAIL: *JH2678@COLUMBIA.EDU*

PROJECT DURATION: Four years

DESCRIPTION: Characterizing the totality of WTC exposure—both psychological and chemical—has been challenging, particularly among pregnant women and children, which has limited our ability to identify WTC-related health effects. New advances in high resolution gas chromatography can characterize WTC-related exposure and biological response to exposure in ways that were previously impossible. This study uses novel metabolomic and exposomic methods to characterize WTC exposure and the effects of WTC exposure among those who were exposed in utero or as children, two sensitive windows of development.

WTC SUBPOPULATION(S) UNDER STUDY: Survivors (those who were exposed to WTC either in utero or during early childhood).

PRIMARY DISEASES OR CONDITIONS: Children's Research (WTC Youth), where conditions include subclinical molecular changes measurable in stored blood plasma and associations with adverse birth outcomes, neurodevelopment and cardiometabolic endpoints.

STUDY DESIGN: Cohort Study

Grief and Health-related Quality of Life in WTCHR Survivors: Associations with Bereavement, Trauma Exposures, and Mental and Physical Health Conditions

PROJECT NUMBER: 1 U01 OH012485-01

INSTITUTION: Henry M. Jackson Foundation for the Advancement of Military Medicine, Inc.

PRINCIPAL INVESTIGATORS: Stephen J. Cozza, MD (contact PI); Joscelyn Elizabeth Fisher, PhD

PHONE NUMBER: (301) 295-2470

EMAIL: *STEPHEN.COZZA@USUHS.EDU*

PROJECT DURATION: 3 years

DESCRIPTION: Minimal research has examined grief (e.g., prolonged grief disorder) in bereaved WTCHR Survivors, including its effects on mental, social, environmental, and physical health-related quality of life (HRQoL). Using existing WTCHR data regarding 9/11 trauma burden and newly-collected information (regarding other traumas, bereavement burden, physical and mental health burden, grief severity, HRQoL, and cognitive difficulties), we will examine the inter-relationships among these variables in a gender, race, and ethnically diverse sample to outline risk pathways to inform WTCHP programming. We also intend to examine whether WTCHR Survivors at-risk for PGD have access to and would engage grief-specific treatments.

WTC SUBPOPULATION(S) UNDER STUDY: WTC Survivors with a history of 9/11 or post-9/11 bereavement

PRIMARY DISEASES OR CONDITIONS: Adult Mental Health (prolonged grief disorder)

STUDY DESIGN: Longitudinal Cohort Study

Cognitive Decline among WTC Survivors with Chronic Mental and Physical Disorders

PROJECT NUMBER: 1 U01 OH012486-01

INSTITUTION: New York University Grossman School of Medicine

PRINCIPAL INVESTIGATORS: Yongzhao Shao, PhD (contact PI); Joan Reiman, MD; Thomas Wisniewski, MD

PHONE NUMBER: (646) 501-3645

EMAIL: *YONGZHAO.SHAO@NYULANGONE.ORG*

PROJECT DURATION: Four years

DESCRIPTION: Despite widely-reported cognitive impairments among World Trade Center (WTC) Responders, there is a lack of information about cognitive status among community members affected by the 9/11 terrorist attack on the WTC towers ("Survivors"). Post-traumatic stress disorder (PTSD) and chronic respiratory symptoms remain prevalent among WTC Survivors. We propose to investigate the biological mechanisms linking WTC exposures, comorbid chronic mental and physical disorders, with baseline cognitive function and decline among WTC Survivors by assessing blood-based biomarkers of inflammation and neurodegeneration as mediators of WTC exposures and risk of cognitive abnormality and as possible modifiable targets for novel interventions.

WTC SUBPOPULATION(S) UNDER STUDY: Survivors (enrolled at the WTC Environmental Health Center)

PRIMARY DISEASES OR CONDITIONS: Respiratory Disease, Adult Mental Health, Emerging Conditions (Cognitive Function).The Respiratory Disease includes chronic lower respiratory symptoms and impaired lung functions. The Adult Mental Health conditions include symptoms of post-traumatic stress disorder (PTSD) and depression and anxiety. The Emerging Conditions (cognitive functions) include probable cognitive decline as indicated by low Montreal Cognitive Assessment (MoCA) or the Clinical Dementia Rating Scale Sum of Boxes (CDR-SB) scores among the WTC Survivors.

STUDY DESIGN: Longitudinal Follow Up StudyMetabolomics of World Trade Center-Lung Injury: Biomarker Validation, Longitudinal Assessment and Dietary Intervention

Metabolomics of World Trade Center-Lung Injury: Biomarker Validation, Longitudinal Assessment and Dietary Intervention

PROJECT NUMBER: 2 U01 OH011300-05

INSTITUTION: New York University School of Medicine

PRINCIPAL INVESTIGATOR: Anna Nolan, MD, MSc

PHONE NUMBER: (646) 501-6783

EMAIL: *ANNA.NOLAN@NYULANGONE.ORG*

PROJECT DURATION: Four years

DESCRIPTION: The adverse health effects at the intersection of metabolic syndrome, particulate matter exposure, and pulmonary disease are a global concern. In the context of our FIREHOUSE cohort, we will i. perform comprehensive/integrative multiOMIC profiling to identify metabolic contributors and biosignatures of disease and its potential therapeutic targets; ii. Determine long-term effectiveness of our multidisciplinary approach to improve health outcomes; iii. validate our observations made in the prior funding period and iv. determine feasibility and need using shared decision making of the technology supported nutritional intervention. This work falls squarely within the purview of the James Zadroga 9/11 Health & Compensation Act. WTC Subpopulation(s) under study: FDNY First Responders (90%) and WTCHP/CCE Enrollees (10%).

PRIMARY DISEASES OR CONDITIONS: Respiratory Disease

STUDY DESIGN: Randomized Controlled Clinical Trial (Data Analysis); Observational

Association of PTSD Dose with Cardiovascular Disease Risk in Multi-ethnic WTC Heart Cohort: 13-Year Follow Up

PROJECT NUMBER: 1 U01 OH012265-01A1

INSTITUTION: Queens College, CUNY

PRINCIPAL INVESTIGATOR: Alfredo Morabia, MD, PhDPhone Number: (917) 670-4180

EMAIL: *AMORABIA@QC.CUNY.EDU*

PROJECT DURATION: Four years

DESCRIPTION: The proposed study ambitions to provide guidance for whether

effective treatment for posttraumatic stress disorder (PTSD) would aid in the prevention of cardiovascular disease (CVD), a leading cause of death. Its innovative aspects are a) a consideration of the influence of cumulated symptoms of PTSD over time (PTSD "dose") in relation to cardiovascular disease risk in the full cohort; b) the ability to stratify theses analyses by race/ethnicity, and c) an examination of the association between PTSD dose and behavioral and biological, and trauma history plausibility markers of stress and CVD risk in a subsample of the cohort.WTC Subpopulation under study: General Responders

PRIMARY DISEASES OR CONDITIONS: Cardiovascular Diseases (fatal and nonfatal coronary artery disease and cerebrovascular events); Adult Mental Health (Depression and Post-Traumatic Stress Disorder.)

STUDY DESIGN: Prospective Cohort Study

Promoting Healthy Aging among WTC Responders: Frailty Trajectories and Intervention Strategies

PROJECT NUMBER: 1 U01 OH012473-01 Institution: Icahn School of Medicine at Mount Sinai

PRINCIPAL INVESTIGATORS: Fred Chau-Yang Ko, MD (contact PI); William Hung, MD; Katherine Orstein, PHD

PHONE NUMBER: (212) 241-9370

EMAIL: *FRED.KO@MSSM.EDU*

PROJECT DURATION: Four years

DESCRIPTION: As the World Trade Center general responder cohort ages, the assessment of aging-related syndromes (e.g., falls, functional decline) and implementation of healthy aging interventions become increasingly important. The goals of this study are to: (1) validate a frailty index among the general responder cohort that will allow identification of risk factors that worsen frailty trajectories and predict aging-related outcomes; and (2) implement a pilot multicomponent intervention targeting modifiable risk factors of frailty among responders. This work will enable timely monitoring for frailty and the development of interventions to promote healthy aging and to prevent clinical decline in this high-risk population.

WTC SUBPOPULATION(S) UNDER STUDY: General Responders (WTCHP/CCE Enrollees) Primary Diseases or

CONDITIONS: Emerging Conditions (Aging)

STUDY DESIGN: Prospective Cohort

Developing and Evaluating Artificial Intelligence-based Longitudinal Assessmentsof PTSD in 9/11 Responders

PROJECT NUMBER: 1 U01 OH012476-01

INSTITUTION: State University New York Stony Brook

PRINCIPAL INVESTIGATOR: Hansen Andrew Schwartz, PhD

PHONE NUMBER: (631) 632-2459

EMAIL: *HAS@CS.STONYBROOK.EDU*

PROJECT DURATION: Four years

DESCRIPTION: Two decades after the disaster, symptoms and severity of post-traumatic stress disorder (PTSD) manifest differently and fluctuate within each WTC responders' daily life, making it difficult to measure and predict. This project will leverage recent advances in artificial intelligence (AI) techniques, applied across time and natural communication, to enable more accurate and fine-grained longitudinal assessments of PTSD symptoms and future outcome risks based on patients' own words. This work will develop a tool PTSD-STOP to aid in such assessment of PTSD symptoms over three communication modalities and determine the optimum inputs as well as generalizability across demographic and population attributes. WTC Subpopulation(s) under study: WTC Responders (currently residing on Long Island and serviced by the Stony Brook World Trade Center Wellness Clinic): Police (48%), Fire Fighters (33%), General Responders (19%).

PRIMARY DISEASES OR CONDITIONS: Adult Mental Health (PTSD)

STUDY DESIGN: Cross-sectional (Aim 1), Retrospective Longitudinal Cohort (Aim 2), and Prospective Longitudinal Cohort (Aim 3).

RFA-OH-22-004 WORLD TRADE CENTER HEALTH RESEARCH RELATED TO WTC SURVIVORS (U01)

Exposomic Approach to Identifying WTC Exposures and Effects in Survivor Youth

PROJECT NUMBER: 1 U01 OH012472-01

INSTITUTION: Columbia University Health Sciences

PRINCIPAL INVESTIGATORS: Julie Beth Herbstman, PhD (contact PI); Leonardo Trasande, MD

PHONE NUMBER: (212) 304-7273

EMAIL: *JH2678@COLUMBIA.EDU*

PROJECT DURATION: Four years

DESCRIPTION: Characterizing the totality of WTC exposure—both psychological and chemical—has been challenging, particularly among pregnant women and children, which has limited our ability to identify WTC-related health effects. New advances in high resolution gas chromatography can characterize WTC-related exposure and biological response to exposure in ways that were previously impossible. This study uses novel metabolomic and exposomic methods to characterize WTC exposure and the effects of WTC exposure among those who were exposed in utero or as children, two sensitive windows of development.

WTC SUBPOPULATION(S) UNDER STUDY: Survivors (those who were exposed to WTC either in utero or during early childhood).

PRIMARY DISEASES OR CONDITIONS: Children's Research (WTC Youth), where conditions include subclinical molecular changes measurable in stored blood plasma and associations with adverse birth outcomes, neurodevelopment and cardiometabolic endpoints.

STUDY DESIGN: Cohort Study

Grief and Health-related Quality of Life in WTCHR Survivors: Associations with Bereavement, Trauma Exposures, and Mental and Physical Health Conditions

PROJECT NUMBER: 1 U01 OH012485-01

INSTITUTION: Henry M. Jackson Foundation for the Advancement of Military Medicine, Inc.

PRINCIPAL INVESTIGATORS: Stephen J. Cozza, MD (contact PI); Joscelyn Elizabeth Fisher, PhD

PHONE NUMBER: (301) 295-2470

EMAIL: *STEPHEN.COZZA@USUHS.EDU*

PROJECT DURATION: 3 years

DESCRIPTION: Minimal research has examined grief (e.g., prolonged grief disorder) in bereaved WTCHR Survivors, including its effects on mental, social, environmental, and physical health-related quality of life (HRQoL). Using existing WTCHR data regarding 9/11 trauma burden and newly-collected information (regarding other traumas, bereavement burden, physical and mental health burden, grief severity, HRQoL, and cognitive difficulties), we will examine the inter-relationships among these variables in a gender, race, and ethnically diverse sample to outline risk pathways to inform WTCHP programming. We also intend to examine whether WTCHR Survivors at-risk for PGD have access to and would engage grief-specific treatments.

WTC SUBPOPULATION(S) UNDER STUDY: WTC Survivors with a history of 9/11 or post-9/11 bereavement

PRIMARY DISEASES OR CONDITIONS: Adult Mental Health (prolonged grief disorder)

STUDY DESIGN: Longitudinal Cohort Study

Cognitive Decline among WTC Survivors with Chronic Mental and Physical Disorders

PROJECT NUMBER: 1 U01 OH012486-01

INSTITUTION: New York University Grossman School of Medicine

PRINCIPAL INVESTIGATORS: Yongzhao Shao, PhD (contact PI); Joan Reiman, MD; Thomas Wisniewski, MD

PHONE NUMBER: (646) 501-3645

EMAIL: *YONGZHAO.SHAO@NYULANGONE.ORG*

PROJECT DURATION: Four years

DESCRIPTION: Despite widely-reported cognitive impairments among World Trade Center (WTC) Responders, there is a lack of information about cognitive status among community members affected by the 9/11 terrorist attack on the WTC towers ("Survivors"). Post-traumatic stress disorder (PTSD) and chronic respiratory symptoms remain prevalent among WTC Survivors. We propose to investigate the biological mechanisms linking WTC exposures, comorbid chronic mental and physical disorders, with baseline cognitive function and decline among WTC Survivors by assessing blood-based biomarkers of inflammation and neurodegeneration as mediators of WTC exposures and risk of cognitive abnormality and as possible modifiable targets for novel interventions.

WTC SUBPOPULATION(S) UNDER STUDY: Survivors (enrolled at the WTC Environmental Health Center)

PRIMARY DISEASES OR CONDITIONS: Respiratory Disease, Adult Mental Health, Emerging Conditions (Cognitive Function).The Respiratory Disease includes chronic lower respiratory symptoms and impaired lung functions. The Adult Mental Health conditions include symptoms of post-traumatic stress disorder (PTSD) and depression and anxiety. The Emerging Conditions (cognitive functions) include probable cognitive decline as indicated by low Montreal Cognitive Assessment (MoCA) or the Clinical Dementia Rating Scale Sum of Boxes (CDR-SB) scores among the WTC Survivors.

STUDY DESIGN: Longitudinal Follow Up Studydisorder (PTSD) manifest differently and fluctuate within each WTC responders' daily life, making it difficult to measure and predict. This project will leverage recent advances in artificial intelligence (AI) techniques, applied across time and natural communication, to enable more accurate and fine-grained longitudinal assessments of PTSD symptoms and future outcome risks based on patients' own words. This work will develop a tool PTSD-STOP to aid in such assessment of PTSD symptoms over three communication modalities and determine the optimum inputs as well as generalizability across demographic and population attributes.

WTC SUBPOPULATION(S) UNDER STUDY: WTC Responders (currently residing on Long Island and serviced by the Stony Brook World Trade Center Wellness Clinic): Police (48%), Fire Fighters (33%), General Responders (19%).

PRIMARY DISEASES OR CONDITIONS: Adult Mental Health (PTSD)

STUDY DESIGN: Cross-sectional (Aim 1), Retrospective Longitudinal Cohort (Aim 2), and Prospective Longitudinal Cohort (Aim 3).

RFA-OH-22-004 WORLD TRADE CENTER HEALTH RESEARCH RELATED TO WTC SURVIVORS (U01)

Exposomic Approach to Identifying WTC Exposures and Effects in Survivor Youth

PROJECT NUMBER: 1 U01 OH012472-01

INSTITUTION: Columbia University Health Sciences

PRINCIPAL INVESTIGATORS: Julie Beth Herbstman, PhD (contact PI); Leonardo Trasande, MD

PHONE NUMBER: (212) 304-7273

EMAIL: *JH2678@COLUMBIA.EDU*

PROJECT DURATION: Four years

DESCRIPTION: Characterizing the totality of WTC exposure—both psychological and chemical—has been challenging, particularly among pregnant women and children, which has limited our ability to identify WTC-related health effects. New advances in high resolution gas chromatography can characterize WTC-related exposure and biological response to exposure in ways that were previously impossible. This study uses novel metabolomic and exposomic methods to characterize WTC exposure and the effects of WTC exposure among those who were exposed in utero or as children, two sensitive windows of development.

WTC SUBPOPULATION(S) UNDER STUDY: Survivors (those who were exposed to WTC either in utero or during early childhood).

PRIMARY DISEASES OR CONDITIONS: Children's Research (WTC Youth), where conditions include subclinical molecular changes measurable in stored blood plasma and associations with adverse birth outcomes, neurodevelopment and cardiometabolic endpoints.

Appendix 1, Section 3

WTC Health Program • Research Publications by Project

2011 Summary

Eight Research Projects Awarded

Eight Research Projects Completed

Seven Research Projects Have Published

Thirty-nine Publications

Pulmonary Function Abnormalities, Diastolic Dysfunction and World Trade Center Exposure: Implications for Diagnosis and Treatment

CONTRACT NUMBER: 200-2011-39405

INSTITUTION: Icahn School of Medicine at Mount Sinai

PRINCIPAL INVESTIGATOR: Maryann McLaughlin, MD, MPH

PUBLICATION

Iyengar-Kapuganti RL, Maceda CS, Croft LB, et al. 2022. Obstructive sleep apnoea and left ventricular diastolic dysfunction among first responders to the 9/11 World Trade Center terrorist attack: A cross-sectional study. BMJ Open. 12 (4):e058366.

HTTPS://DOI.ORG/10.1136/BMJOPEN-2021-058366

Burden of Mental-Physical Comorbidity in World Trade Center Responders

CONTRACT NUMBER: 200-2011-39410

INSTITUTION: State University of New York at Stony Brook

PRINCIPAL INVESTIGATOR: Evelyn Bromet, PhD

PUBLICATIONS

Ruggero CJ, Kotov R, Callahan JL, et al. 2013. PTSD symptom dimensions and their relationship to functioning in World Trade Center responders. Psychiatry Res. 210 (3):1049–1055.

HTTPS://DOI.ORG/10.1016/J.PSYCHRES.2013.08.052

Litcher-Kelly L, Lam Y, Broihier JA, et al. 2014. Longitudinal study of the impact of psychological distress symptoms on new-onset upper gastrointestinal symptoms in World Trade Center responders. Psychosom Med. 76 (9):686–693.

HTTPS://DOI.ORG/10.1097/PSY.0000000000000116

Kotov R, Bromet EJ, Schechter C, et al. 2015. Posttraumatic stress disorder and the risk of respiratory problems in World Trade Center responders: Longitudinal test of a pathway. Psychosom Med. 77 (4):438–448.

HTTPS://DOI.ORG/10.1097/PSY.0000000000000179

Zvolensky MJ, Farris SG, Kotov R, et al. 2015. World Trade Center disaster and sensitization to subsequent life stress: A longitudinal study of disaster responders. Prev Med. 75:70–74.

HTTPS://DOI.ORG/10.1016/J.YPMED.2015.03.017

Zvolensky MJ, Kotov R, Schechter CB, et al. 2015. Post-disaster stressful life events and WTC-related posttraumatic stress, depressive symptoms, and overall functioning among responders to the World Trade Center disaster. J Psychiatr Res. 61:97–105.

HTTPS://DOI.ORG/10.1016/J.JPSYCHIRES.2014.11.010

Bromet EJ, Hobbs MJ, Clouston SA, et al. 2016. DSM-IV post-traumatic stress disorder among World Trade Center responders 11-13 years after the disaster of 11 September 2001 (9/11). Psychol Med. 46 (4):771–783.

HTTPS://DOI.ORG/10.1017/S0033291715002184

Clouston SA, Kotov R, Pietrzak RH, et al. 2016. Cognitive impairment among World Trade Center responders: Long-term implications of re-experiencing the 9/11 terrorist attacks. Alzheimers Dement (Amst). 4 (1):67–75.

HTTPS://DOI.ORG/10.1016/J.DADM.2016.08.001

Friedberg F, Adamowicz JL, Caikauskaite I, et al. 2016. Fatigue severity in World Trade Center (9/11) responders: A preliminary study. Fatigue: Biomedicine, Health and Behavior. 4 (2):70–79.

HTTPS://DOI.ORG/10.1080/21641846.2016.1169726

Bromet EJ, Clouston S, Gonzalez A, et al. 2017. Hurricane sandy exposure and the mental health of World Trade Center responders. J Trauma Stress. 30 (2):107–114.

HTTPS://DOI.ORG/10.1002/JTS.22178

Waszczuk MA, Li K, Ruggero CJ, et al. 2018. Maladaptive personality traits and 10-year course of psychiatric and medical symptoms and functional impairment following trauma. Ann Behav Med. 52 (8):697–712.

HTTPS://DOI.ORG/10.1093/ABM/KAX030

Evaluation of Distal Airway Injury Following Exposure to World Trade Center Dust

CONTRACT NUMBER: 200-2011-39413

PRINCIPAL INVESTIGATOR: Kenneth Berger,MD

INSTITUTION: New York University School of Medicine

PUBLICATIONS

Caplan-Shaw CE, Yee H, Rogers L, et al. 2011. Lung pathologic findings in a local residential and working community exposed to World Trade Center dust, gas, and fumes. J Occup Environ Med. 53 (9):981–991.

HTTPS://DOI.ORG/10.1097/JOM.0B013E31822FFF60

Friedman SM, Maslow CB, Reibman J, et al. 2011. Case-control study of lung function in World Trade Center Health Registry area residents and workers. Am J Respir Crit Care Med. 184 (5):582–589.

HTTPS://DOI.ORG/10.1164/RCCM.201011-1909OC

Liu M, Qian M, Cheng Q, et al. 2012. Longitudinal spirometry among patients in a treatment program for community members with World Trade Center-related illness. J Occup Environ Med. 54 (10):1208–1213.

HTTPS://DOI.ORG/10.1097/JOM.0B013E31826BB78E

Berger KI, Reibman J, Oppenheimer BW, et al. 2013. Lessons from the World Trade Center disaster: Airway disease presenting as restrictive dysfunction. Chest. 144 (1):249–257.

HTTPS://DOI.ORG/10.1378/CHEST.12-1411

Kazeros A, Maa MT, Patrawalla P, et al. 2013. Elevated peripheral eosinophils are associated with new-onset and persistent wheeze and airflow obstruction in World Trade Center-exposed individuals. J Asthma. 50 (1):25–32.

HTTPS://DOI.ORG/10.3109/02770903.2012.743149

Berger KI, Turetz M, Liu M, et al. 2015. Oscillometry complements spirometry in evaluation of subjects following toxic inhalation. ERJ Open Res. 1 (2)

HTTPS://DOI.ORG/10.1183/23120541.00043-2015

Kazeros A, Zhang E, Cheng X, et al. 2015. Systemic inflammation associated with World Trade Center dust exposures and airway abnormalities in the local community. J Occup Environ Med. 57 (6):610–616.

HTTPS://DOI.ORG/10.1097/JOM.0000000000000458

Berger KI, Kalish S, Shao Y, et al. 2016. Isolated small airway reactivity during bronchoprovocation as a mechanism for respiratory symptoms in WTC dust-exposed community members. Am J Ind Med. 59 (9):767–776.

HTTPS://DOI.ORG/10.1002/AJIM.22639

Pradhan D, Xu N, Reibman J, et al. 2019. Bronchodilator response predicts longitudinal improvement in small airway function in World Trade Center dust exposed community members. Int J Environ Res Public Health. 16 (8)

HTTPS://DOI.ORG/10.3390/IJERPH16081421

Cohort Studies of Incident Cancers in the FDNY WTC Responder Population

CONTRACT NUMBER: 200-2011-39489

PRINCIPAL INVESTIGATOR: David Prezant, MD

INSTITUTION: Fire Department of New York

PUBLICATION

Zeig-Owens R, Webber MP, Hall CB, et al. 2011. Early assessment of cancer outcomes in New York City firefighters after the 9/11 attacks: An observational cohort study. Lancet. 378 (9794):898–905.

HTTPS://DOI.ORG/10.1016/S0140-6736(11)60989-6

Cancer among WTC Responders: Enhanced Surveillance, Exposure Assessment, and Cancer-Specific Risks

CONTRACT NUMBER: 200-2011-41815

INSTITUTION: Icahn School of Medicine at Mount Sinai

PRINCIPAL INVESTIGATOR: Paolo Boffetta, MD

PUBLICATIONS

Solan S, Wallenstein S, Shapiro M, et al. 2013. Cancer incidence in World Trade Center rescue and recovery workers, 2001-2008. Environ Health Perspect. 121 (6):699–704.

HTTPS://DOI.ORG/10.1289/EHP.1205894

Boffetta P, Zeig-Owens R, Wallenstein S, et al. 2016. Cancer in World Trade Center responders: Findings from multiple cohorts and options for future study. Am J Ind Med. 59 (2):96–105.

HTTPS://DOI.ORG/10.1002/AJIM.22555

Trajectories of Psychological Risk and Resilience in World Trade Center Responders

CONTRACT NUMBER: 200-2011-41919

INSTITUTIONS: Icahn School of Medicine at Mount Sinai School of Medicine and the Yale School of Medicine

PRINCIPAL INVESTIGATORS: Adriana Feder, MD, Robert Pietrzak, PhD, Steven Southwick, MD

PUBLICATIONS

Pietrzak RH, Feder A, Schechter CB, et al. 2014. Dimensional structure and course of post-traumatic stress symptomatology in World Trade Center responders. Psychol Med. 44 (10):2085–2098.

HTTPS://DOI.ORG/10.1017/S0033291713002924

Pietrzak RH, Feder A, Singh R, et al. 2014. Trajectories of PTSD risk and resilience in World Trade Center responders: An 8-year prospective cohort study. Psychol Med. 44 (1):205–219.

HTTPS://DOI.ORG/10.1017/S0033291713000597

Feder A, Mota N, Salim R, et al. 2016. Risk, coping and PTSD symptom trajectories in World Trade Center responders. J Psychiatr Res. 82:68–79.

HTTPS://DOI.ORG/10.1016/J.JPSYCHIRES.2016.07.003

Horn SR, Pietrzak RH, Schechter C, et al. 2016. Latent typologies of posttraumatic stress disorder in World Trade Center responders. J Psychiatr Res. 83:151–159.

HTTPS://DOI.ORG/10.1016/J.JPSYCHIRES.2016.08.018

Uchida M, Feng H, Feder A, et al. 2018. Parental posttraumatic stress and child behavioral problems in World Trade Center responders. Am J Ind Med. 61 (6):504–514.

HTTPS://DOI.ORG/10.1002/AJIM.22838

Chen C, Salim R, Rodriguez J, et al. 2020. The burden of subthreshold posttraumatic stress disorder in World Trade Center responders in the second decade after 9/11. J Clin Psychiatry. 81 (1)

HTTPS://DOI.ORG/10.4088/JCP.19M12881

Diab O, DePierro J, Cancelmo L, et al. 2020. Mental healthcare needs in World Trade Center responders: Results from a large, population-based health monitoring cohort. Administration and Policy in Mental Health and Mental Health Services Research. 47 (3):427–434.

HTTPS://DOI.ORG/10.1007/S10488-019-00998-Z

Ciro D, Pietrzak RH, Lee RJ, et al. 2021. Acculturation, coping, and PTSD in hispanic 9/11 rescue and recovery workers. Psychol Trauma. 13 (1):84–93.

HTTPS://DOI.ORG/10.1037/TRA0000624

Enhanced Smoking Cessation for WTC Responders

CONTRACT NUMBER: 200-2011-42057

PRINCIPAL INVESTIGATOR: Evelyn Bromet, PhD

INSTITUTION: State University of New York at Stony Brook

PUBLICATIONS

Farris SG, Paulus DJ, Gonzalez A, et al. 2015. Anxiety sensitivity mediates the association between post-traumatic stress symptom severity and interoceptive threat-related smoking abstinence expectancies among World Trade Center disaster-exposed smokers. Addict Behav. 51:204–210.

HTTPS://DOI.ORG/10.1016/J.ADDBEH.2015.07.031

Zvolensky MJ, Farris SG, Kotov R, et al. 2015. Posttraumatic stress symptoms and smoking among World Trade Center disaster responders: A longitudinal investigation. Comprehensive Psychiatry. 63:46–54.

HTTPS://DOI.ORG/10.1016/J.COMPPSYCH.2015.08.006

Farris SG, Paulus DJ, Gonzalez A, et al. 2016. Posttraumatic stress symptoms and body mass index among World Trade Center disaster-exposed smokers: A preliminary examination of the role of anxiety sensitivity. Psychiatry Research. 241:135–140.

HTTPS://DOI.ORG/10.1016/J.PSYCHRES.2016.04.074

Mahaffey BL, Gonzalez A, Farris SG, et al. 2016. Smoking to regulate negative affect:

Disentangling the relationship between posttraumatic stress and emotional disorder symptoms, nicotine dependence, and cessation-related problems. Nicotine Tob Res. 18 (6):1471–1478.

HTTPS://DOI.ORG/10.1093/NTR/NTV175

Gonzalez A, Friedberg F, Li X, et al. 2017. Trauma-focused smoking cessation for smokers exposed to the World Trade Center disaster: A randomized clinical trial. Nicotine and Tobacco Research. 19 (8):968–975.

HTTPS://DOI.ORG/10.1093/NTR/NTW384

Mahaffey BL, Gonzalez A, Farris SG, et al. 2017. Understanding the connection between post-traumatic stress symptoms and respiratory problems: Contributions of anxiety sensitivity. Journal of Traumatic Stress. 30 (1):No Pagination Specified.

HTTPS://DOI.ORG/10.1002/JTS.22159

Waszczuk MA, Li X, Bromet EJ, et al. 2017. Pathway from PTSD to respiratory health: Longitudinal evidence from a psychosocial intervention. Health Psychol. 36 (5):429–437.

HTTPS://DOI.ORG/10.1037/HEA0000472

Zvolensky MJ, Rodriguez-Cano R, Paulus DJ, et al. 2017. Respiratory problems and anxiety sensitivity in smoking lapse among treatment seeking smokers. Addict Behav. 75:25–29.

HTTPS://DOI.ORG/10.1016/J.ADDBEH.2017.06.015

2012 Summary

TEN RESEARCH PROJECTS AWARDED

SEVEN RESEARCH PROJECTS HAVE PUBLISHED

TEN RESEARCH PROJECTS COMPLETED

TWENTY-SIX PUBLICATIONS

Health and Socioeconomic Sequelae of the WTC Disaster Among Responders

PROJECT NUMBER: U01 OH010399

PRINCIPAL INVESTIGATOR: Hyun Kim, ScD

INSTITUTION: Northwell Health

PUBLICATIONS

Liu B, Tarigan LH, Bromet EJ, et al. 2014. World Trade Center disaster exposure-related probable posttraumatic stress disorder among responders and civilians: A meta-analysis. PLoS One. 9 (7):e101491.

HTTPS://DOI.ORG/10.1371/JOURNAL.PONE.0101491

Kim H, Baron S, Baidwan NK, et al. 2017. New onset of asthma and job status change among World Trade Center responders and workers. American Journal of Industrial Medicine. 60 (12):1039–1048.

HTTPS://DOI.ORG/10.1002/AJIM.22774

Kim H, Baidwan NK, Kriebel D, et al. 2018. Asthma among World Trade Center first responders: A qualitative synthesis and bias assessment. Int J Environ Res Public Health. 15 (6)

HTTPS://DOI.ORG/10.3390/IJERPH15061053

Kim H, Kriebel D, Liu B, et al. 2018. Standardized morbidity ratios of four chronic health conditions among World Trade Center responders: Comparison to the national health interview survey. Am J Ind Med. 61 (5):413–421.

HTTPS://DOI.ORG/10.1002/AJIM.22825

Pulmonary Diseases in WTC Workers: Symptoms, Function, and Chest CT Correlates

PROJECT NUMBER: U01 OH010401

PRINCIPAL INVESTIGATOR: Rafael E. de la Hoz, MD

INSTITUTION: Icahn School of Medicine at Mount Sinai

PUBLICATIONS

de la Hoz RE, Jeon Y, Miller GE, et al. 2016. Post-traumatic stress disorder, bronchodilator response, and incident asthma in World Trade Center rescue and recovery workers. Am J Respir Crit Care Med. 194 (11):1383–1391.

HTTPS://DOI.ORG/10.1164/RCCM.201605-1067OC

de la Hoz RE, Liu X, Doucette JT, et al. 2018. Increased airway wall thickness is associated with adverse longitudinal first-second forced expiratory volume trajectories of former World Trade Center workers. Lung. 196 (4):481–489.

HTTPS://DOI.ORG/10.1007/S00408-018-0125-7

de la Hoz RE, Liu X, Celedón JC, et al. 2019. Association of obesity with quantitative chest ct measured airway wall thickness in WTC workers with lower airway disease. Lung. 197 (4):517–522.

HTTPS://DOI.ORG/10.1007/S00408-019-00246-Z

de la Hoz RE, Weber J, Xu D, et al. 2019. Chest ct scan findings in World Trade Center workers. Arch Environ Occup Health. 74 (5):263–270.

HTTPS://DOI.ORG/10.1080/19338244.2018.1452712

Prognosis and Determinants of Asthma Morbidity in WTC Rescue and Recovery Workers

PROJECT NUMBER: U01 OH010405

PRINCIPAL INVESTIGATOR: Juan Wisnivesky, MD, DrPH

INSTITUTION: Icahn School of Medicine at Mount Sinai

PUBLICATIONS

Xu KY, Goodman E, Goswami R, et al. 2016. Determinants of asthma morbidity in World Trade Center rescue and recovery workers. Ann Allergy Asthma Immunol. 117 (5):568–570.

HTTPS://DOI.ORG/10.1016/J.ANAI.2016.08.033

Mindlis I, Morales-Raveendran E, Goodman E, et al. 2017. Post-traumatic stress disorder dimensions and asthma morbidity in World Trade Center rescue and recovery workers. Journal of Asthma. 54 (7):723–731.

HTTPS://DOI.ORG/10.1080/02770903.2016.1263650

Morales-Raveendran E, Goodman E, West E, et al. 2019. Associations between asthma trigger reports, mental health conditions, and asthma morbidity among World Trade Center rescue and recovery workers. J Asthma. 56 (8):833–840.

HTTPS://DOI.ORG/10.1080/02770903.2018.1502300

Rojano B, West E, Ferdermann E, et al. 2019. Allergen sensitization and asthma outcomes among World Trade Center rescue and recovery workers. Int J Environ Res Public Health. 16 (5):737.

HTTPS://DOI.ORG/10.3390/IJERPH16050737

Rojano B, West E, Goodman E, et al. 2019. Self-management behaviors in World Trade Center rescue and recovery workers with asthma. J Asthma. 56 (4):411–421.

HTTPS://DOI.ORG/10.1080/02770903.2018.1462377

Bronchial Reactivity and the Course of Lung Function

PROJECT NUMBER: U01 OH010411

PRINCIPAL INVESTIGATOR: Thomas Aldrich, MD

INSTITUTION: Albert Einstein College of Medicine

PUBLICATIONS

Aldrich TK, Weakley J, Dhar S, et al. 2016. Bronchial reactivity and lung function after World Trade Center exposure. Chest. 150 (6):1333–1340.

HTTPS://DOI.ORG/10.1016/J.CHEST.2016.07.005

For How Long is WTC Exposure Associated with Incident Airway Obstruction

PROJECT NUMBER: U01 OH010412

PRINCIPAL INVESTIGATOR: Charles Hall, PhD

INSTITUTION: Albert Einstein College of Medicine

PUBLICATIONS

Glaser MS, Webber MP, Zeig-Owens R, et al. 2014. Estimating the time interval between exposure to the World Trade Center disaster and incident diagnoses of obstructive airway disease. Am J Epidemiol. 180 (3):272–279.

HTTPS://DOI.ORG/10.1093/AJE/KWU137

Hall CB, Liu X, Zeig-Owens R, et al. 2016. The duration of an exposure response gradient between incident obstructive airways disease and work at the World Trade Center site: 2001-2011. PLoS Curr. 7

HTTPS://DOI.ORG/10.1371/CURRENTS.DIS.8A93E7682624698558A76A1FA8C5893F

Obstructive Sleep Apnea in WTC Responders; Role of Nasal Pathology

PROJECT NUMBER: U01 OH010415

PRINCIPAL INVESTIGATORS: Jag Sunderram,MD and Indu Ayappa, PhD

INSTITUTION: Robert Wood Johnson Medical School at Rutgers University and NYU School of Medicine

PUBLICATIONS

Ayappa I, Sunderram J, Black K, et al. 2015. A comparison of cpap and cpapflex in the treatment of obstructive sleep apnea in World Trade Center responders: Study protocol for a randomized controlled trial. Trials. 16 (1):403.

HTTPS://DOI.ORG/10.1186/S13063-015-0907-7

Gumb T, Twumasi A, Alimokhtari S, et al. 2018. Comparison of two home sleep testing devices with different strategies for diagnosis of osa. Sleep Breath. 22 (1):139–147.

HTTPS://DOI.ORG/10.1007/S11325-017-1547-9

Ayappa I, Chen Y, Bagchi N, et al. 2019. The association between health conditions in World Trade Center responders and sleep-related quality of life and sleep complaints. International Journal of Environmental Research and Public Health. 16 (7)

HTTPS://DOI.ORG/10.3390/IJERPH16071229

Sunderram J, Weintraub M, Black K, et al. 2019. Chronic rhinosinusitis is an independent risk factor for osa in World Trade Center responders. Chest. 155 (2):375–383.

HTTPS://DOI.ORG/10.1016/J.CHEST.2018.10.015

Wu BG, Sulaiman I, Wang J, et al. 2019. Severe obstructive sleep apnea is associated with alterations in the nasal microbiome and increase in inflammation. Am J Respir Crit Care Med. 199 (1):99–109.

HTTPS://DOI.ORG/10.1164/RCCM.201801-01190C

Parekh A, Castillo B, Kim DH, et al. 2021. 401 clinical phenotypes of obstructive sleep apnea in World Trade Center responders. Sleep. 44

(0):A159–A160.

HTTPS://DOI.ORG/10.1093/SLEEP/ZSAB072.400

Sunderram J, Ayappa I, Lu S-E, et al. 2021. Pap adherence and nasal resistance: A randomized control trial of cpapflex vs cpap. Annals of the American Thoracic Society. 18 (4):668–677.

HTTPS://DOI.ORG/10.1513/ANNALSATS.202009-1161OC

Epigenetic Linkage between PTSD and Respiratory Disease in WTC Responders

PROJECT NUMBER: U01 OH010416

PRINCIPAL INVESTIGATOR: Benjamin Luft, MD

INSTITUTION: State University of New York at Stony Brook

PUBLICATIONS

Kuan PF, Waszczuk MA, Kotov R, et al. 2017. Gene expression associated with PTSD in World Trade Center responders: An rna sequencing study. Transl Psychiatry. 7 (12):1297.

HTTPS://DOI.ORG/10.1038/S41398-017-0050-1

Kuan PF, Waszczuk MA, Kotov R, et al. 2017. An epigenome-wide DNA methylation study of PTSD and depression in World Trade Center responders. Transl Psychiatry. 7 (6):e1158.

HTTPS://DOI.ORG/10.1038/TP.2017.130

Clouston SAP, Edelman NH, Abraham A, et al. 2019. Shortened leukocyte telomere length is associated with reduced pulmonary function and greater subsequent decline in function in a sample of World Trade Center responders. Scientific Reports (Nature Publisher Group). 9 (1):8148.

HTTPS://DOI.ORG/10.1038/S41598-019-44625-1

2013 Summary

Six Research Projects Awarded

Six Research Projects Completed

Five Research Projects Published

Fifteen Publications and

One PhD Dissertation

Early Identification of World Trade Center Conditions in Adolescents

PROJECT NUMBER: U01 OH010394

PRINCIPAL INVESTIGATOR: Leonardo Trasande, MD, MPP

INSTITUTION: New York University School of Medicine

PUBLICATIONS

Trasande L, Koshy TT, Gilbert J, et al. 2017. Serum perfluoroalkyl substances in children exposed to the World Trade Center disaster. Environ Res. 154:212–221.

HTTPS://DOI.ORG/10.1016/J.ENVRES.2017.01.008

Trasande L, Koshy TT, Gilbert J, et al. 2017. Cardiometabolic profiles of adolescents and young adults exposed to the World Trade Center disaster. Environ Res. 160:107–114.

HTTPS://DOI.ORG/10.1016/J.ENVRES.2017.09.026

Kahn LG, Han X, Koshy TT, et al. 2018. Adolescents exposed to the World Trade Center collapse have elevated serum dioxin and furan concentrations more than 12years later. Environ Int. 111:267–268.

HTTPS://DOI.ORG/10.1016/J.ENVINT.2017.11.026

Trace Elements in Autopsy Tissue from World Trade Center Decedents

PROJECT NUMBER: U01 OH010395

PRINCIPAL INVESTIGATOR: Michael Marmor, PhD

INSTITUTION: New York University School of Medicine

PUBLICATIONS

Lin IH. 2017. Associations of major and trace elements in lung tissues with World Trade Center exposures and subsequent respiratory symptoms. Dissertation Abstracts International: Section B: The Sciences and Engineering. 77:No Pagination Specified.

Thawani S, Wang B, Shao Y, et al. 2019. Time to onset of paresthesia among community members exposed to the World Trade Center disaster. Int J Environ Res Public Health. 16 (8)

HTTPS://DOI.ORG/10.3390/IJERPH16081429

Marmor M, Thawani S, Cotrina ML, et al. 2020. Case-control study of paresthesia among World Trade Center-exposed community members. J Occup Environ Med. 62 (4):307–316.

HTTPS://DOI.ORG/10.1097/JOM.0000000000001828

Prostate Cancer Risk and Outcome in WTC Respondents

PROJECT NUMBER: U01 OH010396

PRINCIPAL INVESTIGATOR: Emanuela Taioli, MD, PhD

INSTITUTION: Icahn School of Medicine at Mount Sinai

PUBLICATIONS

Hashim D, Boffetta P, Galsky M, et al. 2018. Prostate cancer characteristics in the World Trade Center cohort, 2002-2013. Eur J Cancer Prev. 27 (4):347–354.

HTTPS://DOI.ORG/10.1097/CEJ.0000000000000315

Yu H, Tuminello S, Alpert N, et al. 2022. Global DNA methylation of WTC prostate cancer tissues show signature differences compared to non-exposed cases. Carcinogenesis.

HTTPS://DOI.ORG/10.1093/CARCIN/BGAC025

Uncontrolled Lower Respiratory Symptoms in the WTC Survivor Program

PROJECT NUMBER: U01 OH010404

PRINCIPAL INVESTIGATOR: Joan Reibman, MD

INSTITUTION: New York University School of Medicine

PUBLICATIONS

Caplan-Shaw C, Kazeros A, Pradhan D, et al. 2016. Improvement in severe lower respiratory symptoms and small airway function in World Trade Center dust exposed community members. Am J Ind Med. 59 (9):777–787.

HTTPS://DOI.ORG/10.1002/AJIM.22642

Reibman J, Levy-Carrick N, Miles T, et al. 2016. Destruction of the World Trade Center towers. Lessons learned from an environmental health disaster. Ann Am Thorac Soc. 13 (5):577–583.

HTTPS://DOI.ORG/10.1513/ANNALSATS.201509-572PS

Rosen RL, Levy-Carrick N, Reibman J, et al. 2017. Elevated c-reactive protein and posttraumatic stress pathology among survivors of the 9/11 World Trade Center attacks. J Psychiatr Res. 89:14–21.

HTTPS://DOI.ORG/10.1016/J.JPSYCHIRES.2017.01.007

Reibman J, Caplan-Shaw C, Wu Y, et al. 2020. Characterization of persistent uncontrolled asthma symptoms in community members exposed to World Trade Center dust and fumes. Int. J. Environ. Res. Public Health. 17 (18):6645.

HTTPS://DOI.ORG/10.3390/IJERPH17186645

Baba RY, Zhang Y, Shao Y, et al. 2022. COPD in smoking and non-smoking community members exposed to the World Trade Center dust and fumes. Invternational Journal of Environmental Research and Public Health. 19 (7):4249.

HTTPS://DOI.ORG/10.3390/IJERPH19074249

Post-9/11 Incidence of Systemic Autoimmune Diseases in the FDNY Cohort

PROJECT NUMBER: U01 OH010513

INSTITUTION: Albert Einstein College of Medicine

PRINCIPAL INVESTIGATOR: Mayris Webber, DrPH

PUBLICATIONS

Loupasakis K, Berman J, Jaber N, et al. 2015. Refractory sarcoid arthritis in World Trade Center-exposed New York City firefighters: A case series. J Clin Rheumatol. 21 (1):19–23.

HTTPS://DOI.ORG/10.1097/RHU.0000000000000185

Webber MP, Moir W, Zeig-Owens R, et al. 2015. Nested case-control study of selected systemic autoimmune diseases in World Trade Center rescue/recovery workers. Arthritis Rheumatol. 67 (5):1369–1376.

HTTPS://DOI.ORG/10.1002/ART.39059

Webber MP, Moir W, Crowson CS, et al. 2016. Post-September 11, 2001, incidence of systemic autoimmune diseases in World Trade Center-exposed firefighters and emergency medical service workers. Mayo Clin Proc. 91 (1):23–32.

HTTPS://DOI.ORG/10.1016/J.MAYOCP.2015.09.019

2014 Summary

TEN RESEARCH PROJECTS AWARDED

TEN RESEARCH PROJECTS COMPLETED

EIGHT RESEARCH PROJECTS HAVE PUBLISHED

TWENTY PUBLICATIONS

Biorepository of Cancer Tissue Samples from WTC Responders

PROJECT NUMBER: U01 OH010512

PRINCIPAL INVESTIGATOR: Emanuela Taioli, MD, PhD

INSTITUTION: Feinstein Institute for Medical Research

PUBLICATIONS

Lieberman-Cribbin W, Tuminello S, Gillezeau C, et al. 2018. The development of a biobank of cancer tissue samples from World Trade Center responders. J Transl Med. 16 (1):280.

HTTPS://DOI.ORG/10.1186/S12967-018-1661-X

Mental Health Impact and Service Use among Asian Survivors and Rescuers Exposed to the WTC Attack

PROJECT NUMBER: U01 OH010516

PRINCIPAL INVESTIGATOR: Winnie Kung, PhD

INSTITUTION: Fordham University

PUBLICATIONS

Kung WW, Liu X, Goldmann E, et al. 2018. Posttraumatic stress disorder in the short and medium term following the World Trade Center attack among asian americans. J Community Psychol. 46 (8):1075–1091.

HTTPS://DOI.ORG/10.1002/JCOP.22092

Kung WW, Liu X, Huang D, et al. 2018. Factors related to the probable PTSD after the 9/11 World Trade Center attack among asian americans. J Urban Health. 95 (2):255–266.

HTTPS://DOI.ORG/10.1007/S11524-017-0223-5

Kung WW, Goldmann E, Liu X, et al. 2019. Mental health service use among asian americans five to six years after exposure to the World Trade Center attack. Social Service Review. 93 (1):96–128.

HTTPS://DOI.ORG/10.1086/702767

Kung WW, Wang X, Liu X, et al. 2019. Unmet mental health care needs among asian americans 10(-)11 years after exposure to the World Trade Center attack. Int J Environ Res Public Health. 16 (7)

HTTPS://DOI.ORG/10.3390/IJERPH16071302

Huang D, Wang X, and Kung W. 2020. The impact of job loss on posttraumatic stress disorder among asian americans: 11-12 years after the World Trade Center attack. Traumatology (Tallahass Fla). 26 (1):117–126.

HTTPS://DOI.ORG/10.1037/TRM0000216

For How Long is the WTC Exposure Associated with Chronic Rhinosinusitis

PROJECT NUMBER: U01 OH010711

PRINCIPAL INVESTIGATOR: Charles B. Hall, PhD

INSTITUTION: Albert Einstein College of Medicine

PUBLICATIONS

Weakley J, Hall CB, Liu X, et al. 2016. The effect of World Trade Center exposure on the latency of chronic rhinosinusitis diagnoses in New York City firefighters: 2001-2011. Occup Environ Med. 73 (4):280–283.

HTTPS://DOI.ORG/10.1136/OEMED-2015-103094

Liu X, Yip J, Zeig-Owens R, et al. 2017. The effect of World Trade Center exposure on the timing of diagnoses of obstructive airway disease, chronic rhinosinusitis, and gastroesophageal reflux disease. Front Public Health. 5:2.

HTTPS://DOI.ORG/10.3389/FPUBH.2017.00002

The Daily Burden of PTSD and Respiratory Problems in World Trade Center Responders

PROJECT NUMBER: U01 OH010712

PRINCIPAL INVESTIGATOR: Roman Kotov, PhD

INSTITUTION: State University of New York at Stony Brook

PUBLICATIONS

Dietch JR, Ruggero CJ, Schuler K, et al. 2019. Posttraumatic stress disorder symptoms and sleep in the daily lives of World Trade Center responders. J Occup Health Psychol. 24 (6):689–702.

HTTPS://DOI.ORG/10.1037/OCP0000158

Schuler K, Ruggero CJ, Mahaffey B, et al. 2021. When hindsight is not 20/20: Ecological momentary assessment of PTSD symptoms versus retrospective report. Assessment. 28 (1):238–247.

HTTPS://DOI.ORG/10.1177/1073191119869826

WTC-Heart: A Cohort Study of Heart Diseases in Word Trade Center Responders

PROJECT NUMBER: U01 OH010722

INSTITUTION: Center for the Biology of Natural Systems (CBNS) CUNY-Queens College

PRINCIPAL INVESTIGATOR: Alfredo Morabia, MD

PUBLICATIONS

Remch M, Laskaris Z, Flory J, et al. 2018. Post-traumatic stress disorder and cardiovascular diseases: A cohort study of men and women involved in cleaning the debris of the World Trade Center complex. Circ Cardiovasc Qual Outcomes. 11 (7):e004572.

HTTPS://DOI.ORG/10.1161/CIRCOUTCOMES.117.004572

Evolution of Risk Factors for Sinusitis in WTC Exposed Firefighters

PROJECT NUMBER: U01 OH010726

INSTITUTION: New York University School of Medicine

PRINCIPAL INVESTIGATOR: Michael Weiden, MD

PUBLICATIONS

Kwon S, Putman B, Weakley J, et al. 2016. Blood eosinophils and World Trade Center exposure predict surgery in chronic rhinosinusitis. A 13.5-year longitudinal study. Ann Am Thorac Soc. 13 (8):1253–1261.

HTTPS://DOI.ORG/10.1513/ANNALSATS.201511-742OC

Weiden MD, Kwon S, Caraher E, et al. 2016. Biomarkers of World Trade Center particulate matter exposure: Physiology of distal airway and blood biomarkers that predict fev(1) decline. Semin Respir Crit Care Med. 36 (3):323–333.

HTTPS://DOI.ORG/10.1055/S-0035-1547349

Zeig-Owens R, Nolan A, Putman B, et al. 2016. Biomarkers of patient intrinsic risk for upper and lower airway injury after exposure to the World Trade Center atrocity. Am J Ind Med. 59 (9):788–794.

HTTPS://DOI.ORG/10.1002/AJIM.22643

Putman B, Zeig-Owens R, Singh A, et al. 2018. Risk factors for post-9/11 chronic rhinosinusitis in Fire Department of the City of New York workers. Occup Environ Med. 75 (12):884–889.

HTTPS://DOI.ORG/10.1136/OEMED-2018-105297

Zeig-Owens R, Singh A, Aldrich TK, et al. 2018. Blood leukocyte concentrations, FEV1 decline, and airflow limitation. A 15-year longitudinal study of World Trade Center-exposed firefighters. Ann Am Thorac Soc. 15 (2):173–183.

HTTPS://DOI.ORG/10.1513/ANNALSATS.201703-276OC

Post-9/11 Cancer Incidence in FDNY Firefighters

PROJECT NUMBER: U01 OH010728

PRINCIPAL INVESTIGATOR: Mayris Webber, DrPH

INSTITUTION: Albert Einstein College of Medicine

PUBLICATIONS

Moir W, Zeig-Owens R, Daniels RD, et al. 2016. Post-9/11 cancer incidence in World Trade Center-exposed New York City firefighters as compared to a pooled cohort of firefighters from San Francisco, Chicago and Philadelphia (9/11/2001-2009). Am J Ind Med. 59 (9):722–730.

HTTPS://DOI.ORG/10.1002/AJIM.22635

Zeig-Owens R, Kablanian A, Webber MP, et al. 2016. Agreement between self-reported and confirmed cancer diagnoses in New York City firefighters and ems workers, 2001-2011. Public Health Rep. 131 (1):153–159.

HTTPS://DOI.ORG/10.1177/003335491613100122

Singh A, Zeig-Owens R, Moir W, et al. 2018. Estimation of future cancer burden among rescue and recovery workers exposed to the World Trade Center disaster. JAMA Oncol. 4 (6):828–831.

HTTPS://DOI.ORG/10.1001/JAMAONCOL.2018.0504

Assessing the Impacts of Epidemiologic Biases in WTC Health Studies

PROJECT NUMBER: U01 OH010730

PRINCIPAL INVESTIGATOR: Hyun Kim, ScD

INSTITUTION: Feinstein Institute for Medical Research

PUBLICATIONS

Jurek AM and Maldonado G. 2016. Quantitative bias analysis in an asthma study of rescue-recovery workers and volunteers from the 9/11 World Trade Center attacks. Ann Epidemiol. 26 (11):794–801.

HTTPS://DOI.ORG/10.1016/J.ANNEPIDEM.2016.09.002

2015 Summary

Seven Research Projects Awarded

Seven Research Projects Completed

Four Research Projects Have Published

Eleven Publications

Childhood Exposures to Persistent Organic Pollutants in the World Trade Center Disaster and Cardiovascular Consequences

PROJECT NUMBER: U01 OH010714

PRINCIPAL INVESTIGATOR: Leonardo Trasande, MD, MPP

INSTITUTION: New York University School of Medicine

PUBLICATIONS

Koshy TT, Attina TM, Ghassabian A, et al. 2017. Serum perfluoroalkyl substances and cardiometabolic consequences in adolescents exposed to the World Trade Center disaster and a matched comparison group. Environ Int. 109:128–135.

HTTPS://DOI.ORG/10.1016/J.ENVINT.2017.08.003

Trye A, Berger KI, Naidu M, et al. 2018. Respiratory health and lung function in children exposed to the World Trade Center disaster. J Pediatr. 201:134–140 e136.

HTTPS://DOI.ORG/10.1016/J.JPEDS.2018.06.009

Gaylord A, Berger KI, Naidu M, et al. 2019. Serum perfluoroalkyl substances and lung function in adolescents exposed to the World Trade Center disaster. Environmental Research. 172:266–272.

HTTPS://DOI.ORG/10.1016/J.ENVRES.2019.02.024

A Pilot Test of the Relaxation Response Resiliency Program (3RP) Context and Ethnic Diversity: Children's Responses to 9/11

PROJECT NUMBER: U01 OH0 10721

PRINCIPAL INVESTIGATOR: Christina W. Hoven, DrPH, MPH

INSTITUTION: New York State Psychiatric Institute at Columbia University

PUBLICATIONS

Guffanti G, Geronazzo-Alman L, Fan B, et al. 2016. Homogeneity of severe posttraumatic stress disorder symptom profiles in children and adolescents across gender, age, and traumatic experiences related to 9/11. J Trauma Stress. 29 (5):430–439.

HTTPS://DOI.ORG/10.1002/JTS.22134

Geronazzo-Alman L, Guffanti G, Eisenberg R, et al. 2018. Comorbidity classes and associated impairment, demographics and 9/11-exposures in 8,236 children and adolescents. J Psychiatr Res. 96:171–177.

HTTPS://DOI.ORG/10.1016/J.JPSYCHIRES.2017.10.012

Geronazzo-Alman L, Fan B, Duarte CS, et al. 2019. The distinctiveness of grief, depression, and posttraumatic stress: Lessons from children after 9/11. J Am Acad Child Adolesc Psychiatry. 58 (10):971–982.

HTTPS://DOI.ORG/10.1016/J.JAAC.2018.12.012

Goodwin RD, Cheslack-Postava K, Musa GJ, et al. 2021. Exposure to mass disaster and probable panic disorder among children in New York City. Journal of Psychiatric Research. 138:349–353.

HTTPS://DOI.ORG/10.1016/J.JPSYCHIRES.2021.04.001

Musa GJ, Geronazzo-Alman L, Fan B, et al. 2021. Neighborhood characteristics and psychiatric disorders in the aftermath of mass trauma: A representative study of New York City public school 4th-12th graders after 9/11. J Psychiatr Res. 138:584–590.

HTTPS://DOI.ORG/10.1016/J.JPSYCHIRES.2021.05.002

Enhanced Assessment of WTC Exposure and Global DNA Methylation

PROJECT NUMBER: U01 OH 010987

PRINCIPAL INVESTIGATOR: Paolo Boffetta, MD

INSTITUTION: Icahn School of Medicine at Mount Sinai

PUBLICATIONS

Kuan PF, Mi Z, Georgopoulos P, et al. 2019. Enhanced exposure assessment and genome-wide DNA methylation in World Trade Center disaster responders. Eur J Cancer Prev. 28 (3):225–233.

HTTPS://DOI.ORG/10.1097/CEJ.0000000000000460

Clinical Characteristics and Outcomes of WTC-Associated Sarcoidosis

PROJECT NUMBER: U01 OH0 10993

PRINCIPAL INVESTIGATOR: Simon Spivack, MD, MPH (Thomas Aldrich, MD)

INSTITUTION: Albert Einstein College of Medicine

PUBLICATIONS

Hena KM, Yip J, Jaber N, et al. 2018. Clinical course of sarcoidosis in World Trade Center-exposed firefighters. Chest. 153 (1):114–123.

HTTPS://DOI.ORG/10.1016/J.CHEST.2017.10.014

Cleven KL, Ye K, Zeig-Owens R, et al. 2019. Genetic variants associated with FDNY WTC-related sarcoidosis. International journal of environmental research and public health. 16 (10)

HTTPS://DOI.ORG/10.3390/IJERPH16101830

2016 Summary

Sixteen Research Projects Awarded

Eleven Research Projects Have Published

Nine Research Projects Completed

Thirty-seven Publications

Roles for WTC Dust and DEP Co-pollutant in First Responder Cardiovascular Ailments

PROJECT NUMBER: R01 OH010921

PRINCIPAL INVESTIGATOR: Mitchell Cohen, PhD

INSTITUTION: New York University School of Medicine

PUBLICATIONS

Cohen MD, Chen L-C, and Lippmann M. 2020. World Trade Center (WTC) dust. Journal. (0):973–997.

HTTPS://DOI.ORG/10.1002/9781119438922.CH26

Cohen MD, Prophete C, Horton L, et al. 2020. Impact on rats from acute intratracheal inhalation exposures to WTC dusts. Inhal Toxicol. 32 (5):218–230.

HTTPS://DOI.ORG/10.1080/08958378.2020.1768322

Hernandez M, Harrington A, Ma Y, et al. 2020. World Trade Center dust induces airway inflammation while promoting aortic endothelial dysfunction. Toxicol Appl Pharmacol. 400:115041.

HTTPS://DOI.ORG/10.1016/J.TAAP.2020.115041

Park SH, Lu Y, Shao Y, et al. 2022. Longitudinal impact of WTC dust inhalation on rat cardiac tissue transcriptomic profiles. Int J Environ Res Public Health. 19 (2)

HTTPS://DOI.ORG/10.3390/IJERPH19020919

Thyroid Cancer Risk in WTC Responders

PROJECT NUMBER: U01 OH010984

INSTITUTIONS: Icahn School of Medicine at Mount Sinai, Johns Hopkins School of Medicine

PRINCIPAL INVESTIGATORS: Emanuela Taioli, MD, PhD and Gregory Riggins, MD, PhD

PUBLICATIONS

Tuminello S, van Gerwen MAG, Genden E, et al. 2019. Increased incidence of thyroid cancer among World Trade Center first responders: A descriptive epidemiological assessment. International journal of environmental research and public health. 16 (7):1258.

HTTPS://DOI.ORG/10.3390/IJERPH16071258

van Gerwen MAG, Tuminello S, Riggins GJ, et al. 2019. Molecular study of thyroid cancer in World Trade Center responders. International journal of environmental research and public health. 16 (9)

HTTPS://DOI.ORG/10.3390/IJERPH16091600

Evolution of Risk Factors for Lung Function Decline in WTC Exposed Firefighters

PROJECT NUMBER: U01 OH011302

INSTITUTION: New York University School of Medicine

PRINCIPAL INVESTIGATOR: Michael Weiden, MD

PUBLICATIONS

Singh A, Liu C, Putman B, et al. 2018. Predictors of asthma/COPD overlap in FDNY firefighters with World Trade Center dust exposure: A longitudinal study. Chest. 154 (6):1301–1310.

HTTPS://DOI.ORG/10.1016/J.CHEST.2018.07.002

Liu C, Putman B, Singh A, et al. 2019. Abnormalities on chest computed tomography and lung function following an intense dust exposure: A 17-year longitudinal study. International Journal of Environmental Research and Public Health. 16 (9)

HTTPS://DOI.ORG/10.3390/IJERPH16091655

Putman B, Lahousse L, Zeig-Owens R, et al. 2019. Low serum iga and airway injury in World Trade Center-exposed firefighters: A 17-year

longitudinal study. Thorax. 74 (12):1182–1184.

HTTPS://DOI.ORG/10.1136/THORAXJNL-2019-213715

Putman B, Lahousse L, Goldfarb DG, et al. 2020. Factors predicting treatment of World Trade Center-related lung injury: A longitudinal cohort study. Int J Environ Res Public Health. 17 (23):9056.

HTTPS://DOI.ORG/10.3390/IJERPH17239056

Cleven KL, Vaeth B, Zeig-Owens R, et al. 2021. Performance of risk factor-based guidelines and model-based chest ct lung cancer screening in World Trade Center-exposed fire department rescue/recovery workers. Chest. 159 (5):2060–2071.

HTTPS://DOI.ORG/10.1016/J.CHEST.2020.11.028

World Trade Center Exposures, Neuropathic Symptoms and Nervous System Injury Symptoms, and Nervous System Injury

PROJECT NUMBER: U01 OH0 11305

PRINCIPAL INVESTIGATOR: Michael Marmor, PhD

INSTITUTION: New York University School of Medicine

PUBLICATIONS

Marmor M, Shao Y, Bhatt DH, et al. 2017. Paresthesias among community members exposed to the World Trade Center disaster. J Occup Environ Med. 59 (4):389–396.

HTTPS://DOI.ORG/10.1097/JOM.0000000000000966

Assessing Inflammatory and Behavioral Pathways Linking PTSD to Increased Asthma Morbidity in WTC Workers

PROJECT NUMBER: U01 OH0 11312

PRINCIPAL INVESTIGATOR: Juan Wisnivesky, MD, DrPH

INSTITUTION: Icahn School of Medicine at Mount Sinai

PUBLICATIONS

Wisnivesky J, Markowitz SB, James S, et al. 2021. Comorbid post-traumatic stress disorder and major depression disorder associated with asthma morbidity among WTC workers. Annals of Allergy, Asthma & Immunology. 126 (3):278–283.

HTTPS://DOI.ORG/10.1016/J.ANAI.2020.10.007

Wisnivesky JP, Becker JH, Ankam J, et al. 2022. The relationship between post traumatic stress disorder and self-management behaviors in World Trade Center workers with asthma. The Journal of Allergy and Clinical Immunology: In Practice. 10 (1):242–249.

HTTPS://DOI.ORG/10.1016/J.JAIP.2021.08.035

Structural and Functional Neuroimaging of Post-Traumatic Stress Disorder and Cognitive Impairment in World Trade Center Responders

PROJECT NUMBER: U01 OH011314

PRINCIPAL INVESTIGATOR: Roberto Lucchini, MD

INSTITUTION: Icahn School of Medicine at Mount Sinai

PUBLICATIONS

Clouston SAP, Deri Y, Horton M, et al. 2020. Reduced cortical thickness in World Trade Center responders with cognitive impairment. Alzheimers Dement (Amst). 12 (1):e12059.

HTTPS://DOI.ORG/10.1002/DAD2.12059

Chen APF, Clouston SAP, Kritikos M, et al. 2021. A deep learning approach for monitoring parietal-dominant alzheimer's disease in World Trade Center responders at midlife. Brain Commun. 3 (3):fcab145.

HTTPS://DOI.ORG/10.1093/BRAINCOMMS/FCAB145

Deri Y, Clouston SAP, DeLorenzo C, et al. 2021. Selective hippocampal subfield volume reductions in World Trade Center responders with cognitive impairment. Alzheimer's & Dementia: Diagnosis, Assessment & Disease Monitoring. 13 (1):e12165.

HTTPS://DOI.ORG/10.1002/DAD2.12165

Kritikos M, Clouston SAP, Huang C, et al. 2021. Cortical complexity in world trade center responders with chronic posttraumatic stress disorder. Translational Psychiatry. 11 (1):597.

HTTPS://DOI.ORG/10.1038/S41398-021-01719-7

Clouston SAP, Hall CB, Kritikos M, et al. 2022. Cognitive impairment and world trade centre-related exposures. Nat Rev Neurol. 18 (2):103–116.

HTTPS://DOI.ORG/10.1038/S41582-021-00576-8

Clouston SAP, Kritikos M, Huang C, et al. 2022. Reduced cerebellar cortical thickness in World Trade Center responders with cognitive impairment. Transl Psychiatry. 12 (1):107.

HTTPS://DOI.ORG/10.1038/S41398-022-01873-6

Personality-Informed Care Model for 9/11-Related Comorbid Conditions

PROJECT NUMBER: U01 OH011321

PRINCIPAL INVESTIGATOR: Roman Kotov, PhD

INSTITUTION: State University of New York at Stony Brook

PUBLICATIONS

Waszczuk MA, Ruggero C, Li K, et al. 2019. The role of modifiable health-related behaviors in the association between PTSD and respiratory illness. Behav Res Ther. 115:64–72.

HTTPS://DOI.ORG/10.1016/J.BRAT.2018.10.018

Dornbach-Bender A, Ruggero CJ, Schuler K, et al. 2020. Positive and negative affect in the daily life of World Trade Center responders with PTSD: An ecological momentary assessment study. Psychol Trauma. 12 (1):75–83.

HTTPS://DOI.ORG/10.1037/TRA0000429

Oltmanns JR, Schwartz HA, Ruggero C, et al. 2021. Artificial intelligence language predictors of two-year trauma-related outcomes. Journal of Psychiatric Research. 143:239–245.

HTTPS://DOI.ORG/10.1016/J.JPSYCHIRES.2021.09.015

Ruggero CJ, Schuler K, Waszczuk MA, et al. 2021. Posttraumatic stress disorder in daily life among World Trade Center responders: Temporal symptom cascades. Journal of Psychiatric Research. 138:240–245.

HTTPS://DOI.ORG/10.1016/J.JPSYCHIRES.2021.04.002

Imbriano G, Waszczuk M, Rajaram S, et al. 2022. Association of attention and memory biases for negative stimuli with post-traumatic stress disorder symptoms. Journal of Anxiety Disorders. 85:102509.

HTTPS://DOI.ORG/10.1016/J.JANXDIS.2021.102509

Head and Neck Cancer in the World Trade Center Health Program Cohort; Elucidating Risk Factors to Reduce Incidence and Morbidity

PROJECT NUMBER: U01 OH011322

PRINCIPAL INVESTIGATOR: Judith Graber, PhD

INSTITUTION: The State University of New Jersey, Rutgers

PUBLICATIONS

Graber JM, Chuang CT, Ward CL, et al. 2018. Head and neck cancer in World Trade Center responders: A case series. J Occup Environ Med. 60 (9):e439–e444.

HTTPS://DOI.ORG/10.1097/JOM.0000000000001386

Bover Manderski MT, Black K, Udasin IG, et al. 2019. Risk factors for head and neck cancer in the World Trade Center Health Program general responder cohort: Results from a nested case-control study. Occup Environ Med. 76 (11):854–860.

HTTPS://DOI.ORG/10.1136/OEMED-2019-105890

Graber JM, Harris G, Black K, et al. 2019. Excess hpv-related head and neck cancer in the World Trade Center Health Program general responder cohort. Int J Cancer. 145 (6):1504–1509.

HTTPS://DOI.ORG/10.1002/IJC.32070

Bover Manderski MT, Black K, Udasin IG, et al. 2020. Retrospective assessment of risk factors for head and neck cancer among World Trade Center general responders. Front Public Health. 8:488057.

HTTPS://DOI.ORG/10.3389/FPUBH.2020.488057

Impact of WTC Dust on Immune Functions and Prostate Cancer Promotion

PROJECT NUMBER: U01 OH011328

PRINCIPAL INVESTIGATOR: Stuart Aaronson, MD

INSTITUTION: Icahn School of Medicine at Mount Sinai

PUBLICATIONS

Gong Y, Wang L, Yu H, et al. 2019. Prostate cancer in World Trade Center responders demonstrates evidence of an inflammatory cascade. Molecular Cancer Research. 17 (8):1605–1612.

HTTPS://DOI.ORG/10.1158/1541-7786.MCR-19-0115

Incidence, Latency, and Survival of Cancer Following World Trade Center Exposure

PROJECT NUMBER: U01 OH011932 (formerly U01 OH011315)

INSTITUTIONS: Albert Einstein College of Medicine, Icahn School of Medicine at Mount Sinai, New York City Department of Health, New York State Cancer Registry

PRINCIPAL INVESTIGATORS: Charles B. Hall, Ph.D.; Paolo Boffetta, M.D., M.P.H.

PUBLICATIONS

Brackbill RM, Kahn AR, Li J, et al. 2021. Combining three cohorts of World Trade Center rescue/recovery workers for assessing cancer incidence and mortality. International Journal of Environmental Research and Public Health. 18 (4):1386.

HTTPS://DOI.ORG/10.3390/IJERPH18041386

Goldfarb DG, Colbeth HL, Skerker M, et al. 2021. Impact of healthcare services on thyroid cancer incidence among World Trade Center-exposed rescue and recovery workers. American Journal of Industrial Medicine. 64 (10):861–872.

HTTPS://DOI.ORG/10.1002/AJIM.23277

Goldfarb DG, Zeig-Owens R, Kristjansson D, et al. 2021. Temporal association of prostate cancer incidence with World Trade Center rescue/recovery work. Occup Environ Med. 78 (10):699–706.

HTTPS://DOI.ORG/10.1136/OEMED-2021-107405

Li J, Yung J, Qiao B, et al. 2022. Cancer incidence in World Trade Center rescue and recovery workers: 14 years of follow-up. J Natl Cancer Inst. 114 (2):210–219.

HTTPS://DOI.ORG/10.1093/JNCI/DJAB165

Maintenance and Extension of a Cohort of Career Firefighters as a Non-WTC Exposed Comparison for the FDNY Firefighter Cohort

PROJECT NUMBER: U01 OH011934(formerly U01 OH011309)

PRINCIPAL INVESTIGATOR: Mayris Webber, DrPH

INSTITUTION: Albert Einstein College of Medicine

PUBLICATIONS

Mueller AK, Singh A, Webber MP, et al. 2021. PTSD symptoms, depressive symptoms, and subjective cognitive concerns in WTC-exposed and non-WTC-exposed firefighters. American Journal of Industrial Medicine. 0 (0):803–814.

HTTPS://DOI.ORG/10.1002/AJIM.23285

Webber MP, Singh A, Zeig-Owens R, et al. 2021. Cancer incidence in World Trade Center-exposed and non-exposed male firefighters, as compared with the us adult male population: 2001-2016. Occupational and environmental medicine. 78 (10):707–714.

HTTPS://DOI.ORG/10.1136/OEMED-2021-107570

Zeig-Owens R, Singh A, Triplett S, et al. 2021. Assembling the career firefighter health study cohort: A methods overview. Am J Ind Med. 64 (8):680–687.

HTTPS://DOI.ORG/10.1002/AJIM.23266

2017 Summary

NINE RESEARCH PROJECTS AWARDED

SIX RESEARCH PROJECTS HAVE PUBLISHED

FIVE RESEARCH PROJECT COMPLETED

THIRTY-SIX PUBLICATIONS

Prenatal WTC Chemical Exposures, Birth Outcomes and Cardiometabolic Risks

PROJECT NUMBER: U01 OH011299

PRINCIPAL INVESTIGATOR: Leonardo Trasande, MD

INSTITUTION: New York University School of Medicine

PUBLICATIONS

Spratlen MJ, Perera FP, Lederman SA, et al. 2019. Cord blood perfluoroalkyl substances in mothers exposed to the World Trade Center disaster during pregnancy. Environ Pollut. 246:482–490.

HTTPS://DOI.ORG/10.1016/J.ENVPOL.2018.12.018

Spratlen MJ, Perera FP, Lederman SA, et al. 2020. The association between prenatal exposure to perfluoroalkyl substances and childhood neurodevelopment. Environ Pollut. 263 (0):114444.

HTTPS://DOI.ORG/10.1016/J.ENVPOL.2020.114444

Spratlen MJ, Perera FP, Lederman SA, et al. 2020. The association between perfluoroalkyl substances and lipids in cord blood. The Journal of clinical endocrinology and metabolism. 105 (1)

HTTPS://DOI.ORG/10.1210/CLINEM/DGZ024

Spratlen MJ, Perera FP, Sjodin A, et al. 2022. Understanding the role of persistent organic pollutants and stress in the association between proximity to the World Trade Center disaster and birth outcomes. International Journal of Environmental Research and Public Health. 19 (4)

HTTPS://DOI.ORG/10.3390/IJERPH19042008

Metabolomics of World Trade Center-Lung Injury: Biomarker Validation, Longitudinal Assessment and Dietary Intervention

PROJECT NUMBER: U01 OH011300

PRINCIPAL INVESTIGATOR: Anna Nolan, MD, MS

INSTITUTION: New York University School of Medicine

PUBLICATIONS

Crowley G, Kwon S, Haider SH, et al. 2018. Metabolomics of World Trade Center-lung injury: A machine learning approach. BMJ Open Respir Res. 5 (1):e000274.

HTTPS://DOI.ORG/10.1136/BMJRESP-2017-000274

Haider SH, Kwon S, Lam R, et al. 2018. Predictive biomarkers of gastroesophageal reflux disease and barrett's esophagus in World Trade Center exposed firefighters: A 15 year longitudinal study. Scientific Reports. 8 (1):3106.

HTTPS://DOI.ORG/10.1038/S41598-018-21334-9

Citron J, Willcocks E, Crowley G, et al. 2019. Genomics of particulate matter exposure associated cardiopulmonary disease: A narrative review. Int J Environ Res Public Health. 16 (22)

HTTPS://DOI.ORG/10.3390/IJERPH16224335

Clementi EA, Talusan A, Vaidyanathan S, et al. 2019. Metabolic syndrome and air pollution: A narrative review of their cardiopulmonary effects. Toxics. 7 (1)

HTTPS://DOI.ORG/10.3390/TOXICS7010006

Crowley G, Kwon S, Ostrofsky DF, et al. 2019. Assessing the protective metabolome using machine learning in World Trade Center particulate exposed firefighters at risk for lung injury. Sci Rep. 9 (1):11939.

HTTPS://DOI.ORG/10.1038/S41598-019-48458-W

de la Hoz RE, Jeon Y, Reeves AP, et al. 2019. Increased pulmonary artery diameter is associated with reduced FEV1 in former World Trade Center workers. Clin Respir J. 13 (10):614–623.

HTTPS://DOI.ORG/10.1111/CRJ.13067

Haider SH, Oskuei A, Crowley G, et al. 2019. Receptor for advanced glycation end-products and environmental exposure related obstructive airways disease: A systematic review. Eur Respir Rev. 28 (151)

HTTPS://DOI.ORG/10.1183/16000617.0096-2018

Kwon S, Crowley G, Caraher EJ, et al. 2019. Validation of predictive metabolic syndrome biomarkers of World Trade Center lung injury: A 16-year longitudinal study. Chest. 156 (3):486–496.

HTTPS://DOI.ORG/10.1016/J.CHEST.2019.02.019

Kwon S, Crowley G, Mikhail M, et al. 2019. Metabolic syndrome biomarkers of World Trade Center airway hyperreactivity: A 16-year prospective cohort study. International journal of environmental research and public health. 16 (9)

HTTPS://DOI.ORG/10.3390/IJERPH16091486

de la Hoz RE, Shapiro M, Nolan A, et al. 2020. Association of low fvc spirometric pattern with WTC occupational exposures. Respiratory Medicine. 170:106058.

HTTPS://DOI.ORG/10.1016/J.RMED.2020.106058

Haider SH, Veerappan A, Crowley G, et al. 2020. Multiomics of WTC-particulate induced persistent airway hyperreactivity: Role of receptor for advanced glycation end products. Am J Respir Cell Mol Biol. 63 (2):219–233.

HTTPS://DOI.ORG/10.1165/RCMB.2019-0064OC

Kwon S, Riggs J, Crowley G, et al. 2020. Food intake restriction for health outcome support and education (firehouse) protocol: A randomized clinical trial. Int J Environ Res Public Health. 17 (18):6569.

HTTPS://DOI.ORG/10.3390/IJERPH17186569

Lam R, Haider SH, Crowley G, et al. 2020. Synergistic effect of WTC-particulate matter and lysophosphatidic acid exposure and the role of rage: In-vitro and translational assessment. International Journal of Environmental Research and Public Health. 17 (12):4318.

HTTPS://DOI.ORG/10.3390/IJERPH17124318

Veerappan A, Oskuei A, Crowley G, et al. 2020. World Trade Center-cardiorespiratory and vascular dysfunction: Assessing the phenotype and metabolome of a murine particulate matter exposure model. Scientific reports. 10 (1):3130–3130.

HTTPS://DOI.ORG/10.1038/S41598-020-58717-W

Cleven KL, Rosenzvit C, Nolan A, et al. 2021. Twenty-year reflection on the impact of World Trade Center exposure on pulmonary outcomes in fire department of the city of New York (FDNY) rescue and recovery workers. Lung. 199 (6):569–578.

HTTPS://DOI.ORG/10.1007/S00408-021-00493-Z

Crowley G, Kim J, Kwon S, et al. 2021. PEDF, a pleiotropic WTC-LI biomarker: Machine learning biomarker identification and validation. PLoS Comput Biol. 17 (7):e1009144.

HTTPS://DOI.ORG/10.1371/JOURNAL.PCBI.1009144

Kwon S, Lee M, Crowley G, et al. 2021. Dynamic metabolic risk profiling of World Trade Center-lung disease: A longitudinal cohort study. Am J Respir Crit Care Med. 204 (9):1035–1047.

HTTPS://DOI.ORG/10.1164/RCCM.202006-2617OC

Lam R, Kwon S, Riggs J, et al. 2021. Dietary phenotype and advanced glycation end-products predict WTC-obstructive airways disease: A longitudinal observational study. Respiratory Research. 22 (1):19.

HTTPS://DOI.ORG/10.1186/S12931-020-01596-6

Stein CR, Cooney ML, Frank B, et al. 2021. Mental health mediators of subjective cognitive concerns among World Trade Center responders. J Psychiatr Res. 140:187–196.

HTTPS://DOI.ORG/10.1016/J.JPSYCHIRES.2021.05.081

Longitudinal Genome-wide Transcriptome Study of PTSD Symptom Change in WTC Responders

PROJECT NUMBER: U01 OH011478

INSTITUTION: The Research Foundation for the State University of New York

PRINCIPAL INVESTIGATOR: Pei Fen Kuan, PhD

PUBLICATIONS

Uddin M, Ratanatharathorn A, Armstrong D, et al. 2018. Epigenetic meta-analysis across three civilian cohorts identifies NRG1 and HGS as blood-based biomarkers for post-traumatic stress disorder. Epigenomics. 10 (12):1585–1601.

HTTPS://DOI.ORG/10.2217/EPI-2018-0049

Kuan PF, Yang X, Clouston S, et al. 2019. Cell type-specific gene expression patterns associated with posttraumatic stress disorder in World Trade Center responders. Transl Psychiatry. 9 (1):1.

HTTPS://DOI.ORG/10.1038/S41398-018-0355-8

Kuan P-F, Clouston S, Yang X, et al. 2020. Molecular linkage between post-traumatic stress disorder and cognitive impairment: A targeted proteomics study of World Trade Center responders. Translational Psychiatry. 10 (1):269.

HTTPS://DOI.ORG/10.1038/S41398-020-00958-4

Kuan PF, Clouston S, Yang X, et al. 2021. Single-cell transcriptomics analysis of mild cognitive

impairment in World Trade Center disaster responders. Alzheimer's & Dementia: Diagnosis, Assessment & Disease Monitoring. 13 (1):e12154.

HTTPS://DOI.ORG/10.1002/DAD2.12154

Kuan PF, Ren X, Clouston S, et al. 2021. PTSD is associated with accelerated transcriptional aging in World Trade Center responders. Transl Psychiatry. 11 (1):311.

HTTPS://DOI.ORG/10.1038/S41398-021-01437-0

Kuan PF, Yang X, Ren X, et al. 2021. Mapping the transcriptomics landscape of post-traumatic stress disorder symptom dimensions in World Trade Center responders. Transl Psychiatry. 11 (1):310.

HTTPS://DOI.ORG/10.1038/S41398-021-01431-6

Kuan PF, Yang X, Kotov R, et al. 2022. Metabolomics analysis of post-traumatic stress disorder symptoms in World Trade Center responders. Transl Psychiatry. 12 (1):174.

HTTPS://DOI.ORG/10.1038/S41398-022-01940-Y

Hepatotoxic Exposures, Progressive Fatty Liver Disease (NASH), and Liver Cancer Risk in the World Trade Center Health Program General Responder Cohort

PROJECT NUMBER: U01 OH011489

PRINCIPAL INVESTIGATOR: Andrea Branch, PhD

INSTITUTION: Icahn School of Medicine at Mount Sinai

PUBLICATIONS

Vandromme M, Jun T, Perumalswami P, et al. 2019. Automated phenotyping of patients with non-alcoholic fatty liver disease reveals clinically relevant disease subtypes. Biocomputing 2020. 0:91–102.

HTTPS://DOI.ORG/10.1142/9789811215636_0009

Chen X, Ma T, Yip R, et al. 2020. Elevated prevalence of moderate-to-severe hepatic steatosis in World Trade Center general responder cohort in a program of ct lung screening. Clin Imaging. 60 (2):237–243.

HTTPS://DOI.ORG/10.1016/J.CLINIMAG.2019.12.009

Jirapatnakul A, Yip R, Branch AD, et al. 2021. Dose-response relationship between World Trade Center dust exposure and hepatic steatosis. Am J Ind Med. 64 (10):837–844.

HTTPS://DOI.ORG/10.1002/AJIM.23269

Early Detection of Hematologic Malignancies in New York City Firefighters Exposed To World Trade Center Dust after the 9/11 Attacks

PROJECT NUMBER: U01 OH011933 (formerly U01 OH011475)

PRINCIPAL INVESTIGATOR: Amit Verma, MD

INSTITUTION: Albert Einstein College of Medicine, INC.

PUBLICATIONS

Landgren O, Zeig-Owens R, Giricz O, et al. 2018. Multiple myeloma and its precursor disease among firefighters exposed to the World Trade Center disaster. JAMA Oncol. 4 (6):821–827.

HTTPS://DOI.ORG/10.1001/JAMAONCOL.2018.0509

Jasra S, Giricz O, Zeig-Owens R, et al. 2022. High burden of clonal hematopoiesis in first responders exposed to the World Trade Center disaster. Nature Medicine.

HTTPS://DOI.ORG/10.1038/S41591-022-01708-3

Mortality among WTC Rescue and Recovery Workers

PROJECT NUMBER: U01 OH0112235 (formerly 11480)

PRINCIPAL INVESTIGATOR: Paolo Boffetta, MD (now Stony Brook; was Mount Sinai)

INSTITUTION: Icahn School of Medicine at Mount Sinai

PUBLICATIONS

Goldfarb DG, Zeig-Owens R, Kristjansson D, et al. 2021. Cancer survival among World Trade Center rescue and recovery workers: A collaborative cohort study. Am J Ind Med. 64 (10):815–826.

HTTPS://DOI.ORG/10.1002/AJIM.23278

2018 Summary

Eight Research Projects Awarded

Five Research Projects Have Published

Five Research Projects Completed

Eight Publications

Optimizing Lung Cancer Screening in World Trade Center Rescue and Recovery Workers

PROJECT NUMBER: U01 OH011479

PRINCIPAL INVESTIGATORS: Keith Sigel, MD, PhD, and Juan Wisnivesky, MD, DrPH

INSTITUTION: Icahn School of Medicine at Mount Sinai

PUBLICATIONS

Sigel K, de la Hoz RE, Markowitz SB, et al. 2022. Lung cancer incidence among World Trade Center rescue and recovery workers. Cancer Med.

HTTPS://DOI.ORG/10.1002/CAM4.4672

Exploring Mechanisms of Obstructive Sleep Apnea (OSA) in WTC Responders

PROJECT NUMBER: U01 OH011481

PRINCIPAL INVESTIGATORS: Indu Ayappa, PhD and Jag Sunderram, MD

INSTITUTION: Icahn School of Medicine at Mount Sinai

PUBLICATIONS

Parekh A, Castillo B, Kim DH, et al. 2021. Obstructive sleep apnea pathophysiology in World Trade Center (WTC) responders. American Journal of Respiratory and Critical Care Medicine. 203:A3075.

HTTPS://DOI.ORG/10.1164/AJRCCM-CONFERENCE.2021.203.1_MEETINGABSTRACTS.A3075

Chronic Obstructive Pulmonary Disease in WTC Workers – Diagnoses and Transitions

PROJECT NUMBER: U01 OH011697

PRINCIPAL INVESTIGATOR: Rafael de la Hoz, MD

INSTITUTION: Icahn School of Medicine at Mount Sinai

PUBLICATIONS

Weber J, Reeves AP, Doucette JT, et al. 2020. Quantitative ct evidence of airway inflammation in WTC workers and volunteers with low fvc spirometric pattern. Lung. 198 (3):555–563.

HTTPS://DOI.ORG/10.1007/S00408-020-00350-5

Liu X, Reeves AP, Antoniak K, et al. 2021. Association of quantitative ct lung density measurements and lung function decline in World Trade Center workers. Clinical Respiratory Journal. 15 (6):613–621.

HTTPS://DOI.ORG/10.1111/CRJ.13313

World Trade Center issue Biobank

PROJECT NUMBER: U01 OH011704

PRINCIPAL INVESTIGATOR: Emanuela Taioli, MD, PhD

INSTITUTION: Icahn School of Medicine at Mount Sinai

Wil Lieberman-Cribbin W, Tuminello S, Gillezeau C, et al. 2019. Complementary biobank of rodent tissue samples to study the effect of World Trade Center exposure on cancer development. J Transl Med. 17 (1):342.

HTTPS://DOI.ORG/10.1186/S12967-019-2089-7

Detection and Incidence of Thyroid Cancer among Three Cohorts of WTC Exposed Rescue and Recovery Workers

PROJECT NUMBER: U01 OH011931 (formerly U01 OH011681)

PRINCIPAL INVESTIGATOR: Rachel Zeig-Owens, DrPH

INSTITUTION: Albert Einstein College of Medicine, INC.

PUBLICATIONS

Colbeth HL, Genere N, Hall CB, et al. 2020. Evaluation of medical surveillance and incidence of post-September 11, 2001, thyroid cancer in World Trade Center-exposed firefighters and emergency medical service workers. JAMA Intern Med. 180 (6):888–895.

HTTPS://DOI.ORG/10.1001/JAMAINTERNMED.2020.0950

Boffetta P, Goldfarb DG, Zeig-Owens R, et al. 2022. Temporal aspects of the association between exposure to the World Trade Center disaster and risk of skin melanoma. Journal. 2 (1):100063.

HTTPS://DOI.ORG/10.1101/2021.03.10.21253261

Boffetta P, Hall CB, Todd AC, et al. 2022. Cancer risk among World Trade Center rescue and recovery workers: A review. CA Cancer J Clin.

HTTPS://DOI.ORG/10.3322/CAAC.21723

2019 Summary

Three Research Projects Awarded

One Research Project Completed

Three Research Projects Have Published

Four Publications

Treatment Response of WTC Related Airway Injury

PROJECT NUMBER: 1 U01 OH011682

INSTITUTION: New York University School of Medicine

PRINCIPAL INVESTIGATOR: Michael D. Weiden, MD

PUBLICATIONS

Goldfarb DG, Putman B, Lahousse L, et al. 2021. Lung function decline before and after treatment of World Trade Center associated obstructive airways disease with inhaled corticosteroids and long-acting beta agonists. Am J Ind Med. 64 (10):853–860.

HTTPS://DOI.ORG/10.1002/AJIM.23272

Weiden MD, Singh A, Goldfarb DG, et al. 2021. Serum TH-2 cytokines and FEV 1 decline in WTC-exposed firefighters: A 19-year longitudinal study. American Journal of Industrial Medicine. 64 (10):845–852.

HTTPS://DOI.ORG/10.1002/AJIM.23276

Thyroid Cancer Aggressiveness in WTC Responders

PROJECT NUMBER: 1 U01 OH011849

PRINCIPAL INVESTIGATOR: Emanuela Taioli, MD, PhD

INSTITUTION: ICAHN School of Medicine at Mount Sinai

PUBLICATIONS

van Gerwen M, Cerutti JM, Rapp J, et al. 2021. Post-9/11 excess risk of thyroid cancer: Surveillance or exposure?. Am J Ind Med. 64 (10):881–884.

HTTPS://DOI.ORG/10.1002/AJIM.23268

Polygenic Prediction of PTSD Trajectories and Inflammation in 9/11 Responders

PROJECT NUMBER: 1 U01 OH011864

INSTITUTION: State University of New York Stony Brook

PUBLICATIONS

Waszczuk MA, Docherty AR, Shabalin AA, et al. 2020. Polygenic prediction of PTSD trajectories in 9/11 responders. Psychol Med. :1–9.

HTTPS://DOI.ORG/10.1017/S0033291720003839

2020 Summary

Seven Research Projects Awarded

One Research Projects Has Published

No Research Projects Completed

One Publication

The Aging Process of WTC Responders: Assessment and Consequences of Frailty

PROJECT NUMBER: 1 U01 OH012068

CO-PRINCIPAL INVESTIGATOR: Roberto Lucchini (Icahn School of Medicine at Mount Sinai)

PRINCIPAL INVESTIGATOR: Katherine Ornstein (Icahn School of Medicine at Mount Sinai)

PUBLICATIONS

Bello GA, Ornstein KA, Lucchini RG, et al. 2021. Development and validation of a clinical frailty index for the World Trade Center general responder cohort. Journal of Aging and Health. 33 (44750):531–544.

HTTPS://DOI.ORG/10.1177/0898264321997675

2021 Summary

Twenty-three Research Projects Awarded (19 NIOSH and 4 NIA WTC Research Projects)

Two Research Projects Have Published

No Research Projects Completed

Two Publications

Assessing the Feasibility and Acceptability of Using Non-invasive Transcutaneous Auricular Vagus Nerve Stimulation (taVNS) to Reduce PTSD Symptoms in WTC Responders

PROJECT NUMBER: 1 U01 OH012050-01 A1

INSTITUTION: Feinstein Institute for Medical Research

PRINCIPAL INVESTIGATORS: Rebecca Schwartz, PhD (contact PI); Theodoros Zanos

PUBLICATION

Schwartz RM, Shaam P, Williams MS, et al. 2022. Understanding mental health needs and gathering feedback on transcutaneous auricular vagus nerve stimulation as a potential ptsd treatment among 9/11 responders living with ptsd symptoms 20 years later: A qualitative approach. Int J Environ Res Public Health. 19 (8)

HTTPS://DOI.ORG/10.3390/IJERPH19084847

DNA Methylation Profiles and Breast Cancer among WTC Survivors

PROJECT NUMBER: 1 R21 OH012238

PRINCIPAL INVESTIGATOR: Alan Arslan, MD

INSTITUTION: New York University School of Medicine

PUBLICATION

Tuminello S, Zhang Y, Yang L, et al. 2022. Global DNA methylation profiles in peripheral blood of WTC-exposed community members with breast cancer. International Journal of Environmental Research and Public Health. 19 (9):5104.

HTTPS://DOI.ORG/10.3390/IJERPH19095104

2022 Summary

Place Number Here Research Projects Awarded (xx NIOSH and xx NIA WTC Research Projects)

No Research Projects Completed

Place Number Here Research Projects Have Published

Place Number Here Publications

Appendix 1, Section 4

WTC Health Registry Key Accomplishments April 2012–June 2016

World Trade Center Health Registry Key Accomplishments April 2012–June 2016

FINAL DOCUMENT: NIOSH GRANT YEARS 04-07

This study is currently supported by Cooperative Agreement U50/OH009739 from the National Institute for Occupational Safety and Health (NIOSH) of the U.S. Centers for Disease Control and Prevention (CDC) and the New York City Department of Health and Mental Hygiene (NYC DOHMH).

Support prior to April 2009 was provided by Cooperative Agreement U50/ATU272750 from the Agency for Toxic Substances and Disease Registry (ATSDR), which included support from the National Center for Environmental Health (NCEH), and the New York City Department of Health and Mental Hygiene (NYC DOHMH).

Specific Aim 1: Maintain the Registry as a valuable public health resource to allow health professionals to track and investigate possible trends in illness and recovery

1a: Maximize the number of enrollees with valid, updated contact information through ongoing communications and tracing activities to locate enrollees lost to follow-up

- ► Registry enrollees remain committed and engaged with the Registry nearly fifteen years after 9/11
  - » Nearly 160,000 enrollee contact information updates received since June 2009
  - » Relatively few withdrawals (about 1,024; or about 1.43 percent of all enrollees)
  - » LexisNexis used to trace approximately 2,000 to 5,000 enrollees per year with missing or invalid contact information
  - » Very few enrollees currently lost to follow-up (about 55)
  - » High participation rates in follow-up and in-depth surveys

1b: Maintain timely, accurate and professional communications and feedback with enrollees to address concerns and keep them engaged and interested in participating in future research

► Respond to approximately 50 calls, emails and letters from enrollees and the public per day

► All key communications prepared in English, Spanish, and traditional and simplified Chinese languages; English, Spanish, Mandarin and Cantonese speaking staff available to speak with enrollees and the public

► Provide core communications to all enrollees, including an Annual Report and Annual Card

► Maintain an active website to report Registry and other 9/11 research findings and resources with approximately five thousand unique visitors per month at ***HTTPS://WWW1.NYC.GOV/SITE/911HEALTH/INDEX.PAGE***

► Disseminate quarterly e-newsletter with 9/11-related news to approximately 50,000, including enrollees and the public

► Collaborated with the federal 9/11 Victim's Compensation Fund to identify applicants who are enrollees; provided 1,358 enrollees to-date with their Wave 1 survey as documentation for their VCF applications.

► Secured a signed NYC Mayor's letter of support for 9/11 Environmental Action WTC Health Program outreach. The letter was translated into 9 languages and directed by the NYC Dept of Education to be sent home as a "backpack" letter to all approximately 1.1 million NYC public high school students

1c: Conduct outreach to boost response to Registry surveys and studies

► Key communications were sent, including multiple surveys, email invitations and postcard reminders

► Conducted social media outreach, door-to-door outreach and telephone reminders

Specific Aim 2: Expand knowledge about the long-term health effects of the 9/11 disaster by facilitating medical, public health or emergency preparedness research, or other scientific research relevant to the WTC Health Program (WTCHP)

2a: Describe the health of enrollees and risk factors by analyzing periodic Registry health surveys and assessing the course of health conditions and unmet healthcare needs

► Made a substantial scientific contribution to the 9/11 physical and mental health literature

» Seventy publications (including sixty articles, four letters, and five conference abstracts in peer-reviewed journals and one book chapter)

» 147 presentations at scientific conferences and meetings

» Nine technical reports, three collaborative WTC-related clinical guidelines, and four public use data tools

► Conducted periodic multi-mode health surveys

» Initial Wave 1 survey (2003-4) conducted to enroll participants

» Wave 2 survey (2006-8) included adults, parents/guardian of minors, and adolescents. The adult survey had a common core of questions and three exposure-specific modules.

» Staten Island landfill and barge workers survey (2010-11)

» Wave 3 survey (2011-12) assessed current physical and mental health status of enrollees, including functioning and disability, unmet health care needs, barriers to health care access, and for the first time depression and anxiety

» Hurricane Sandy survey (2013)

» Autoimmune Diseases survey (enrollee survey 2014-16; physician verification ongoing)

2b: Develop and conduct a Wave 4 survey to ascertain cohort health status 13-14 years after 9/11

► Wave 4 core survey (Mar 2015-Jan 2016) sent to about 67,503 adult enrollees, including young adults

» Approximately 36,348 enrollees completed the survey (with about a fifty-four percent response rate, RR; and about an eighty percent RR among "longitudinal" enrollees, those who completed all Wave 1-4 surveys)

► Wave 4 asthma survey (Sept 2015-Mar 2016) sent to all approximately 14,983 enrollees who ever reported asthma on a Registry survey

» About 8,482 enrollees completed the survey (about a fifty-seven percent RR)

» Analyses in process

2c: Conduct assessment of cancer and mortality incidence

► Conducted periodic links to NYC Vital Statistics death files, the National Death Index, NYS SPARCS hospitalization records, and eleven state cancer registries

► Published initial mortality findings in Lancet based on six to eight years of follow-up post 9/11

» Jordan HT, Brackbill RM, Cone JE, Debchoudhury I, Farfel MR, Greene CM, Hadler JL, Kennedy J, Li J, Liff J, Stayner L, Stellman SD. Mortality among survivors of the Sept 11, 2001, World Trade Center disaster: results from the World Trade Center Health Registry cohort. Lancet 2011;378:879-887.

» *HTTPS://DOI.ORG/10.1016/S0140-6736(11)60966-5*

► Published initial cancer findings in JAMA based on seven to eight years of follow-up post 9/11

» Li J, Cone JE, Kahn AR, Brackbill RM, Farfel MR, Greene CM, Hadler JL, Stayner LT, Stellman SD. 2012. Association between World Trade Center exposure and excess cancer risk. JAMA. 308: 2479-2488. *HTTPS://DOI.ORG/10.1001/JAMA.2012.110980*

► Cancer incidence ten years post-9/11 (manuscript in preparation as of

06/30/2016)

► Mortality incidence ten years post-9/11 (data linkages completed; manuscript in preparation as of 6/30/2016)

► Collaborated or collaborating with FDNY and Mount Sinai WTC researchers on:

» A WTCHP-funded review of cancer in WTC rescue/recovery workers from the Registry, FDNY and Mt. Sinai cohorts

◊ Boffetta P, Zeig-Owens R, Wallenstein S, Li J, Brackbill R, Cone J, Farfel M, Holden W, Lucchini R, Webber MP, Prezant D, Stellman SD. 2016. Cancer in World Trade Center Responders: Findings from Multiple Cohorts and Options for Future Study. Am J Ind Med. 59(2):96-105. doi: 10.1002/ajim.22555. https://doi.org/10.1002/ajim.22555

» A WTCHP-funded study to conduct a pooled analysis of cancer incidence, latency and survival across WTC rescue/recovery worker cohorts

2d: Conduct surveillance activities to identify and investigate potential emerging health conditions in collaboration with a network of WTCHP and other clinical colleagues

► Respiratory studies in collaboration with NYU/Bellevue: Completed first study (2008-10); 785 enrollees completed interviews and pulmonary function tests (PFTs). Completed a follow-up study (2013-14; 545 enrollees completed interviews and PFTs; approximately a seventy-four percent RR) to assess longer-term persistent lower respiratory symptoms. Published first study findings.

» Friedman SM, Maslow CB, Reibman J, Pillai PS, Goldring RM, Farfel MR, Stellman SD, Berger KI. 2011. Case-control study of lung function in World Trade Center Health Registry area residents and workers. Am J Respir Crit Care Med. 184:582-589. https://doi.org/10.1164/rccm.201011-1909OC

» Maslow CB, Friedman SM, Pillai PS, Reibman J, Berger KI, Goldring R, Stellman SD, Farfel M. 2012. Chronic and acute exposures to the World Trade Center disaster and lower respiratory symptoms: area residents and workers. Am J Public Health. 102:1186-1194. https://doi.org/10.2015/AJPH.2011.300561

► **Sarcoidosis:** Completed in-depth study, including medical record review

» Jordan HT, Stellman SD, Prezant D, Teirstein A, Osahan SS, Cone JE. 2011. Sarcoidosis diagnosed after September 11, 2001, among adults exposed to the World Trade Center disaster. J Occup Environ Med 2011;53:966-974.https://doi.org/10.1097/JOM.0b013e31822a3596

► **Post-Hurricane Sandy:** Completed nested study in 2013 to assess mental and physical health effects among nearly 4,400 en-

rollees living in flooded zones in NY, NJ, and CT and a sample of another almost 4,400 enrollees in non-flood zones in these areas. 4,558 surveys completed (with nearly a fifty-one percent RR).

» Brackbill RB, Caramanica K, Maliniaki M, Stellman SD, Fairclough MA, Farfel MR, Turner L, Maslow CB, Moy AJ, Wu D, Yu S, Welch AE, Cone JE, Walker DJ. 2014. Nonfatal injuries 1 week after Hurricane Sandy – New York City Metropolitan Area, October 2012. MMWR Morb Mortal Wkly Rep. 63(42):950-954. *https://www.cdc.gov/mmwr/preview/mmwrhtml/mm6342a4.htm*

» Brown S, Gargano LM, Parton H, Caramanica K, Farfel MR, Stellman SD, Brackbill RM. 2016. Hurricane Sandy Evacuation among World Trade Center Health Registry (WTCHR) Enrollees in New York City. Disaster Med Public Health Prep. 10(3): 411-419. https://doi.org/10.1017/dmp.2016.57

» Caramanica K, Brackbill RM, Stellman SD, Farfel MR. 2015. Posttraumatic stress disorder after Hurricane Sandy among persons exposed to the 9/11 disaster. Int J Emerg Ment Health. 17(1): 356-62. *https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4424196/*

» Gargano LM, Caramanica K, Sisco S, Brackbill RM, Stellman SD. 2015. Exposure to the World Trade Center Disaster and 9/11-Related Post-Traumatic Stress Disorder and Household Disaster Preparedness. Disaster Med Public Health Prep. 9(6):625-633. *HTTPS://DOI.ORG/10.1017/DMP.2015.71*

► **Staten Island landfill and barge workers:** Completed data collection, qualitative analysis (Ekenga et al 2011), and quantitative analysis (Fairclough et al 2015).

» Ekenga CC, Scheu KE, Cone JE, Stellman SD, Farfel MR. 2011. 9/11-Related experiences and tasks of landfill and barge workers: qualitative analysis from the World Trade Center Health Registry. BMC Public Health. 11:321. *HTTPS://DOI.ORG/10.1186/1471-2458-11-321*

» Fairclough MA, Miller-Archie SA, Cone JE, Dechen T, Ekenga CC, Osahan S, Perlman SE, Gargano LM, Imasuen J, Farfel MR. 2015. Relationship between persistent post-traumatic stress disorder and human remains exposure for Staten Island Barge and Landfill recovery and clean-up workers after 9/11. Int J Emerg Ment Health. 17(3): 661-663. *HTTPS://DX.DOI.ORG/10.4172/1522-4821.1000261*

► **Autoimmune disease survey:** Launched study to assess incidence of physician verified rheumatoid arthritis and other autoimmune diseases among enrollees who reported an autoimmune disease at Wave 3 and to examine potential 9/11-risk factors. A total of 2,042 enrollee surveys completed, for an approximate seventy-three percent RR. Physician verification surveys ongoing. Physician surveys or

medical records received to-date for 627 enrollees; about a sixty percent RR of the 1,043 enrollees who provided authorization to contact their physician.

► **Health and Quality of Life (Injury) Study:** Completed in 2015 Phase I: qualitative interviews with thirty-nine enrollees who sustained a 9/11 injury (manuscript in prep as 6/30/2016). Analysis underway to inform development of a Phase II quantitative survey to better understand the long-term mental and physical health consequences of 9/11 injuries. Phase II survey to be launched to approximately 6,000 enrollees in early 2017.

2e: Conduct and/or facilitate collaborative in-depth studies with researchers at the WTCHP Centers of Excellence and qualified academic researchers on topics of importance to the WTCHP

► Published twelve manuscripts with WTCHP co-authors

► Co-authored ten publications with other external researchers to whom we provided de-identified data

► Co-authored eighteen publications with additional researchers outside of NYC DOHMH

► At least another twenty-two publications authored by principal investigators from external research studies facilitated by the Registry

► Responded to nearly 120 data requests from potential external researchers

► Approved and implemented 25 applications from external researchers (eighteen external studies completed)

► Facilitated recruitment of thousands of Registry enrollees into nine external research studies

► Provided de-identified data to fifteen external research studies and will provide to another approved study

► Worked with nine federally funded WTCHP external studies, including two active studies (Hoven, Marmor)

► Working with seven active approved external research projects, including two with federal WTCHP funding (Hoven, Marmor), two other CDC projects (Antao, Pearson), and three others (Bowler, Wyka (n=2)).

► Posted informational brochure for potential external researchers on www.nyc.gov/9-11HealthInfo

2f and g: Registry education and training

► Twelve MPH degrees completed using Registry data under the guidance of Registry senior staff in

a mentored research environment during this time period

► Eleven medical residents, six medical students, and seventeen graduate/undergraduate interns/college aides or volunteers participated in Registry research in a mentored environment during this time period

SPECIFIC AIMS 3 AND 4 BELOW ARE THE RESEARCH TRANSLATION COMPONENTS OF THE REGISTRY.

Specific Aim 3: Conduct community activities to respond to the physical and mental health concerns and specific health care needs of enrollees and others exposed to 9/11

3a: Disseminate Registry findings and recommendations to enrollees, the public, WTC Health Program leadership and policy makers

► Employed multiple dissemination channels, including the Registry-9/11healthinfo website, sixteen YouTube videos, annual reports, press announcements, media interviews;

► Made 147 presentations at scientific conferences; meetings of the WTCHP STAC, Responder and Survivor steering committees, and Outreach committee; and to community groups, hospitals, and local health departments

3b: Develop and provide Registry data resources for enrollees, the public, and researchers

► Posted Wave 1, 2 and 3 survey materials, including the Data File Users' Manuals (DFUMs), the questionnaires and the public use datasets for each survey on www.nyc.gov/9/11-HealthInfo

► Also posted the Hurricane Sandy, Staten Island landfill and barge worker, and the Wave 4 questionnaires and DFUM. Completed the Wave 4 public use dataset; pending posting.

► Provided an interactive 9/11 Health Online Data Tool to permit users to query de-identified Wave 1 survey data; this tool has been accessed by over 2,140 users outside of NYC DOHMH

► Responded to approximately 329 data requests from advisors, researchers, media and others since May 2007

3c: Conduct health promotion activities

Completed two smoking cessation projects targeted to all enrollees who reported smoking; Sent no-cost NRT kits or smoking cessation services to over 800 enrollees or their household members

- Created condition-specific physical and mental health fact sheets which represent current scientific information and provides answers to common questions received from enrollees and the public. Current fact sheets include: asthma, bronchiectasis, anxiety, and gastroesophageal reflux disease
  - » In May 2016, sent asthma fact to approximately 7,000 enrollees who reported asthma on their Wave 4 survey

Specific Aim 4: Develop and maintain the 9/11 Treatment Referral Program (TRP) to help enrollees and others find care for 9/11-related health problems

4a: Inform enrollees of 9/11-related services and resources

- Conducted six focus groups with diverse enrollee survivors to identify barriers to 9/11-related health care
- TRP staff trained in motivational interviewing techniques which helps to identify and address barriers to applying to and utilizing 9/11-related health services
- TRP informational brochures sent to all enrollees
- TRP I: In 2009-2011, conducted personalized outreach to approximately 8,500 enrollees (or parents/guardians).
- Personalized communications, including a TRP brochure, sent in English, Spanish and Chinese
- Over 1,100 survivor enrollees in the NYC area scheduled a first-time appointment at the WTC Environmental Health Center at Bellevue Hospital.
- TRP was the largest source of survivor applications.

4b: Expand TRP in collaboration with the WTCHP to offer health care referrals to rescue/recovery workers as well as survivors based on health updates from the Wave 3 survey

- TRP II: Launched in July 2013 with outreach expanded to rescue/recovery workers and survivors residing in and outside of the NYC area
- Phone outreach expanded to include English, Spanish, Mandarin and Cantonese
- Staff identified approximately 23,000 enrollees for outreach based on Wave 3 symptoms and unmet health care needs
- Outreach conducted to-date to nearly 19,000 enrollees, including groups under-represented in the WTCHP such as NYC Department of Sanitation workers and Chinese language enrollees
- On average, two to three contacts with staff were needed before an enrollee completed the outreach process

- Approximately 6,000 enrollees to-date have requested applications
- Since 2013, over 3,600 Registry-branded applications have been received by the WTCHP, making the Registry the major source of new applications for both rescue/recovery workers and survivors
- Provided over 4,400 enrollees to-date with their Wave 1 survey report as documentation of their presence near the WTC site on 9/11 for their WTCHP application

4c: Conduct qualitative research with healthcare providers to inform future efforts

- Conducted in-depth telephone interviews with twenty NYC providers to understand how they engage patients in 9/11-related health care. Most were knowledgeable about 9/11-associated respiratory and psychological conditions, but less informed about other 9/11-related health conditions. Most providers were interested in learning more about 9/11-related health programs and conditions.
  - » Welch AE, Caramanica K, Yip J, Petrsoric LJ, Cone JE. 2015. A Qualitative Analysis of New York City Based Primary Care and Specialty Providers' Knowledge of 9/11-Related Health Conditions and Health Care Services. Austin J Emergency and Crit Care Med. 2(5):1029. http://austinpublishinggroup.com/emergency-critical-care-medicine/fulltext/ajeccm-v2-id1029.php

4d: Evaluate effectiveness of TRP and share findings with the WTCHP

- TRP-I evaluation completed; TRP shown to be effective
  - » Welch AE, Debchoudhury I, Jordan HT, Petrsoric LJ, Farfel MR, Cone JE. 2014. Translating research into action: An evaluation of the World Trade Center Health Registry's Treatment Referral Program. Disaster Health. 2(1):97-105 https://doi.org/10.4161/dish.28219
- TRP-II evaluation is in progress, including analysis on pre- and post-application submission outcomes

Appendix 1, Section 5

WTC Health Registry Key Accomplishments July 2016–June 2020

World Trade Center Health Registry Key Accomplishments July 2016–June 2020

NIOSH GRANT YEARS 08–12

This study is currently supported by Cooperative Agreement U50/OH009739 from the National Institute for Occupational Safety and Health (NIOSH) of the U.S. Centers for Disease Control and Prevention (CDC) and the New York City Department of Health and Mental Hygiene (NYC DOHMH). Support prior to April 2009 was provided by Cooperative Agreement U50/ATU272750 from the Agency for Toxic Substances and Disease Registry (ATSDR), which included support from the National Center for Environmental Health (NCEH), and the New York City Department of Health and Mental Hygiene (NYC DOHMH).

Specific Aim 1: Maintain the Registry as a valuable public health resource to allow health professionals to track and investigate possible trends in illness and recovery

1a: Maximize the number of enrollees with valid, updated contact information through ongoing communications with enrollees and conduct tracing to locate enrollees with invalid or missing contact information

- Maintained multiple communication channels (i.e., phone, fax, email, mail, secure web app) for enrollees to use to contact the Registry with questions or to provide updated contact information
- Obtained consent from new young adults - child enrollees who have aged into adulthood
- Children: approximately 2,625 children were under age 18 years at time of enrollment in 2003-2004; about 377 enrollees are children as of June 2017
- Among new young adults, approximately 1,192 have consented to remain in the Registry as adults (including 144 in Year 8), sixty-two have withdrawn and approximately nine are deceased. Staff is conducting outreach to the remaining new young adults
- Registry enrollees remain com-

mitted and engaged with the Registry nearly sixteen years after 9/11

- » Over 9,700 enrollee contact information updates received in Year 8
- » Few withdrawals (thirty-five in Year 8; a total of 1,059, or about 1.48 percent of all enrollees)
- » LexisNexis used to trace approximately 2,000 to 5,000 enrollees per year with missing or invalid contact information
- » Very few enrollees currently lost to follow-up (about 54)

1b: Keep enrollees engaged and interested in participating in future research by maintaining timely, accurate and professional communications and providing feedback to address enrollee concerns

- ► Responded to approximately 50 incoming communications from enrollees and the public per day
- ► Prepared all key written communications in English, Spanish, and traditional and simplified Chinese
- ► Staff available to speak with enrollees and the public in English, Spanish, Mandarin and Cantonese
- ► Provided core communications to all enrollees, including an Annual Report of findings and Annual Card
- ► Maintained an active website to report Registry and other 9/11 research findings and resources with approximately three thousand unique visitors per month from about forty-nine countries at: http://www1.nyc.gov/site/911health/index.page. The Research Videos page receives nearly eight thousand views per month at: ***HTTP://WWW1.NYC.GOV/SITE/911HEALTH/UPDATES/NEWS-VIDEOS.PAGE***
- ► Disseminated quarterly e-newsletter with 9/11-related news to approximately 50,000, including enrollees and the public
- ► Collaborated with the federal 9/11 Victim's Compensation Fund (VCF) to identify applicants who are enrollees. Provided 1,380 enrollees to-date, including twenty-two in Year 8, with their Wave 1 survey report as supporting eligibility documentation for their VCF application
- ► High enrollee participation rates in follow-up and in-depth surveys
- ► In May 2017, conducted 10 focus groups with targeted groups of enrollees including: young adults (four groups); separate groups for Mandarin, Cantonese and Spanish language speakers; a group of enrollees who completed all W1-4 survey waves; and a group of enrollees who completed only a W1 survey and an external or in-depth survey. A total of seventy-eight enrollees participated in these focus groups. Findings will be used to enhance our communication strategies to better engage and inform enrollees of findings and resources

1c: Conduct outreach to boost response

to Registry studies, as needed

- ► Sent key communications including multiple paper surveys, email invitations with a link to an online survey, and email and postcard reminders
- ► Conducted social media outreach, door-to-door outreach and telephone reminders

Specific Aim 2: Expand knowledge about the long-term health effects of 9/11 by facilitating medical, public health or emergency preparedness research, or other scientific research relevant to the WTC Health Program (WTCHP) – with special emphasis on impacts to those who lived, worked or attended school in the disaster area (i.e.,non-"responders")

2a: Assess the contribution of 9/11 exposure and other risk factors to the course of health conditions and unmet healthcare needs 15 years post-9/11 by analyzing the 2015-16 Wave 4 survey, other Registry surveys and hospital discharge and other data linked to the Registry

- ► Made a substantial scientific contribution to the 9/11 physical and mental health literature
  - » Twenty-three publications, including fourteen articles, two letters, and two conference abstracts in peer-reviewed journals and five publications in-press
  - » Forty-three presentations at scientific conferences and meetings
- ► Conducted public health training
  - » Two MPH degrees completed using Registry data under the guidance of Registry senior staff
  - » Conducted periodic multi-mode health surveys

◊ See section 2c below

2b: Extend assessment of cancer and mortality incidence through 15 years post-9/11

- ► Conduct periodic links to NYC Vital Statistics death files, the National Death Index (NDI), NYS SPARCS hospitalization records, and eleven state cancer registries
- ► Cancer incidence completed through 10 years post-9/11
  - » Li J, Brackbill RM, Liao TS, Qiao B, Cone JE, Farfel MR, Hadler JL, Kahn AR, Konty KJ, Stayner LT, Stellman SD. Ten-year cancer incidence in rescue/recovery workers and civilians exposed to the September 11, 2001 terrorist attacks on the World Trade Center. Am J Ind Med. 2016 Sep;59(9):709-721. ***HTTPS://DOI.ORG/10.1002/AJIM.22638***
  - » Mortality incidence through ten years post-9/11 (manuscript under clearance as of 6/30/2017)

2c: Conduct independent or collaborative surveillance and in-depth studies to identify and investigate potential emerging health conditions and treatment outcomes on topics important to

the WTCHP Published additional quantitative analysis findings

► Staten Island landfill and barge workers: Published additional quantitative analysis findings

» Cone JE, Osahan S, Ekenga CC, Miller-Archie SA, Stellman SD, Fairclough M, Friedman SM, Farfel MR. Asthma among Staten Island fresh kills landfill and barge workers following the September 11, 2001 World Trade Center terrorist attacks. Am J Ind Med. 2016 Sep;59(9):795-804. ***HTTPS://DOI.ORG/10.1002/AJIM.22645***

► **Autoimmune disease survey:** (2014-2017)

» Phase I: Assess incidence of physician verified rheumatoid arthritis and other autoimmune diseases (AD) among enrollees who reported post-9/11 autoimmune disease at Wave 3 and examine 9/11-risk factors; 2,042 enrollee surveys completed; with about a seventy-three percent response rate (RR). Physician surveys or medical records received for 732 enrollees, with about a seventy percent RR out of the 1,042 enrollees who provided authorization to contact their physician. Medical record vendor to obtain these remaining medical records.

» Phase II: Assess incidence of physician verified MS and ALS among approximately 580 additional enrollees who reported post-9/11 MS or ALS at Waves 3 or 4 and examine 9/11-risk factors. Received 394 enrollee surveys to-date; for an approximate sixty-eight percent RR to-date. Physician verification/ medical record review pending.

► **Health and quality of life (Injury) study:**

» Phase I (Qualitative): In 2015, completed qualitative interviews with thirty-nine enrollees who sustained a 9/11 injury. Findings published in Year 08. Analysis informed development of a Phase II survey

◊ Gargano LM, Gershon RR, Brackbill RM. Quality of life of persons injured on 9/11: Qualitative analysis from the World Trade Center Health Registry. PLOS Currents Disasters. 2016 Oct 27. Edition 1. http://doi.org/10.1371/currents.dis.7c70f66c1e6c5f-41b43c797cb2a04793

» Phase II (Quantitative): Launched in March 2017 to approximately 8,500 enrollees to better understand the long-term mental and physical health consequences of 9/11 injuries. Data collection to end in mid-July 2017. Preliminary: About 6,000 surveys received to-date; for an approximate seventy-one percent RR.

► Early Labor Force Exit Study:

» Analysis of W1-W3 findings (Yu et al., 2016) informed the development of this in-depth study.

» Yu S, Brackbill RM, Locke S, Stellman SD, Gargano LM. Impact of 9/11-related chronic conditions and PTSD comorbidity on early

retirement and job loss among World Trade Center disaster rescue and recovery workers. Am J Ind Med. 2016 Sep;59(9):731-741.

◊ https://doi.org/10.1002/ajim.22640

» Finalized content and developed paper and web surveys in Year 8. Survey planned to launch August 2017. The study will examine the impact of 9/11-related health on early retirement and job loss among approximately 24,500 responders and survivors and further investigate the interrelationship of income, health, and premature labor force exit

2d: Develop and conduct a Wave 5 survey to ascertain cohort health status 18-19 years after 9/11

► Conducted planning for a Request for Proposal (RFP) to select a Wave 5 survey vendor to be released later in 2017

2e: Develop new research resources by assessing the feasibility of matching to additional administrative databases and establishing a sub-cohort of enrollees willing to participate in "rapid research" to provide rapid turnaround of brief, directed surveys implemented with greater frequency

► We discussed the proposal to establish a sub-cohort of enrollees for rapid research with the NYC DOHMH IRB chair. The IRB chair advised the Registry that she was not receptive to approving this proposal because of potential bias in the research outcomes if enrollees with less rapid survey response times were excluded. No further steps are planned

► Conducted an initial assessment of NYC DOHMH or NYC Dept of Education (DoE) administrative databases that may provide: (1) information about the health effects of 9/11 on children; and/or (2) a sampling frame to establish a new children's cohort. Registry staff recommended focus on using administrative databases for expanded research on children because it is likely to be more feasible, timely and cost-effective than establishing a new cohort. Presented to the Survivor Steering Committee and sent NIOSH an initial briefing paper on the assessment. Discussions are ongoing

SPECIFIC AIMS 3 AND 4 BELOW ARE THE RESEARCH TRANSLATION COMPONENTS OF THE REGISTRY.

Specific Aim 3: Conduct community activities to respond to the physical and mental health concerns and specific healthcare needs of enrollees and others exposed to 9/11

3a: Disseminate Registry findings and recommendations to enrollees, the pub-

lic, WTCHP leadership and policy makers, using formats such as video, social media, and websites

- ► Employed multiple dissemination channels, including the Registry's 9/11healthinfo website, annual reports, press announcements, media interviews, and YouTube videos, including ten research videos and nine testimonial videos http://www1.nyc.gov/site/911health/enrollees/testimonial-videos.page (five of the videos were posted in Year 8 and two more are in production)
- ► Made forty-three presentations at scientific conferences; meetings of the WTCHP STAC, Survivor steering committee and Outreach committee meeting; and to community groups, hospitals, and local health departments
- ► Completed a redesign of the 9/11healthinfo website to better organize the content with the goal to enhance user engagement and to ensure that it was mobile friendly
- ► Conducted ten focus groups (see section 1b above)

3b: Provide Registry data resources and other resources to enrollees, the general public, external researchers and WTCHP entities

- ► Posted Wave 4 survey materials, including the Data File Users' Manual (DFUM) and the questionnaires for the Wave 4 Core and Asthma Surveys. The Wave 4 public use dataset with codebook is complete and pending posting on the 9/11 website
- ► http://www1.nyc.gov/site/911health/researchers/health-data-tools.page
- ► Our interactive 9/11 Health Online Data Tool that permits users to query de-identified Wave 1 survey data has been accessed by over 800 unique users outside of NYC DOHMH in Year 8
- ► Responded to approximately sixteen data requests from advisors, researchers, media and others in Year 8

3c: Continue to conduct health promotion activities, including health education

- ► Create condition-specific physical and mental health fact sheets which represent current scientific information and provide answers to common questions received from enrollees and the public. All fact sheets are available in English, Spanish, and traditional and simplified Chinese
  - » In April 2017, sent GERD Fact Sheet to nearly 25,000 enrollees who reported GERD on their W4 survey
  - » Fact sheets in-preparation: sleep apnea, sinusitis, hearing loss, anxiety, PTSD and others
  - » Posted related health educational materials on

» *www.nyc.gov/9-11HealthInfo*

Specific Aim 4: Maintain the 9/11 Treatment Referral Program (TRP) to help enrollees and others find care for 9/11-related health problems

4a: Inform enrollees of 9/11-related services and resources

► TRP staff trained in motivational interviewing techniques which helps to identify and address barriers to applying to and utilizing 9/11-related health service; TRP informational brochures sent to all enrollees

► Personalized communications sent in English, Spanish and traditional and simplified Chinese

► Updated TRP III brochures created and printed in 2017

► Posted TRP, VCF and other resource information on the Registry's 9-11HealthInfo website

4b: In coordination with the WTCHP, conduct outreach to potentially eligible enrollees in English, Spanish, and Chinese to encourage them to apply to the WTCHP

► TRP II: Identified approximately 23,000 enrollees for outreach; conducted outreach to nearly all of these enrollees. TRP staff made contact with about 7,417 enrollees with nearly 6,000 requesting a WTCHP application

► TRP II ended on 12/31/2016. By then, approximately 4,351 Registry-branded applications had been received by the WTCHP, and approximately 5,257 enrollees had been provided with their Wave 1 report as documentation of their presence near the WTC site on 9/11 for their WTCHP application

► On average, three to five contacts with staff were needed before an enrollee completed the outreach process

► TRP III: Launched in January 2017 to enrollees residing in and outside of the NYC area, including English (approximately 15,000), Spanish, Mandarin and Cantonese (together about 500) language speakers

► The outreach sample was drawn from responder and survivor enrollees who reported no prior access to the WTCHP on their Wave 4 survey. Survivors also needed to report least one of the following symptoms (uncontrolled asthma, COPD, RADS, GERS, probable 9/11-related PTSD, or depression on their Wave 4 survey or generalized anxiety disorder on their Wave 3 survey) to be included in the sample targeted for TRP III outreach

► In Year 8, approximately 1,121 enrollees requested a WTCHP application, all under TRP III outreach

► In Year 8, over 880 Regis-

try-branded applications had been received by the WTCHP including 517 under TRP II. In May 2017, TRP received the highest number of applications ever in a month (212), which was 40 percent of all WTCHP applications received that month

► In Year 8, provided approximately 2,235 enrollees with their Wave 1 survey report as documentation of their presence near the WTC site on 9/11 for their WTCHP application, with 1,595 reports provided under TRP III

4c: Conduct targeted outreach to enrollees with specific conditions or unmet healthcare needs (e.g.,poorly controlled asthma, current smokers, or those accepted to the WTCHP but never seen

► Targeted outreach based on specific medical conditions is planned to begin with uncontrolled asthma

4d: Evaluate impact of TRP and share findings with the WTCHP

► TRP-II evaluation under analysis, including two manuscripts in-prep: analysis on pre- and post-application submission outcomes

Specific Aim 5: Collaborate with other WTCHP entities (Data Centers, Clinical Centers of Excellence) to explore surveillance signals and treatment outcomes as follows: 9/11 linkage with uncommon health conditions, such as cancer and autoimmune and neurological disease (including age at diagnosis), and treatment outcomes for selected conditions related to 9/11

5a.: Continue communications and collaborations with WTCHP clinical/data centers, including attending Responder and Survivor Steering Committee, NIOSH scientific advisory and NIOSH PI meetings

► Published four manuscripts with WTCHP co-authors

► Respiratory studies in collaboration with NYU/Bellevue: Completed the follow-up study (2013-14; 545 enrollees completed interviews and PFTs; with about a seventy-four percent RR) to assess longer-term persistent lower respiratory symptoms. Published follow-up findings in Year 8.

» Jordan HT, Friedman SM, Reibman J, Goldring RM, Miller-Archie SA, Ortega F, Alper H, Yongzhao S, Maslow CB, Cone JE, Farfel MR, Berger KI. Risk factors for persistence of lower respiratory symptoms among community members exposed to the 2001 World Trade Center terrorist attacks. Occup Environ Med. 2017 March; 74(6): 449-455.

» http://doi.org/10.1136/oemed-2016-104157

► Hearing loss study in collaboration with FDNY:

» Using existing, longitudinal FDNY audiometric surveillance data, we are examining the role of 9/11-re-

lated exposures on change in hearing over time among approximately 15,000 FDNY personnel active on 9/11. In collaboration with FDNY, audiometric data has been recovered and cleaned and we are in the process of defining change in hearing status

► Collaborated or collaborating with FDNY, Einstein and Mount Sinai WTC researchers on WTCHP-funded studies, including:

» A review of cancer in WTC rescue/recovery workers from the Registry, FDNY and Mount Sinai cohorts:

◊ Boffeta, P, Zeig-Owens R, Wallenstein S, Li J, Brackbill RM, Cone JE, Farfel MR, Holden W, Lucchini R, Webber MP, Prezant D, Stellman SD, Hall CB. Response to Soskolne [2017]. Am J Ind Med. 2017 April; 60(5): 512. https://doi.org/10.1002/ajim.22713 [Letter]

» A study to conduct a pooled analysis of cancer incidence, latency and survival across three cohorts of WTC rescue/recovery workers from the Registry, FDNY and Mount Sinai.

► Developed and executed NYC DOHMH Data Use Agreements (DUAs) or a Memo of Understanding (MOU) with study partners (Mount Sinai, FDNY, NYS Cancer Registry) and six of the targeted thirteen state cancer registries (CA,CT,MA,NC,NJ, and NY)

► Submitted a National Death Index (NDI) application for the joint cancer project. Approval pending

► Will continue to outreach to the remaining seven state cancer registries to obtain DUAs

» Participated in an application for a WTCHP-funded study to conduct a pooled analysis of overall, cause-specific and occupational-specific mortality in a combined dataset from these three WTC rescue/recovery workers cohorts

► Continued to attend and participate in the WTCHP Responder and Survivor Steering Committee meetings, the NIOSH scientific advisory meeting, the NIOSH PI meetings and the NIOSH Scientific Forum meetings.

5b: Serve as a platform for external research by providing facilitated recruitment of enrollees and de-identified survey data

► Co-authored another six publications with researchers outside of NYC DOHMH

► At least another four publications authored by principal investigators from external research studies facilitated by the Registry

► Responded to thirteen data requests from potential external researchers

► Reviewed applications from six external researchers; approved five

applications and provided de-identified data to four external researchers (one data release pending implementation of a DUA)

► In August 2016, completed facilitated recruitment of Registry enrollees into a WTCHP-funded study of the mental health of children and young adults (Hoven, Columbia)

► Under the guidance of an external researcher using Registry data, one graduate degree (MPH) completed

► Worked with nine active approved external research projects, including two with federal WTCHP funding (Kung, Marmor), one other CDC project (Pallos), and six others (Bowler, Mancini, Shen, Wyka (n=2) and Todd).

WTC Health Registry Key Accomplishments July 1, 2017 – June 30, 2018 NIOSH Grant Year 09

This study is currently supported by Cooperative Agreement U50/OH009739 from the National Institute for Occupational Safety and Health (NIOSH) of the U.S. Centers for Disease Control and Prevention (CDC) and the New York City Department of Health and Mental Hygiene (NYC DOHMH).

Support prior to April 2009 was provided by Cooperative Agreement U50/ATU272750 from the Agency for Toxic Substances and Disease Registry (ATSDR), which included support from the National Center for Environmental Health (NCEH), and the New York City Department of Health and Mental Hygiene (NYC DOHMH).

Specific Aim 1: Maintain the Registry as a valuable public health resource to allow health professionals to track and investigate possible trends in illness and recovery

1a: Maximize the number of enrollees with valid, updated contact information through ongoing communications with enrollees and conduct tracing to locate enrollees with invalid or missing contact information

► Maintained multiple communication channels (i.e., phone, fax, email, mail, secure web app) for enrollees to use to contact the Registry with questions or to provide updated contact information

► Obtained consent from new young adults - child enrollees who have aged into adulthood

» Children: about 2,625 children were under age 18 years at time of enrollment in 2003-2004; about 203 enrollees are children as of

June 2018.

► Since 2013, 93% of the new adults successfully contacted have consented to remain in the Registry, 97 have withdrawn and nine are deceased. Among new young adults, 1,358 have consented to remain in the Registry as adults (including 152 in Year 09) Staff are conducting outreach to the remaining unconsented new young adults

► Registry enrollees remain committed and engaged with the Registry over sixteen years after 9/11

» Over 14,315 enrollee contact information updates received in Year 09

» Few withdrawals (39 in Year 09; a total of 1,104, or about 1.55% of all enrollees)

» Traced over 6,000 enrollees with missing or invalid contact information using LexisNexis.

» Very few enrollees currently lost to follow-up (about 49)

1b: Keep enrollees engaged and interested in participating in future research by maintaining timely, accurate and professional communications and providing feedback to address enrollee concerns

► Responded to about 40 incoming communications from enrollees and the public per day

► Prepared all key written communications in English, Spanish, and traditional and simplified Chinese

► Staff available to speak with enrollees and the public in English, Spanish, Mandarin and Cantonese

► Provided core communications to all enrollees, including an Annual Report of findings and Annual Card

► Maintained an active website to report Registry and other 9/11 research findings and resources with an average of over 4,200 unique visitors per month from about 57 countries at: http://www1.nyc.gov/site/911health/index.page. The Research Videos Page (with 18 videos posted to-date) receives on average about 167 views per month at: ***HTTP://WWW1.NYC.GOV/SITE/911HEALTH/UPDATES/NEWS-VIDEOS.PAGE***. The Registry's Research and Testimonial videos have been viewed over 10,400 times since they were placed on YouTube in May 2014.

► Disseminated quarterly e-newsletter with 9/11-related news to approximately 50,000, including enrollees and the public

► Collaborated with the federal 9/11 Victim's Compensation Fund (VCF) to identify applicants who are enrollees. Provided 1,425 enrollees to-date, including 49 in Year 9, with their Wave 1 survey report as supporting eligibility documentation for their VCF application

► High enrollee participation rates in follow-up and in-depth surveys

1c: Conduct outreach to boost response to Registry studies, as needed

- ► Sent key communications including multiple paper surveys, email invitations with a link to an online survey, and email and postcard reminders
- ► Conducted social media outreach, door-to-door outreach and telephone reminders

Specific Aim 2: Expand knowledge about the long-term health effects of 9/11 by facilitating medical, public health or emergency preparedness research, or other scientific research relevant to the WTC Health Program (WTCHP) – with special emphasis on impacts to those who lived, worked or attended school in the disaster area (i.e.,non-"responders")

2a: Assess the contribution of 9/11 exposure and other risk factors to the course of health conditions and unmet healthcare needs 16 years post-9/11 by analyzing the 2015-16 Wave 4 survey, other Registry surveys and hospital discharge and other data linked to the Registry

- ► Made a substantial scientific contribution to the 9/11 physical and mental health literature
  - » 19 publications, including 13 articles, one conference abstract and 5 publications in-press.
  - » 36 presentations at scientific conferences and meetings
- ► Conducted periodic multi-mode health surveys
- ► **See section 2c below:**
- ► Conducted public health training
  - » One MPH degree completed using Registry data under the guidance of senior staff

2b: Extend assessment of cancer and mortality incidence through 16 years post-9/11

- ► Conduct periodic links to NYC Vital Statistics death files, the National Death Index (NDI), NYS SPARCS hospitalization records, and eleven state cancer registries
  - » Conducted a linkage with NDI for the years 2015 and 2016
  - » Conducted a linkage with NYC DOHMH Vital Records for the year of 2016
- ► Mortality incidence through ten years post-9/11
  - » The manuscript titled "Mortality among rescue and recovery workers and community members exposed to the September 11, 2001 World Trade Center terrorist attacks, 2003-2014" has been published in the Journal of "Environmental Research".

2c: Conduct independent or collaborative surveillance and in-depth studies to identify and investigate potential emerging health conditions and treatment outcomes on topics important to the WTCHP

► **Autoimmune disease survey:** (2014-2018)

» **Phase I:** Assess incidence of physician verified rheumatoid arthritis and other autoimmune diseases (AD) among enrollees who reported post-9/11 autoimmune disease at Wave 3 and examine 9/11-risk factors; 2,042 enrollee surveys completed; with about a 73% response rate (RR). Physician surveys or medical records received for 817 enrollees, with a 78.4% percent RR out of the 1,042 enrollees who provided authorization to contact their physician. Medical record vendor to obtain these remaining medical records.

» **Phase II:** Assess incidence of physician verified MS and ALS among approximately 580 additional enrollees who reported post-9/11 MS or ALS at Waves 3 or 4 and examine 9/11-risk factors. Received 415 enrollee surveys to-date; for a 71.5% response rate. Total of 6 self-reported cases of ALS. Two of these returned signed release of medical information forms. Physician verification/medical record review pending.

► PTSD and Lower Respiratory Symptoms: A qualitative study:

» We conducted in-depth qualitative interviews to gain an understanding of enrollees' perceptions of how their lower respiratory symptoms and PTSD are related. An IRB application was submitted to DOHMH IRB for approval. Interview questions were developed. Two consultants, a pulmonologist (Dr. de la Hoz, Mt. Sinai), and a psychologist (Dr. Bromet, Stony Brook) were recruited to assist with this project. The services of an expert in conducting interviews for qualitative research studies was procured. In March 2018, interviews with 34 enrollees were completed. All interviews have been transcribed and analysis is currently underway.

► **Health and quality of life (Injury) study:**

» **Phase I (Qualitative):** In 2015, completed qualitative interviews with 39 enrollees who sustained a 9/11 injury. Analysis informed development of a Phase II survey. Findings published in Year 8 (citation below).

◊ Gargano LM, Gershon RR, Brackbill RM. Quality of life of persons injured on 9/11: Qualitative analysis from the World Trade Center Health Registry. PLOS Currents Disasters. 2016 Oct 27. Edition 1.http://doi.org/10.1371/currents.dis.7c70f66c1e-6c5f41b43c797cb2a04793

» **Phase II (Quantitative):** Launched in March 2017 to 8,575 enrollees to better understand the long-term mental and physical health consequences of 9/11 injuries. Data collection ended in July 2017 with a final response rate of 76%, and 6,544 surveys received. Posters about the study have been pre-

sented at 2 scientific conferences:

◊ Brackbill RM, et. al. Quality of Life 15 Years after 9/11 of Persons who Sustained an Injury on the Day of the Attacks who have not Exhibited Symptoms of Post-traumatic Stress Disorder (PTSD). APHA Annual Meeting and Expo, November 4-8, 2017, Atlanta, GA. [Poster]

◊ Brackbill R, Gargano L, Jacobson M, Alper H, Garrey S. Comparison of quality of life 15 years after 9/11 of persons who did or did not sustain an injury on the day of the attacks. Society for Epidemiologic Research, Annual Meeting SER. June 19-22, 2018. Baltimore, MD. [Poster]

► **Early Labor Force Exit Study:**

» Analysis of W1-W3 findings informed the development of this in-depth study. The findings were published in Year 8 (citation below).

◊ Yu S, Brackbill RM, Locke S, Stellman SD, Gargano LM. Impact of 9/11-related chronic conditions and PTSD comorbidity on early retirement and job loss among World Trade Center disaster rescue and recovery workers. Am J Ind Med. 2016 Sep;59(9):731-741. https://doi.org/10.1002/ajim.22640

» The study will examine the impact of 9-11 related health on early retirement and job loss. Paper and web surveys were launched in September 2017 to 23,036 responders and survivors. Data collection for "9/11 Health and Employment Study" ended on March 31 2018. Data cleaning is being completed and the dataset will soon be ready for data analysis. In total, we received 7,406 Web surveys and 7,481 paper surveys, and the response rate is 65%. Multiple research analyses will be conducted using data collected from this survey in the coming year(s).

2d: Develop and conduct a Wave 5 survey to ascertain cohort health status 18-19 years after 9/11

► A draft Request for Proposal (RFP) for a Wave 5 Survey vendor was completed in October 2017 and submitted to DOHMH Office of the Agency Chief Contracting Officer (ACCO). The RFP is currently at the Mayor's Office of Contracts (MOCS) for review. The RFP is expected to be released in the summer of 2018, and the survey vendor is expected to be selected in 2019. The Registry research group is proposing topics to cover in the Wave 5 survey and will make decisions on topics and then the actual questions for the survey instrument.

2e: Develop new research resources by assessing the feasibility of matching to additional administrative databases and establishing a sub-cohort of enrollees

willing to participate in "rapid research" to provide rapid turnaround of brief, directed surveys implemented with greater frequency

- In Year 8, we discussed the proposal to develop a sub-cohort of enrollees for rapid research with the NYC DOHMH IRB chair. The IRB chair advised the Registry that she was not receptive to approving this proposal because of the potential bias in the research outcomes if enrollees with less rapid survey response times were excluded. No further steps are planned.

- Conducted an initial assessment of NYC DOHMH and NYC Department of Education (DoE) administrative databases that may provide: (1) information about the health/educational effects of 9/11 on children; and/or (2) a sampling frame to establish a new children's cohort. Presented to the Survivor Steering Committee and sent NIOSH an initial briefing paper on the assessment. Submitted a request to DoE in October 2017 for directory information on children in exposed and unexposed school districts at the time of 9/11 and their parent/guardians, which includes names and contact information.

- Attended August 2017 meeting with representatives of DoE, NYC DOHMH, NIOSH, City Hall and 9/11 Health Watch to discuss collaboration on establishing a new cohort of children for expanded research.

- DoE confirmed the availability of the requested administrative directory information and has shared some aggregate data with the Registry.

- Met with DoE in March 2018 to discuss potential for matching of directory information with administrative databases.

- Participated in monthly conference calls with representatives of DoE, NYC DOHMH, City Hall and Labor to report on progress and next steps. Participated in several calls with DoE and Registry staff regarding work now underway to: 1) establish a Data Use Agreement between DoE and NYC DOHMH; 2) draft DoE's public notification regarding sharing directory information with NYC DOHMH that will provide people with an opt-out option; 3) prepare a protocol for NYC DOHMH IRB approval related to assessing the feasibility of establishing a new cohort based on the ability to trace and contact a sample of people and their level of interest in participating in a new cohort for research on 9/11-related health outcomes; and 4) have DoE pull electronic directory data requested by NYCDOHMH.

- On a related but separate track, the Registry submitted an on-line application in December 2017,

requesting de-identified administrative/testing data for assessing the impact of 9/11 on educational outcomes among children. The Registry received the DoE data in June 2018 and we are in the process of reviewing and standardizing it.

SPECIFIC AIMS 3 AND 4 BELOW ARE THE RESEARCH TRANSLATION COMPONENTS OF THE REGISTRY.

Specific Aim 3: Conduct community activities to respond to the physical and mental health concerns and specific healthcare needs of enrollees and others exposed to 9/11

3a: Disseminate Registry findings and recommendations to enrollees, the public, WTCHP leadership and policy makers, using formats such as video, social media, and websites

- Employed multiple dissemination channels, including the Registry's 9/11healthinfo website, annual reports, press announcements, media interviews, and YouTube videos, including 18 research videos (including , a Treatment Referral Program and Victim's Compensation Fund informational video) and nine testimonial videos. http://www1.nyc.gov/site/911health/enrollees/testimonial-videos.page (Of the 27 videos, three were posted in Year 09.)
- Made 36 presentations at scientific conferences; meetings of the WTCHP STAC, Survivor steering committee and Outreach committee meeting; and to community groups, hospitals, and local health departments

3b: Provide Registry data resources and other resources to enrollees, the general public, external researchers and WTCHP entities

- Our interactive 9/11 Health Online Data Tool that permits users to query de-identified Wave 1 survey data has been accessed by about 740 unique users outside of NYC DOHMH to-date in Year 09.
- Responded to about 31 data requests from advisors, researchers, media and others in Year 09.

3c: Continue to conduct health promotion activities, including health education

- Create condition-specific physical and mental health fact sheets which represent current scientific information and provide answers to common questions received from enrollees and the public. All fact sheets are available in English, Spanish, and traditional and simplified Chinese.
  - » Completed 3 fact sheets in Year 9

that are planned to be mailed in 2018 after translations are completed: obstructive sleep apnea, obstructive sleep apnea treatment and chronic sinusitis

» Fact sheets in preparation: hearing loss, malignant melanoma, social isolation and others

» Posted related health educational materials on http://www.nyc.gov/9-11HealthInfo

Specific Aim 4: Maintain the 9/11 Treatment Referral Program (TRP) to help enrollees and others find care for 9/11-related health problems

4a: Inform enrollees of 9/11-related services and resources

► TRP staff trained in motivational interviewing techniques which helps to identify and address barriers to applying to and utilizing 9/11-related health service.

► Personalized communications sent in English, Spanish and traditional and simplified Chinese

► Updated TRP III informational brochures are sent to enrollees who request a WTCHP application.

► Posted TRP, VCF and other resource information on the Registry's 9-11HealthInfo website

4b: In coordination with the WTCHP, conduct outreach to potentially eligible enrollees in English, Spanish, and Chinese to encourage them to apply to the WTCHP

► **TRP III:** Launched in February 2017 to enrollees residing in and outside of the NYC area, including English (approximately 15,000), Spanish, Mandarin and Cantonese (together about 500) language speakers. The outreach sample was drawn from responder and survivor enrollees who reported no prior access to the WTCHP on their Wave 4 survey. Survivors also needed to report at least one of the following symptoms (uncontrolled asthma, COPD, RADS, GERS, probable 9/11-related PTSD, or depression on their Wave 4 survey or generalized anxiety disorder on their Wave 3 survey) to be included in the sample targeted for TRP III outreach.

► In Year 09, TRP sent out over 2,400 applications.

► In Year 09, TRP provided 2,942 Registry enrollees with their Wave 1 survey report as documentation of their presence near the WTC site on 9/11 for their WTCHP.

► In Year 09, over 1600 Registry-branded WTCHP applications were received by the WTCHP.

4c: Conduct targeted outreach to enrollees with specific conditions or unmet healtcare needs (e.g.,poorly controlled asthma, current smokers, or those accepted to the WTCHP but never seen

► A smoking cessation intervention program is being planned. The sample will include ~1,800 NYC or New York State residents who reported being smokers on the Registry's Wave 4 survey.

4d: Evaluate impact of TRP and share findings with the WTCHP

► TRP-II evaluation is under analysis. A manuscript based on the TRP-II process was published in the journal of Disaster Management and Prevention. A second manuscript on post submission outcomes is underway.

► Petrsoric L, Welch AE, Miller-Archie SA, Cone JE, Farfel MR. Considerations for Future Disaster Registries: Effectiveness of Treatment Referral Outreach in Addressing Long-Term Unmet 9/11 Disaster Needs. Disaster Prevention and Management. 2018; 27(3): 321-333. https://doi.org/10.1108/DPM-01-2018-0026

Specific Aim 5: Collaborate with other WTCHP entities (Data Centers, Clinical Centers of Excellence) to explore surveillance signals and treatment outcomes as follows: 9/11 linkage with uncommon health conditions, such as cancer and autoimmune and neurological disease (including age at diagnosis), and treatment outcomes for selected conditions related to 9/11

5a: Continue communications and collaborations with WTCHP clinical/data centers, including attending Responder and Survivor Steering Committee, NIOSH scientific advisory and NIOSH PI meetings

► Published one manuscript with WTCHP co-authors.

► **Hearing loss study in collaboration with FDNY:**

» Using existing, longitudinal FDNY audiometric surveillance data, we are examining the role of 9/11-related exposures on change in hearing over time among approximately 15,000 FDNY personnel active on 9/11. In collaboration with FDNY, audiometric data has been recovered and cleaned and we are in the process of analyzing change in hearing status.

► Collaborated or collaborating with FDNY, Einstein and Mount Sinai WTC researchers on WTCHP-funded studies, including:

» A study to conduct a pooled analysis of cancer incidence, latency and survival across three cohorts of WTC rescue/recovery workers from the Registry, FDNY and Mount Sinai.

◊ Developed and executed NYC DOHMH Data Use Agreements (DUAs) or a Memo of Understanding (MOU) with study partners (Mount Sinai, FDNY, NYS Cancer Registry) and 11 of the targeted 13 state cancer registries (AZ,

CA,CT,MA,NC,NJ, NY, OH, PA, TX and VA)

◊ Submitted a National Death Index (NDI) application for the joint cancer project. Official approval letter pending

» Will continue to outreach to the remaining 2 state cancer registries (FL, WA) to obtain DUAs

► A study to conduct a pooled analysis of overall, cause-specific and occupational-specific mortality in a combined dataset of WTC rescue / recovery workers from the Registry, FDNY and Mount Sinai cohort.

» Began work on an amendment to our joint NDI application.

» Evaluated the algorithm used by the State Cancer Registries, for processing NDI return outputs, by comparing it with the Registry's algorithm and determined that the NYS Cancer Registry's algorithm is the best one for the Registry and the WTCHP to use.

► Continued to attend and participate in the WTCHP Responder and Survivor Steering Committee meetings, the NIOSH scientific advisory meeting, the NIOSH PI meetings and the NIOSH Scientific Forum meetings.

5b: Serve as a platform for external research by providing facilitated recruitment of enrollees and de-identified survey data

Co-authored another 4 publications with researchers outside of NYC DOHMH At least 5 publication authored by principal investigators from external research studies facilitated by the Registry Responded to 11 data requests from potential external researchers Reviewed applications from 5 external researchers; approved 3 applications and provided de-identified data to 4 external researchers Worked with 10 active approved external research projects, including two with federal WTCHP funding (Feder, Marmor), one other CDC project (Pallos), and seven others (Berger, Bowler, Mancini, Shen, Wyka (n=2) and Todd)

WTC Health Registry

Key Accomplishments

July 1, 2018 – June 30, 2019 NIOSH Grant Year 10

This study is currently supported by Cooperative Agreement U50/OH009739

from the National Institute for Occupational Safety and Health (NIOSH) of the U.S. Centers for Disease Control and Prevention (CDC) and the New York City Department of Health and Mental Hygiene (NYC DOHMH).

Support prior to April 2009 was provided by Cooperative Agreement U50/ATU272750 from the Agency for Toxic Substances and Disease Registry (ATSDR), which included support from the National Center for Environmental Health (NCEH), and the New York City Department of Health and Mental Hygiene (NYC DOHMH).

Specific Aim 1: Maintain the Registry as a valuable public health resource to allow health professionals to track and investigate possible trends in illness and recovery

1a: Maximize the number of enrollees with valid, updated contact information through ongoing communications with enrollees and conduct tracing to locate enrollees with invalid or missing contact information

► Maintained multiple communication channels (i.e., phone, fax, email, mail, secure web app) for enrollees to use to contact the Registry with questions or to provide updated contact information Obtained consent from new young adults - child enrollees who have aged into adulthood

» Children: about 2,625 children were under age 18 years at time of enrollment in 2003-2004; about 37 enrollees are children as of July 2019.

► Since 2013, 93% of the new adults successfully contacted have consented to remain in the Registry, 114 have withdrawn and 12 are deceased. Among new young adults, 1,476 have consented to remain in the Registry as adults (including 75 in Year 10). Staff are conducting outreach to the remaining unconsented new young adults

► Registry enrollees remain committed and engaged with the Registry over seventeen years after 9/11

» Over 15,390 enrollee contact information updates received in Year 10

» Few withdrawals (19 in Year 10; a total of 1,122; about 1.6% of all enrollees)

» Traced over 1,480 enrollees (in Year 10) with missing or invalid contact information using LexisNexis, along with phone call and email attempts; totaling over 3,500 tracing attempts. Contracted with a vendor to conduct batch tracing of 4,100 enrollees with bad phone numbers. Received at least 1 updated phone number for 3,554 enrollees (a total of 4,841 updated phone numbers).

» Very few enrollees currently lost to follow-up (about 49)

1b: Keep enrollees engaged and interested in participating in future research by

maintaining timely, accurate and professional communications and providing feedback to address enrollee concerns

- ► Responded to about 35 incoming communications from enrollees and the public per day
- ► Prepared all key written communications in English, Spanish, and traditional and simplified Chinese
- ► Staff available to speak with enrollees and the public in English, Spanish, Mandarin and Cantonese
- ► Provided core communications to all enrollees, including the Registry's Annual Card, Annual Report and Time-to-Update Your Contact Information Reply card
- ► Maintained an active website to report Registry and other 9/11 research findings and resources with an average of over 2,900 unique visitors per month from about 78 countries at: ***HTTP://WWW1.NYC.GOV/SITE/911HEALTH/INDEX.PAGE.***
  - » The Research Videos Page (with 16 videos posted to-date) receives on average about 243 views per month at: ***HTTP://WWW1.NYC.GOV/SITE/911HEALTH/UPDATES/NEWS-VIDEOS.PAGE*** Four additional videos are posted at: ***HTTPS://WWW1.NYC.GOV/SITE/911HEALTH/UPDATES/ANNOUNCEMENTS.PAGE***
  - » The Registry's Research and Testimonial videos have been viewed over 13,494 times since they were placed on YouTube in May 2014.
  - » Redesigned the Registry's webpages which allow enrollees to update their contact information, to give it a better user experience.
- ► Collaborated with the federal 9/11 Victim's Compensation Fund (VCF) to identify applicants who are enrollees. Provided 1,460 enrollees to-date, including 35 in Year 10, with their Wave 1 survey report as supporting eligibility documentation for their VCF application.

1c: Conduct outreach to boost response to Registry studies, as needed

- ► Conducted social media outreach to keep enrollees engaged with the Registry in between surveys and studies, and door-to-door outreach to consent new adults.
- ► Developed two quarterly e-newsletters that were sent to almost 43,000 enrollees who provided email addresses and posted them on the 9/11healthinfo website (https://www1.nyc.gov/site/911health/researchers/published-research-publications.page).

Specific Aim 2: Expand knowledge about the long-term health effects of 9/11 by facilitating medical, public health or emergency preparedness research, or other scientific research relevant to the WTC Health Program (WTCHP) – with special emphasis on impacts to those who lived, worked or attended school in the disaster area (i.e.,non-"responders")

2a: Assess the contribution of 9/11 exposure and other risk factors to the course of health conditions and unmet healthcare needs 17 years post-9/11 by analyzing the 2015-16 Wave 4 survey, other Registry surveys and hospital discharge and other data linked to the Registry

- ► Made a substantial scientific contribution to the 9/11 physical and mental health literature
  - » 20 publications, including 1 conference abstract
  - » 28 presentations at scientific conferences and meetings
  - » More than 25 manuscripts in progress
- ► Conducted periodic multi-mode health surveys
  - » See section 2c below

2b: Extend assessment of cancer and mortality incidence through 16 years post-9/11

- ► Conduct periodic links to NYC Vital Statistics death files, the National Death Index (NDI), NYS SPARCS hospitalization records, and eleven state cancer registries
  - » Plan to conduct a linkage with NYC DOHMH Vital Records for the years of 2017 and 2018 in July 2019.
  - » Completed cancer linkage with 9 state cancer registries (TX, OH, CA, NC, MA, CT, PA, NY and WA), in Year 10, for cancer data to the end of 2015.
  - » Cancer linkage is planned for Year 11 for the remaining 2 state cancer registries (NJ and FL).

2c: Conduct independent or collaborative surveillance and in-depth studies to identify and investigate potential emerging health conditions and treatment outcomes on topics important to the WTCHP

- ► Autoimmune disease survey: (2014-2018)
- ► **Phase I:** Assess incidence of physician verified rheumatoid arthritis and other autoimmune diseases (AD) among enrollees who reported post-9/11 AD at Wave 3 and examine 9/11-risk factors; 2,042 enrollee surveys completed; with about a 73% response rate (RR). P hysician surveys and/or medical records received for 906 enrollees, an 87% RR out of the 1,042 enrollees who provided authorization to contact their physician
  - » In Year 10, medical record collection was completed in Dec 2018, with records for an additional 89 enrollees obtained. Medical record review was completed for about 60-65 enrollee records (including 29 of the new records obtained in Year 10 plus the remaining records from Year 9).
    Review of the medical records for the remaining 60 enrollees was completed in Year 10 and the database finalized. A manuscript of initial findings was submitted to a journal, and is undergoing revision and resubmission to the same journal.

- **Phase II:** Assess incidence of self-reported MS and ALS among 580 additional enrollees who reported post-9/11 MS or ALS at Waves 3 or 4 and examine 9/11-risk factors. Received 419 enrollee surveys; a 72% RR rate. A total of 76 MS cases and 6 ALS cases were self-reported. Medical records releases were requested for the 6 enrollees who reported ALS; two provided signed releases. Review of medical records for these 2 enrollees did not confirm ALS. With such small numbers of self-reported MS and ALS cases, we are unlikely to conduct further medical record review. Instead we will examine the MS and ALS cases self-reported at the Wave 5 survey to determine whether to conduct a new follow-up in-depth study with medical record review.
- PTSD and Lower Respiratory Symptoms: A qualitative study:
- We conducted in-depth qualitative interviews to understand enrollees' perceptions of how their lower respiratory symptoms and PTSD are related. Two consultants, a pulmonologist (Dr. de la Hoz, Mt. Sinai), and a psychologist (Dr. Bromet, Stony Brook) assisted with this project. In March 2018, interviews with 34 enrollees were completed. All interviews have been transcribed.
- A manuscript with findings has been submitted to a journal and is under review.

► Health and quality of life (Injury) study:

- **Phase I (Qualitative):** In 2015, completed qualitative interviews with 39 enrollees who sustained a 9/11 injury. Analysis informed development of a Phase II survey.
- Gargano LM, Gershon RR, Brackbill RM. Quality of life of persons injured on 9/11: Qualitative analysis from the World Trade Center Health Registry. PLOS Currents Disasters. 2016 Oct 27. Edition 1. ***HTTP://DOI.ORG/10.1371/CURRENTS.DIS.7C70F66C1E6C5F41B43C-797CB2A04793*** (Publication #80)
- **Phase II (Quantitative):** Launched in March 2017 to 8,575 enrollees to better understand the long-term mental and physical health consequences of 9/11 injuries. Data collection ended in July 2017 with 6,544 surveys received, a 76% RR.
- Posters about the study have been presented at 3 scientific conferences, including one in Year 10.
- The following manuscripts have been published based on these data:
  - ◊ Jacobson MH, Brackbill RM, Frazier P, Gargano LM. Conducting a study to assess the long-term impacts of injury after 9/11: Participation, recall, and description. Inj Epidemiol 2019 March; 6(1):8. ***HTTPS://DOI.ORG/10.1186/S40621-019-0186-Y***. (Publication #118)
  - ◊ Brackbill RM, Alper HE, Frazier

P, Gargano LM, Jacobson MH, Solomon A. An assessment of long-term physical and emotional quality of life of person injured on 9/11/2001. Int. J. Environ. Res. Public Health 2019 March; 16(6):1054. ***HTTPS://DOI.ORG/10.3390/IJERPH16061054*** (Publication #119)

◊ Gargano LM, Mok HK, Jacobson MH, Frazier P, Garrey SK, Petrsoric LJ, Brackbill RM. Comparing Life Satisfaction and Functioning 15 years after September 11, 2001 among survivors with and without injuries: a mixed-method study. Qual Life Res. 2019 May. ***HTTPS://DOI.ORG/10.1007/S11136-019-02194-W***. (Publication #122)

◊ Early Labor Force Exit/ Health and Employment Survey (HES) Study:

» Analysis of W1-W3 findings informed the development of this in-depth study.

» Yu S, Brackbill RM, Locke S, Stellman SD, Gargano LM. Impact of 9/11-related chronic conditions and PTSD comorbidity on early retirement and job loss among World Trade Center disaster rescue and recovery workers. Am J Ind Med. 2016 Sep; 59(9):731-741. doi: 10.1002/ajim.22640. https://doi.org/10.1002/ajim.22640 (Publication #74)

» The study examines the impact of 9-11 related health on early retirement and job loss. Data collection ended in April 2018 with 14,887 surveys received, a 65% RR. Data cleaning has been completed and the HES dataset is ready for analysis. A paper focusing on residents/ area workers was presented at 2018 APHA and published (see citation below).

◊ **Yu, S, Seil, K, Maqsood, J.** Impact of Health on Early Retirement and Post-Retirement Income Loss among Survivors of the 11 September 2001 World Trade Center Disaster. International Journal of Environmental Research and Public Health. 2019 April, 16(7), 1177. https://doi.org/10.3390/ijerph16071177 ***(Publication #120)***

» A few other research studies using HES data are in progress. One study focuses on the effects of 9/11-related injury on retirement patterns; another uses survival analysis to assess risk of early retirement and evaluate post-retirement health-related quality of life; and another study compares early retirement patterns by employment group and examines the likelihood of having a post-retirement income-generating job.

2d: Develop and conduct a Wave 5

survey to ascertain cohort health status 18-19 years after 9/11

- The Wave 5 (W5) Request for Proposal (RFP) was released in September 2018. Evaluation of the proposals from potential vendors was completed in December 2018. The survey vendor was selected in early 2019. The contract with the vendor is being registered and is expected to be fully executed in August 2019 when work with the vendor may begin.

- The W5 survey development team has been working on the contents of Wave 5. New questions were proposed, and some old questions were proposed to be removed or revised. A mock questionnaire was developed. A meeting with advisors to discuss W5 was held in early 2019. Input from advisors and external researchers were incorporated into the revised questionnaire. The finalization of survey content will be completed by the end of 2019, with an anticipated W5 survey launch in early 2020.

2e: Develop new research resources by assessing the feasibility of matching to additional administrative databases and establishing a sub-cohort of enrollees willing to participate in "rapid research" to provide rapid turnaround of brief, directed surveys implemented with greater frequency

- In Year 10, Registry staff have worked in coordination with NIOSH to plan for a late 2019 scientific symposium focused on exploring new data sources and methods for linkages to existing administrative and other databases to further research on WTC-related health conditions. To date, we have obtained input from WTCHP clinics and data centers, developed the agenda, and identified most of the symposium speakers and the scope of work for the planned white papers. We also continue to investigate the feasibility of matching to new data resources available within DOHMH.

- In Year 10, the Registry continued work on the feasibility study to create a new cohort of 9/11-exposed children for research based on historical records from the NYC Department of Education (DOE). Key accomplishments include:

  - Obtained DOHMH IRB approval on the feasibility study protocol in November 2018.

  - Released an RFP in November 2018 for a tracing vendor for the feasibility study. Completed evaluation of vendor proposals and selected vendor in December 2018. The selected vendor began work in late-February 2019 and developed a tracing protocol which has been approved by the DOHMH IRB.

  - Continued monthly Registry/

DOH planning calls with DOE's privacy officer, research director, and Chancellor's Office representative with a focus on completing the DOE's mandatory public notice and developing the data use agreement between DOE and DOHMH. Provided periodic updates to NIOSH and members of the Responder and Survivor Steering Committees.

» Finalized DOE public notice with opt-out of sharing of directory information with DOHMH and developed a coordinated plan approved by the DOHMH IRB for DOE's release of the public notice via the DOE website, social media posts, and ads in local English, Spanish and Chinese language local newspapers. DOE released the public notice the weeks of January 10 and January 28, 2019. DOE collected about a dozen opt out forms by the February 15, 2019 deadline. The completion of the public notice process enabled DOE to share directory data with DOHMH.

» Executed the data use agreement between DOE and DOHMH in May 2019.

» Registry staff developed a protocol and STATA program for selecting a stratified random sample of **~1,000** former students who attended school in exposed and "unexposed" areas. DOE used the STATA program to select the sample and then transferred directory data for the sample to the Registry in May 2019. The Registry cleaned the data and worked with DOE to finalize the dataset in a format that would facilitate the next step of initiating tracing activities by the vendor.

► **On a related but separate track in Year 10, the Registry has a) developed an analytical plan for assessing the impact of 9/11 on educational outcomes using de-identified DOE data on NYC public school students acquired from DOE in June of 2018 that cover school years 2000-01 through 2016-2017; b) acquired additional de-identified data for 1998-99 and 1999-00 to allow for an assessment of pre 9/11 trends in outcomes of interest; and c) cleaned the data and began analysis after consulting with university-based researchers.**

SPECIFIC AIMS 3 AND 4 BELOW ARE THE RESEARCH TRANSLATION COMPONENTS OF THE REGISTRY.

Specific Aim 3: Conduct community activities to respond to the physical and mental health concerns and specific healthcare needs of enrollees and others

exposed to 9/11

3a: Disseminate Registry findings and recommendations to enrollees, the public, WTCHP leadership and policy makers, using formats such as video, social media, and websites

► Employed multiple dissemination channels, including the Registry's 9/11healthinfo website, annual reports, e-newsletters, press announcements, media interviews, and YouTube videos, including 19 research videos, 9 testimonial videos, and a Treatment Referral Program and a Victim's Compensation Fund informational videos. http://www1.nyc.gov/site/911health/enrollees/testimonial-videos.page (Of the 30 videos, two were posted in Year 10.

► Made 28 presentations at scientific conferences, including at two WTCHP NIOSH PI meetings, a National Academy of Sciences workshop and a presentation at a UN Roundtable Event

► Maintain a 9/11healthinfo website that is mobile friendly and has better organized content with the goal to enhance user engagement. (see section 1b above)

3b: Provide Registry data resources and other resources to enrollees, the general public, external researchers and WTCHP entities

► Our 9/11 website provides access to all four Waves of survey materials including the Data File Users' Manual (DFUM), questionnaires, and public use datasets with codebooks.

► http://www1.nyc.gov/site/911health/researchers/health-data-tools.page. The website has had over 1,110 visits in Year 10.

► Our interactive 9/11 Health Online Data Tool, that permits users to query de-identified Wave 1 survey data, has been accessed by about 730 unique users outside of NYC DOHMH in Year 10.

► Responded to about 30 data requests from advisors, researchers, media and others in Year 10.

3c: Continue to conduct health promotion activities, including health education

► Create condition-specific physical and mental health fact sheets which represent current scientific information and provide answers to common questions received from enrollees and the public. All fact sheets are available in English, Spanish, and traditional and simplified Chinese.

» Fact sheets posted to the Registry website in 2019 to-date: obstructive sleep apnea, obstructive sleep apnea treatment and chronic sinusitis. A fact sheet on chronic sinusitis was mailed to over **38,000** enrollees in March 2019.

Fact sheets were mailed in English, Spanish, Traditional Chinese and Simplified Chinese.

» Fact sheets in preparation: hearing loss, COPD, malignant melanoma, and others.

» Posted health educational materials on https://www1.nyc.gov/site/911health/researchers/health-materials.page

Specific Aim 4: Maintain the 9/11 Treatment Referral Program (TRP) to help enrollees and others find care for 9/11-related health problems

4a: Inform enrollees of 9/11-related services and resources

► TRP staff trained in motivational interviewing techniques which helps to identify and address barriers to applying to and utilizing 9/11-related health service.

► Personalized communications sent in English, Spanish and traditional and simplified Chinese.

► Updated TRP III informational brochures are sent to enrollees who request a WTCHP application.

► Posted TRP, VCF and other resource information on the Registry's 9-11HealthInfo website.

4b: In coordination with the WTCHP, conduct outreach to potentially eligible enrollees in English, Spanish, and Chinese to encourage them to apply to the WTCHP

► **TRP III:** Launched in February 2017 to enrollees residing in and outside of the NYC area, including English (approximately 15,000), Spanish, Mandarin and Cantonese (together about 500) language speakers. The outreach sample was drawn from responder and survivor enrollees who reported no prior access to the WTCHP on their Wave 4 survey. Survivors also needed to report at least one of the following symptoms (uncontrolled asthma, COPD, RADS, GERS, probable 9/11-related PTSD, or depression on their Wave 4 survey or generalized anxiety disorder on their Wave 3 survey) to be included in the sample targeted for TRP III outreach.

► In Year 10, TRP sent out 798 applications.

► In Year 10, TRP provided 721 Registry enrollees with their Wave 1 survey report as documentation of their presence near the WTC site on 9/11 for their WTCHP applications.

► In Year 10, 586 Registry-branded WTCHP applications were received by the WTCHP.

4c: Conduct targeted outreach to enrollees with specific conditions or unmet healthcare needs (e.g.,poorly controlled asthma, current smokers, or those accepted to the WTCHP but never seen

► A smoking cessation intervention was launched in October 2018 to approximately 1,800 NYC/NYS residents.

► In Year 10, a letter informing them about the NYS Smokers' Quit line has been sent to over 1,800 enrollees.

► Intervention staff have spoken with about 1,100 enrollees who were mailed a letter, with over 160 enrollees successfully being referred to the NYS Quit Line

► In Year 10, intervention staff have completed follow-up calls with over 100 of the enrollees who were referred to the NYS Quit Line to track their usage of the nicotine replacement therapy. Remaining calls will be made by September 2019

► The baseline phase of an emergency preparedness intervention targeting 1,000 enrollees who completed a Wave 4 survey and live in NYC was approved by the DOHMH IRB in November 2018. The intervention will assess if emergency preparedness increases based on a mail or enhanced phone intervention. The baseline assessment began February 2019.

» In Year 10, intervention staff have completed over 300 emergency preparedness baseline assessment calls, 61 phone intervention calls, and mailings of intervention materials to 92 enrollees.

4d: Evaluate impact of TRP and share findings with the WTCHP

► **TRP-II evaluation is in process. A manuscript based on the TRP-II process was published (see below). A second manuscript on post submission outcomes is underway.**

» Petrsoric L, Welch AE, Miller-Archie SA, Cone JE, Farfel MR. Considerations for Future Disaster Registries: Effectiveness of Treatment Referral Outreach in Addressing Long-Term Unmet 9/11 Disaster Needs. Disaster Prevention and Management. 2018; 27(3): 321-333. https://doi.org/10.1108/DPM-01-2018-0026 ***(Publication #105)***

Specific Aim 5: Collaborate with other WTCHP entities (Data Centers, Clinical Centers of Excellence) to explore surveillance signals and treatment outcomes as follows: 9/11 linkage with uncommon health conditions, such as cancer and autoimmune and neurological disease (including age at diagnosis), and treatment outcomes for selected conditions related to 9/11

5a: Continue communications and collaborations with WTCHP clinical/data centers, including attending Responder and Survivor Steering Committee, NIOSH scientific advisory and NIOSH PI meetings

► Hearing loss study in collaboration with FDNY:

► Using existing, longitudinal FDNY audiometric surveillance data, we are examining the role of 9/11-related exposures on change in hearing over time among 11,627 active-duty male firefighters and EMS workers who were FDNY employees on September 11, 2001. Analysis is completed and a manuscript has been submitted to a journal.

► Collaborated or collaborating with FDNY, Einstein and Mount Sinai WTC researchers on WTCHP-funded studies, including:

» A study to conduct a pooled analysis of cancer incidence, latency and survival across three cohorts of WTC rescue/recovery workers from the Registry, FDNY and Mount Sinai.

◊ Developed and executed NYC DOHMH Data Use Agreements (DUAs) or a Memo of Understanding (MOU) with study partners (Mount Sinai, FDNY, NYS Cancer Registry) and 12 of the targeted 13 state cancer registries (AZ, CA,CT,MA,NC,NJ, NY, OH, PA, TX, VA and WA). Continued outreach to the one remaining state cancer registry (FL).

◊ Submitted a National Death Index (NDI) application for the joint cancer project. The application was approved by NDI in August 2018.

◊ Analysts became proficient with SEER*STAT software in order to begin performing data analysis comparisons of cancer incidence within the Registry population and the general population.

» A study to conduct a pooled analysis of overall, cause-specific and occupational-specific mortality in a combined dataset of WTC rescue/recovery workers from the Registry, FDNY and Mount Sinai cohort.

◊ Developed NYC DOHMH Data Use Agreements (DUAs) or a Memo of Understanding (MOU) with study partners (Mount Sinai, FDNY, NYS Cancer Registry). Executed the MOU with FDNY. Execution pending for Mt. Sinai and NYSCR DUA's.

◊ Evaluated the NPCR's (National Program of Cancer Registries) algorithm used by the state cancer registries, for processing NDI return outputs, by comparing it with the Registry's algorithm using our most recent NDI search results, and determined that the NPCR's algorithm is the better one for the Registry to use.

◊ We shared our evaluation results with collaborators from FDNY and Mount Sinai, which led to an agreement to use the NPCR algorithm on NDI search results by

all collaborators.

◊ Submitted a manuscript regarding this evaluation and results for publication.

◊ Prepared a National Death Index (NDI) application for the joint mortality project to be submitted to NDI in Year 11. (Update: submitted in July 2019)

» Continued to attend and participate in the WTCHP Responder and Survivor Steering Committee meetings, the **NIOSH** scientific advisory meeting, the **NIOSH** PI meetings and the **NIOSH** Scientific Forum meetings.

5b: Serve as a platform for external research by providing facilitatedrecruitment of enrollees and de-identified survey data

► Co-authored another 7 publications with researchers outside of NYC DOHMH

► Responded to 2 data requests from potential external researchers

► Reviewed and approved applications from 2 external researchers (Adams, Sembajwe); provided de-identified data to 4 active external researchers, and facilitated recruitment into 1 approved external research study (Feder)

► Worked with 17 active approved external research projects, including 5 with federal WTCHP funding (Feder, Marmor, Hall, Boffetta, Zeig-Owens), 2 with DOHMH's Division of Epidemiology (Lim, Liu), and 10 others (Adams, Bowler, Mancini, Sembajwe, Shen (n=2), Wyka (n=3), and Todd)

WTC Health Registry Key Accomplishments: July 1, 2019 – June 30, 2020 NIOSH Grant Year 11

Specific Aim 1: Maintain the Registry as a valuable public health resource to allow health professionals to track and investigate possible trends in illness and recovery

1a: Maximize the number of enrollees with valid, updated contact information through ongoing communications with enrollees and conduct tracing to locate enrollees with invalid or missing contact information

► Maintained multiple communication channels (i.e., phone, fax, email, mail, secure web app) for enrollees to use to contact the Registry with questions or to provide updated contact information.

► Obtained consent from new adults - child enrollees who have

aged into adulthood.

- About 2,625 children were under age 18 years at time of enrollment in 2003-2004.
- As of 9/11/2019 all child enrollees are 18 years of age or older. Since 2013, 93% of the new adults successfully contacted have consented to remain in the Registry as adults, 122 have withdrawn and 15 are deceased.
- In Year 11, 124 new adults have consented to remain in the Registry, bringing the total to 1,600.
- Staff are conducting outreach to the remaining unconsented new young adults.

► Registry enrollees remain committed and engaged with the Registry over eighteen years after 9/11.

- Over 11,229 enrollee contact information updates received in Year 11.
- Few withdrawals (17 in Year 11; a total of 1,139; about 1.6% of all enrollees).
- Traced 3500 enrollees (in Year 11) with missing or invalid contact information using LexisNexis and phone and email attempts to the enrollee and their secondary contacts; totaling over 4,149 tracing attempts.
- Very few enrollees currently lost to follow-up (47).

1b: Keep enrollees engaged and interested in participating in future research by maintaining timely, accurate and professional communications and providing feedback to address enrollee concerns

► Responded to about 39 incoming communications from enrollees and the public per day.

► Prepared all key written communications in English, Spanish, and traditional and simplified Chinese

► Staff available to speak with enrollees and the public in English, Spanish, Mandarin and Cantonese

► Provided core communications to all enrollees, including the Registry's Annual Card and Annual Report.

► Maintained an active website (*WWW1.NYC.GOV/SITE/911HEALTH/INDEX.PAGE*) to report Registry and other 9/11 research findings and resources which received an average of 2,783 unique visitors per month from about 72 countries in Year 11.

- The Research Videos Page (with 22 videos posted to-date) received on average about 244 views per month in Year 11 at: *WWW1.NYC.GOV/SITE/911HEALTH/UPDATES/NEWS-VIDEOS.PAGE* Four additional videos are posted at: *WWW1.NYC.GOV/SITE/911HEALTH/UPDATES/ANNOUNCEMENTS.PAGE*
- The Registry's Research and Testimonial videos were viewed over 2,920 times in Year 11, a total of over 19,660 views since they were

placed on YouTube in May 2014.

► Provided 1,475 enrollees, including 15 in Year 11, with their Wave 1 survey report as supporting eligibility documentation for their federal 9/11 Victim Compensation Fund application.

1c: Conduct outreach to boost response to Registry studies, as needed

► Conducted social media outreach to keep enrollees engaged with the Registry and door-to-door outreach to consent new adults.

► Developed a 2019 Fall and 2020 Spring e-newsletter, in English, Spanish and Traditional and Simplified Chinese, that was sent to about 42,000 enrollees and about 10,000 members of the public who provided email addresses, and posted it on the 9/11healthinfo website (*WWW1.NYC.GOV/SITE/911HEALTH/RESEARCHERS/PUBLISHED-RESEARCH-PUBLICATIONS.PAGE*).

Specific Aim 2: Expand knowledge about the long-term health effects of 9/11 by facilitating medical, public health or emergency preparedness research, or other scientific research relevant to the WTC Health Program (WTCHP) – with special emphasis on impacts to those who lived, worked or attended school in the disaster area (i.e.,non-"responders")

2a: Assess the contribution of 9/11 exposure and other risk factors to the course of health conditions and unmet healthcare needs 17 years post-9/11 by analyzing the 2015-16 Wave 4 survey, other Registry surveys and hospital discharge and other data linked to the Registry

► Made a substantial scientific contribution to the 9/11 physical and mental health literature

» 14 publications plus 4 additional manuscripts in press (see sections 2b, 2c and 5a below)

» 19 presentations at scientific conferences and meetings

» More than 25 manuscripts in progress

► Conducted periodic multi-mode health surveys

» See section 2c below

2b: Extend assessment of cancer and mortality incidence through 18 years post-9/11

► Conduct periodic links to NYC Vital Statistics death files, the National Death Index (NDI), NYS SPARCS hospitalization records, and eleven state cancer registries

» A linkage with NYC Vital Statistics for the years 2017 & 2018 was completed in December 2019.

» In Year 11, cancer linkage was conducted with NJ state cancer registry, resulting in completed linkages to 10 state cancer registries that we match to with reported cancer data obtained through the end of 2015. The remaining match with

FL is planned for Year 12 once FL signs a Data Use Agreement.

» A manuscript that reports findings between PTSD and mortality was published in Year 11:

◊ Giesinger I, Li J, Takemoto E, Cone JE, Farfel MR, Brackbill RM. Association between post-traumatic stress disorder and mortality among responders and civilians following the September 11, 2001, disaster. JAMA Network Open February 2020; 3(2):e1920476. ***DOI:10.1001/JAMANETWORKOPEN.2019.20476***. [Registry Publication #130]

◊ A manuscript was submitted that reports the assessment of different methods to process National Death Index matches. Findings were also shared with other 9/11 responder cohort teams.

2c: Conduct independent or collaborative surveillance and in-depth studies to identify and investigate potential emerging health conditions and treatment outcomes on topics important to the WTCHP

► COVID-19 Survey (New)

» Developed and submitted an IRB protocol for a survey of COVID-19-related exposures, experiences and illness among enrollees in the Wave 5 survey sample to understand COVID-19 impacts on enrollees' Wave 5 survey responses and risk factors for severe COVID-19 illness

» Obtained input on survey content from the Responder and Survivor Steering Committees, NIOSH, the WTCHP clinical centers and data centers, and the NYC DOHMH

» Participated in Geoffrey Calvert's Scientific Forum meetings to harmonize COVID-19 questions used across the WTCHP cohorts for assessment and monitoring purposes and incorporated core questions into the Registry COVID-19 survey.

► **Autoimmune disease survey:** (2014-2018)

» In Year 11, a manuscript was published that reports initial findings of the incidence of physician verified autoimmune diseases (AD) among 2,042 enrollees who reported a post-9/11 AD and completed an AD survey:

◊ Miller-Archie SA, Izmirly PM, Berman JR, Brite J, Walker DJ, Dasilva RC, Petrsoric LJ, Cone JE. Systemic autoimmune disease among adults exposed to the September 11, 2001, terrorist attack. Arthritis and Rheumatology April 2020 72(5), 849. ***DOI.ORG/10.1002/ART.41175*** [Registry Publication #132]

» A second manuscript, to examine whether mental health conditions (e.g., depression, anxiety) mediate the association between 9/11 exposure and development of AD,

is in process.

► **PTSD and Lower Respiratory Symptoms:** A qualitative study:

» In Year 11 we published a manuscript to report findings of qualitative interviews with enrollees to understand their perceptions of how their PTSD and lower respiratory symptoms are related:

◊ Gargano LM, Gershon RR, Ogunyemi A, Dorlette D, Petrsoric LJ, Cone JE. Comorbid posttraumatic stress disorder and lower respiratory symptoms in disaster survivors: Qualitative results of a 17-year follow-up of World Trade Center disaster survivors. Progress in Disaster Science. December 2019; 4:1. ***HTTPS://DOI.ORG/10.1016/J.PDISAS.2019.100050*** [Registry Publication #127]

► **Hurricane Sandy survey (2013):**

» In Year 11 we published a collaborative manuscript to report findings of the differential impact of Hurricane Sandy exposure on subsequent PTSD symptoms among enrollees in three communities affected by the hurricane:

◊ Schwartz RM, Rasul R, Gargano, ML, Lieberman-Cribbin W, Brackbill RM, Taioli E. Examining Associations Between Hurricane Sandy Exposure and Posttraumatic Stress Disorder by Community of Residence. J Traum Stress. 2019 October; 32(5): 677. ***HTTPS://DOI.ORG/10.1002/JTS.22445*** [Registry Publication #125]

► **Wave 4 Asthma Survey (2015-2016):**

» In Year 11 a manuscript was accepted that examines the association between mental health conditions and poor asthma control among nearly 1,300 enrollees who completed the Wave 4 Asthma survey:

◊ Brite J, Friedman S, de la Hoz RE, Reibman J, Cone JE. Mental health, long-term medication adherence, and the control of asthma symptoms among persons exposed to the WTC 9/11 disaster. Journal of Asthma. ***DOI.ORG/10.1080/02770903.2019.1672722***. [In press]

► **Health and quality of life (Injury) study:** (2015-2017)

» A quantitative survey was sent to 8,575 enrollees to better understand the long-term mental and physical health consequences of 9/11 injuries. A total of 6,544 surveys were received, a 76% response rate.

» In Year 11 a manuscript was published that examines the association between the subsequent burden of somatic symptoms and physical and psychological consequences of 9/11 exposure.

◊ Alper H, Gargano LM, Cone JE, Brackbill RM. Injury severity and psychological distress sustained in the aftermath of the attacks of 11 September 2001 predict somatic symptoms in World Trade Center Health Registry enrollees sixteen years later. Int. J. Environ. Res. Public Health. June 2020;17(12):4232.***HTTPS://DOI.ORG/10.3390/IJERPH17124232***. [Registry Publication #135]

► Neighborhood displacement study:

» This study is a collaboration between Registry researchers and researchers in the DOHMH's Bureau of Epi Services. In Year 11, two manuscripts were published that examined the association between residential mobility and post-9/11 diabetes and/or hypertension among Registry enrollees:

◊ Jacobson M, Crossa A, Liu SY, Locke S, Poirot E, Stein C, Lim S. Residential mobility and chronic disease among World Trade Center Health Registry enrollees, 2004-2016. Health and Place. January 2020, vol 61. ***DOI.ORG/10.1016/J.HEALTHPLACE.2019.102270***.[Registry Publication #133]

◊ Lim S, Liu SY, Jacobson MH, Poirot E, Crossa A, Locke S, Brite J, Hamby E, Bailey Z, Farquhar S. (2020). Housing stability and diabetes among people living in New York City public housing. SSM - Population Health, June 2020. Vol. 11. ***HTTPS://DOI.ORG/10.1016/J.SSMPH.2020.100605*** [Registry Publication #137]

2d: Develop and conduct a Wave 5 survey to ascertain cohort health status 18-19 years after 9/11

► The survey vendor contract for Wave 5 was registered in August 2019.

► Survey content was developed and revised further after survey expert review and cognitive interviews with enrollees were completed in October 2019. The survey content was finalized in December 2019.

► The Wave 5 protocol was submitted for DOHMH IRB review in December 2019.

► Communication materials for Wave 5 were approved and translated by the DOHMH Communications Office.

► The paper survey was coded in TeleForm in English, Spanish, traditional and simplified Chinese by the survey vendor in early 2020.

► The English version of the paper survey was mailed to those in the

study sample who did not have an email address with the Registry in early April 2020. Spanish paper surveys were mailed in late April and Chinese paper surveys were mailed in early June 2020.

► The web survey was launched in English in early May 2020.

► At the end of Year 11, seven email reminders, one postcard reminder, and a second round of paper surveys (to all non-respondents) were sent out.

► The current survey response rate is ~32%. Data collection will continue until January 2021

2e: Develop new research resources by assessing the feasibility of matching to additional administrative databases and establishing a sub-cohort of enrollees willing to participate in "rapid research" to provide rapid turnaround of brief, directed surveys implemented with greater frequency

► In December 2019, Registry staff, in coordination with NIOSH, held a scientific WTC Data Linkage Symposium focused on exploring new data sources and methods for linkages to existing administrative and other databases to further research on WTC-related health conditions. From that symposium, we have a) completed a white paper that is under internal review and that we plan to submit to a journal in Year 12 and b) formed a cross cohort working group that has held meetings as needed. We have submitted an IRB modification to link to Medicaid and Medicare without additional enrollee consent. We are currently performing a data linkage with Health and Hospitals to determine which and how many Registry Survivor enrollees are participants in the H+H WTC Center of Excellence in order to exclude them from future Registry treatment referral outreach and to position the Registry to better plan for collaborative research on Survivors with H+H.

► In Year 11, the Registry continued work on the feasibility study to create a new cohort of 9/11-exposed children for research based on historical records from the NYC Department of Education (DOE). Key accomplishments include:

» Study information was added to the Registry's website in September 2019 (https://www1.nyc.gov/site/911health/about/millennial-study.page)

» The tracing vendor completed all phases of tracing of the sample of 1,001 former students with sufficient information for tracing – including batch tracing in July 2019, Intensive Tracing Part 1 in December 2019 and Intensive Tracing Part 2 in May 2020.

» Three rounds of brochure mailings (total of 4,761 brochures) were sent to former students/parents in an effort to reach the 1,001 former

students.

» In Year 11, 28 students have responded to the mailings, with 27 indicating an interest in participating in a future cohort.

» Data collection will end in July 2020; a report to NIOSH is planned for September 2020.

► Registry staff continued work on the educational outcomes study using DOE data (1998/99-2016/17). In Year 11, Registry staff:

» Created a multi-year dataset with geocoded schools

» Conducted propensity score matching to identify unexposed schools (similar in demographics to the schools defined as exposed) as controls, similar to what we did for the feasibility study

» Submitted an abstract to national conference (abstract accepted, presentation scheduled for December 2020)

» Completed individual level analyses, results under review with external collaborators

» Manuscript in preparation

Specific Aim 3: Conduct community activities to respond to the physical and mental health concerns and specific healthcare needs of enrollees and others exposed to 9/11

3a: Disseminate Registry findings and recommendations to enrollees, the public, WTCHP leadership and policy makers, using formats such as video, social media, and websites

► Employed multiple dissemination channels, including the Registry's 9/11 healthinfo website, annual reports, e-newsletters, press announcements, media interviews, and YouTube videos, including 26 research videos (including a Treatment Referral Program video and a Victim's Compensation Fund informational video) and 10 testimonial videos. ***WWW1.NYC.GOV/SITE/911HEALTH/ENROLLEES/TESTIMONIAL-VIDEOS.PAGE*** (Of the 36 videos, six were posted in Year 11.)

► Made 19 presentations at scientific conferences, including at a WTCHP NIOSH PI meeting.

► Maintain a 9/11healthinfo website that is mobile friendly and has better organized content with the goal to enhance user engagement. (see section 1b above)

3b: Provide Registry data resources and other resources to enrollees, the general public, external researchers and WTCHP entities

► Our 9/11 website provides access to all four Waves of survey materials including the Data File Users' Manual (DFUM), questionnaires, and

public use datasets with codebooks.

► www1.nyc.gov/site/911health/researchers/health-data-tools.page. The page had over 3,000 downloads in Year 11.

► Our interactive 9/11 Health Online Data Tool, that permits users to query de-identified Wave 1 survey data, has been accessed by about 333 unique users outside of NYC DOHMH in Year 11. As of February 2020, there is a new system for tracking EPI Query Analytics and it no longer captures WTCHR analytics.

► Responded to about 25 data requests from advisors, researchers, media and others in Year 11.

3c: Continue to conduct health promotion activities, including health education

► Create condition-specific physical and mental health fact sheets which represent current scientific information and provide answers to common questions received from enrollees and the public. All fact sheets are available in English, Spanish, and traditional and simplified Chinese.

► Health materials posted to the Registry website in Year 11:

► 3 Fact sheets (on non-Hodgkin's lymphoma, melanoma, and new research about the continued health impacts of 9/11), and the Health Bulletin: Is 9/11 affecting your health?

► Health materials in preparation include: hearing loss, COPD, and PTSD fact sheets, and a summary of the Registry's autoimmune disease studies.

► Health educational materials are posted at www1.nyc.gov/site/911health/researchers/health-materials.page

Specific Aim 4: Maintain the 9/11 Treatment Referral Program (TRP) to help enrollees and others find care for 9/11-related health problems

4a: Inform enrollees of 9/11-related services and resources

► TRP staff trained in motivational interviewing techniques which helps to identify and address barriers to applying to and utilizing 9/11-related health service.

► Personalized communications sent in English and Spanish and traditional and simplified Chinese.

► Updated TRP III informational brochures are sent to enrollees who request a WTCHP application.

► Posted TRP, VCF and other resource information on the Registry's 9-11HealthInfo website.

4b: In coordination with the WTCHP, conduct outreach to potentially eligible enrollees in English, Spanish, and Chinese to encourage them to apply to the

WTCHP

► **TRP III:** Launched in February 2017 to about 15,500 responder and survivor enrollees who reported no prior access to the WTCHP on their Wave 4 survey.

► **In Year 11:**

» Staff sent out 590 applications and provided 623 enrollees with their Wave 1 survey report as documentation of their presence near the WTC site on 9/11 for their WTCHP applications.

» 426 Registry-branded applications were received by the WTCHP.

» Secured vendor to conduct outreach calls January-March 2020 to the remaining ~3,000 enrollees for whom we obtained updated phone numbers.

4c: Conduct targeted outreach to enrollees with specific conditions or unmet healthcare needs (e.g., poorly controlled asthma, current smokers, or those accepted to the WTCHP but never seen)

► A smoking cessation intervention was launched in October 2018 to approximately 2,000 NYC/NYS residents. In Year 11:

» A letter about the NYS Smokers' Quit line was sent to 99; a total of over 1,900 letters to-date

» Intervention staff have spoken with nearly 1,000 enrollees who were mailed a letter, with 169 of these enrollees successfully being referred to the NYS Quit Line.

» Completed follow-up calls with 20 of the enrollees who were previously referred to the NYS Quit Line to track their usage of the nicotine replacement therapy.

► An emergency preparedness intervention, launched in February 2019, targets NYC enrollees who completed a Wave 4 survey and a control group. The intervention will assess if emergency preparedness increases based on a mail or enhanced phone intervention.

» In Year 11, staff completed 402 baseline assessment calls, 242 phone intervention calls, and mailings of intervention materials to 309 enrollees. 388 post assessments have been conducted. Outreach efforts will continue until there are 625 enrollees in each arm of the intervention (mail & phone).

4d: Evaluate impact of TRP and share findings with the WTCHP

► A TRP-II manuscript, on the qualitative evaluation of the TRP process after an enrollee submits their WTCHP application, is in process.

Specific Aim 5: Collaborate with other WTCHP entities (Data Centers, Clinical Centers of Excellence) to explore surveillance signals and treatment outcomes as follows: 9/11 linkage with uncommon health conditions, such as cancer and autoimmune and neurological disease (including age at diagnosis), and treatment outcomes for selected conditions related to 9/11

5a: Continue communications and collaborations with WTCHP clinical/data centers, including attending Responder and Survivor Steering Committee, NIOSH scientific advisory and NIOSH PI meetings

► **Hearing loss study in collaboration with FDNY:**

» In Year 11, we published 2 manuscripts to report findings of this collaborative study. Using existing, longitudinal FDNY audiometric surveillance data, the collaborative team examined the effect of 9/11-related exposures on change in hearing over time among 11,627 male FDNY firefighters and EMS workers:

◊ Flamme GA, Deiters KK, Stephenson MR, Themann CL, Murphy WJ, Byrne DC, Goldfarb DG, Zeig-Owens R, Hall C, Prezant DJ, Cone JE. Population-based age adjustment tables for use in occupational hearing conservation programs. Int J Audiol. January 2020 Vol 59 No S1, S20-S30. ***HTTPS://DOI.ORG/10.1080/14992027.2019.1698068*** [Registry publication #134]

◊ Flamme GA, Goldfarb DG, Zeig-Owens R, Hall CB, Vaeth BM, Schwartz T, Yip J, Vossbrinck M, Stein CR, Friedman L, Cone JE, Prezant DJ. Hearing Loss Among World Trade Center Firefighters and Emergency Medical Service Workers. J Occup Environ Med. 2019 Dec;61(12):996-1003. ***HTTPS://DOI.ORG/10.1097/JOM.0000000000001717.*** PMID: 31567659 [Registry publication #128]

» In Year 11, we published another manuscript in collaboration with FDNY focused on hearing loss, but this manuscript examined hearing loss among Registry enrollee survivors:

◊ Cone JE, Stein CR, Lee DJ, Flamme GA, Brite J. Persistent Hearing Loss Among World Trade Center Health Registry Residents, Passersby, and Area Workers, 2006-2007. Int. J. Environ. Res. Public Health. October 2019; 16: 3864. ***HTTPS://DOI.ORG/10.3390/IJERPH16203864*** [Registry Publication #126]

► Collaborated or collaborating with FDNY, Einstein and Mount Sinai WTC researchers on WTCHP-funded studies, including:

» The joint cancer study: a pooled analysis of cancer incidence, latency and survival across three cohorts of WTC rescue/recovery workers from the Registry, FDNY and Mount Sinai. In Year 11:

► Executed final MOU with the last of 13 state cancer registries (FL).

► Completed cancer linkage with 13 state cancer registries in first half of the year 11.

» Received data from NYS Cancer Registry in early 2020 and start-

ed data analysis in March 2020. WTCHR is responsible for Aim 1.

► Conduct regular group meetings to discuss preliminary findings.

► Completed analysis with collaborators on Aim 3 (cancer survival in NYS cases).

» An abstract was drafted by FDNY for conferences in 2020

» Completed a draft manuscript which was reviewed by all co-authors and submitted for DOHMH clearance in June 2020

► **The joint mortality study:** a pooled analysis of overall, cause-specific and occupational-specific mortality in a combined dataset of WTC rescue/recovery workers from the Registry, FDNY and Mount Sinai cohort. In Year 11:

» Executed Data Use Agreements (DUAs) with remaining study partners (Mt. Sinai and NYSCR).

» Completed occupation coding of WTCHR responders using SOC (Standard Occupational Classification System).

» Submitted a National Death Index (NDI) application for the joint mortality project (approval received October 2019).

► Continued to attend and participate in the WTCHP Responder and Survivor Steering Committee meetings, the NIOSH scientific advisory meeting, the NIOSH PI meetings, the NIOSH Scientific Forum meetings, and the collaborative Survivor Research calls (with NIOSH and H+H).

► **Collaborated with NIOSH on an editorial for a special journal issue focused on the long-term health effects from the 9/11 disaster:**

» Brackbill RM. Graber JM, Robison WA. Editorial for Long-Term Health Effects of the 9/11 Disaster. Int. J. Environ. Res. Public Health. 2019 September; 16(18): 3289. *HTTPS://DOI.ORG/10.3390/IJERPH16183289*. [Registry Publication #124]

5b: Serve as a platform for external research by providing facilitated recruitment of enrollees and de-identified survey data

► Responded to 3 data requests from potential external researchers (Cozza, Lawrence and Sandler) and provided a letter of support for Cozza's Zadroga grant application. Provided de-identified survey data to three external researchers for their approved projects (Sembajwe, Adams, Shen).

► Worked with 15 active approved external research projects, including 4 with federal WTCHP funding (Marmor, Hall, Boffetta, Zeig-Owens), 2 with DOHMH's Division of Epidemiology (Lim, Liu), and 9 others (Adams, Mancini, Sembajwe, Shen (n=2), Wyka (n=2), Todd and Cycowitz)

► o-authored another 7 publications with researchers outside of

NYC DOHMH

► Responded to 2 data requests from potential external researchers

► Reviewed and approved applications from 2 external researchers (Adams, Sembajwe); provided de-identified data to 4 active external researchers, and facilitated recruitment into 1 approved external research study (Feder)

► Worked with 17 active approved external research projects, including 5 with federal WTCHP funding (Feder, Marmor, Hall, Boffetta, Zeig-Owens), 2 with DOHMH's Division of Epidemiology (Lim, Liu), and 10 others (Adams, Bowler, Mancini, Sembajwe, Shen (n=2), Wyka (n=3), and Todd)

► Health materials posted to the Registry website in Year 11: 3 Fact sheets (on non-Hodgkin's lymphoma, melanoma, and new research about the continued health impacts of 9/11), and the Health Bulletin: Is 9/11 affecting your health?

► Health materials in preparation include: hearing loss, COPD, and PTSD fact sheets, and a summary of the Registry's autoimmune disease studies.

► Health educational materials are posted at www1.nyc.gov/site/911health/researchers/health-materials.pag**WTC Health Registry Key Accomplishments:** July 1, 2020 – June 30, 2021, and extended to June 30, 2022 via no cost time extension NIOSH Grant Year 12

Specific Aim 1: Maintain the Registry as a valuable public health resource to allow health professionals to track and investigate possible trends in illness and recovery

1a: Maximize the number of enrollees with valid, updated contact information through ongoing communications with enrollees and conduct tracing to locate enrollees with invalid or missing contact information

► **Maintained multiple communication channels (i.e., phone, fax, e-mail, mail, secure web app) for enrollees to use to contact the Registry with questions or to provide updated contact information.**

► **Obtained consent from new adults - child enrollees who have aged into adulthood**.

» About 2,622 children were under age 18 years at time of enrollment in 2003-2004.

» As of 9/11/2019 all child enrollees are 18 years of age or older. Since 2013, 91.5% of the new adults successfully contacted have consented to remain in the Registry as adults, 190 have withdrawn and 15 are deceased.

» o In Year 12, 112 new adults have

consented to remain in the Registry, bringing the total to 1,712.

» Staff are conducting outreach to the remaining unconsented new young adults.

► Registry enrollees remain committed and engaged with the Registry over eighteen years after 9/11.

» Over 8,650 enrollee contact information updates received in Year 12.

» Few withdrawals (36 in Year 12; a total of 1,176; about 1.6% of all enrollees).

» Traced 4,069 enrollees (in Year 12) with missing or invalid contact information using LexisNexis and e-mail attempts to the enrollee; totaling over 6,000 tracing attempts.

» Very few enrollees currently lost to follow-up (47).

1b: Keep enrollees engaged and interested in participating in future research by maintaining timely, accurate and professional communications and providing feedback to address enrollee concerns

► Responded to about 23 incoming communications from enrollees and the public per day.

► Prepared all key written communications in English, Spanish, and traditional and simplified Chinese.

► Staff available to speak with enrollees and the public in English, Spanish, Mandarin, and Cantonese.

► Provided core communications to all enrollees, including the Registry's quarterly e-newsletter.

► Maintained an active website (www1.nyc.gov/site/911health/index.page) to report Registry and other 9/11 research findings and resources which received an average of 3,100 unique visitors per month from about 12 countries in Year 12.

» The Research Videos Page (with 26 videos posted to-date) received on average of about 866 views per month in Year 12 at: www1.nyc.gov/site/911health/updates/news-videos.page. 12 additional videos are posted at: www1.nyc.gov/site/911health/updates/announcements.page

» Testimonial videos are described in section 3a below

» The Registry's Research and Testimonial videos were viewed over 10,398 times in Year 12, a total of over 30,096 views since they were placed on YouTube in May 2014.

► Provided 1,496 enrollees, including 21 in Year 12, with their Wave 1 survey report as supporting eligibility documentation for their federal 9/11 Victim Compensation Fund application.

► Updated and re-organized sections of the 9/11healthinfo website and posted recent findings including those from our Year 12 publications.

1c: Conduct outreach to boost response to Registry studies, as needed

► **Conducted social media outreach to keep enrollees engaged with the Registry.**

► **Developed a 2020 Fall e-newsletter and a Winter 2020/2021 e-newsletter, in English, Spanish and Traditional and Simplified Chinese, that was sent to about 41,810 enrollees and about 10,000 members of the public who provided e-mail addresses, and posted it on the 9/11healthinfo website (*WWW1.NYC.GOV/SITE/911HEALTH/RESEARCHERS/PUBLISHED-RESEARCH-PUBLICATIONS.PAGE*).**

Specific Aim 2: Expand knowledge about the long-term health effects of 9/11 by facilitating medical, public health or emergency preparedness research, or other scientific research relevant to the WTC Health Program (WTCHP) – with special emphasis on impacts to those who lived, worked or attended school in the disaster area (i.e., non-"responders")

2a: Assess the contribution of 9/11 exposure and other risk factors to the course of health conditions and unmet healthcare needs nearly two decades post-9/11 by analyzing the 2015-16 Wave 4 survey, other Registry surveys and hospital discharge and other data linked to the Registry

► **Made a substantial scientific contribution to the 9/11 physical and mental health literature o**

» 21 publications.

» 17 presentations at scientific conferences and meetings.

► **Conducted periodic multi-mode health surveys.**

» See section 2c below

2b: Extend assessment of cancer and mortality incidence through 18 years post-9/11

► **Conduct periodic links to NYC Vital Statistics death files, the National Death Index (NDI), NYS SPARCS hospitalization records, and eleven state cancer registries.**

» Conducted NYC VR linkage in early 2021.

» Conducted mortality linkage with NDI in spring 2021 for years 2017-2018; and in spring 2022 for years 2019 and 2020.

» Maintained up to date DUAs and IRB approvals with state cancer registries.

► **Virtual Pool Registry (VPR-CLS)**

» The Registry was selected to use VPR for cancer linkage in March 2022. We have been working with IT and Information Management Services, Inc. (IMS) and VPR manager to get the approval for the use of VPR internally within the agency.

» Research/manuscripts

» A Registry manuscript on confirming mortality in a longitudinal exposure cohort was accepted in Year 12:

◊ Giesinger I, Li J, Takemoto E, Brackbill RM, Cone JE, Qiao B, Farfel MR. Confirming mortality in a longitudinal exposure cohort: optimizing National Death Index search result processing. Annals of Epidemiology 2021 Apr; 56:40-46.

» The Registry study of change in 9/11-related post-traumatic stress symptoms following cancer diagnosis was completed and preliminary findings was presented at The American College of Epidemiology conference in September 2020.

» o Cleaned and finalized the cancer data identified from 10 state cancer registries and began planning data analysis for the study of Cancer Incidence and Survival among community members (aka "Survivors"), Unable to complete data linkage to the 11th state cancer registry (FL) to obtain reported cancers through 2018 due to no action taken by FL.

» o Conducted data analysis of mortality among enrollees with cancer and the manuscript has been accepted by Cancer Medicine and currently in production.

◊ Kehm RD, Li J,Takemoto E, Yung J, Qiao B, Farfel MR, Cone JE. Mortality after the 9/11 terrorist attacks among World Trade Center Health Registry enrollees with cancer. Cancer Medicine. Accepted June 10, 2022.

» o Preliminary findings of an exploratory case study of suicide among a sample of 9/11 Survivors was presented at the APHA annual conference in October 2020.

» o Completed data linkage to SPARCS to obtain hospitalization and ER records through 2020 based on preliminary 2020 data. Reviewed probable matches and resolved potential matches.

» o Completed the mortality linkage with NYC Vital Records in Year 12.

» o Conducted data analysis for a study of cancer incidence among non-rescue/non-recovery community members in the WTHCR cohort.

o Started data analysis of a collaborative study with an external researcher on assessing how PTSD mediates the association between WTC exposure and cardiovascular-related mortality among WTC rescue/recovery workers in the Registry.

2c: Conduct independent or collaborative surveillance and in-depth studies to identify and investigate potential emerging health conditions and treatment outcomes on topics important to the WTCHP

► COVID-19 Survey (New)

» o Obtained IRB approval and implemented a study of COVID-19-related exposures, experiences, and illness among enrollees in the

Wave 5 survey sample to understand COVID-19 impacts on enrollees' Wave 5 survey responses and risk factors for severe COVID-19 illness.

◊ o Developed final survey content Survey included six questions from COVID-19 questionnaires developed by NIOSH and WTC-related programs.

◊ Programmed and tested in Teleform to create a paper survey for mail distribution.

◊ Programmed and tested a Web-based survey for electronic (e-mail) distribution.

» o Developed a survey communications package in English; translated it into three additional languages (Spanish, Traditional and Simplified Chinese).

» o Launched survey in February 2021 to 36,831 adult enrollees. In total, 22,302 enrollees responded to the survey by the end of data collection in August 2021 (61% response rate).

» o Final clean analytical dataset along with codebook were available to Registry analysts in January 2022.

► Protocol for matching to additional external data sources beginning with the WTCHP for surveillance and research, including emerging medical conditions. o

» Developed protocol and enrollee communications materials and received IRB approval.

» o Met with H+H Data Center staff to review WTCHP variables available.

► Autoimmune disease survey (2014-2018):

» o A manuscript was developed to examine whether mental health conditions (e.g., depression, anxiety) mediate the association between 9/11 exposure and development of autoimmune disease and was submitted for publication in 2021 (Brite J, Miller-Archie SA, Cone J. The relationship between 9/11 exposure, systemic autoimmune disease, and post-traumatic stress disorder: A mediational analysis. IJERPH 2022;19:6514).

► Wave 4 Asthma Survey (2015-2016):

» o In Year 12, a manuscript was published that examined the association between mental health conditions and poor asthma control among nearly 1,300 enrollees who completed the Wave 4 Asthma survey:

◊ Brite J, Friedman S, de la Hoz RE, Reibman J, Cone JE. Mental health, long-term medication adherence, and the control of asthma symptoms among persons exposed to the WTC 9/11 disaster. Journal of Asthma. October 2020; 57(11), 1253 doi:doi.org/10.1080/02770903.2019.1672722. PMID: 31550944 [Registry Publication

#141]

- » o Also, in Year 12 a manuscript was accepted that assesses prevalence and risk factors associated with asthma and COPD in WTCHR enrollees. (Asieh Haghighi, James E. Cone, J. Li & Rafael E. de la Hoz (2021) Asthma-COPD overlap in World Trade Center Health Registry enrollees, 2015–2016, Journal of Asthma,58:11, 1415-1423)
- » o A manuscript was developed that examined asthma control among enrollees who completed the Wave 4 Asthma survey compared to asthma control in the Wave 3 survey. It was submitted for publication in 2022.

2d: Develop and conduct a Wave 5 survey to ascertain cohort health status 18-19 years after 9/11

► The Wave 5 survey was launched in April 2020, in Year 11, in paper and web survey modes.

► During Year 12, eight e-mail reminders, three postcard reminders, and a third round of paper surveys (to all non-respondents) were sent out.

► In the third paper survey mailing (late October 2020) and starting with the 13th e-mail reminder (early November 2020), a notification of incentive was given in survey communications to enrollees to boost survey response rates. The notification stated that we would send the enrollee $10 to thank them for their time spent completing their survey.

► In mid/late December 2020, an e-mail reminder and a postcard reminder were sent out with the survey deadline (January 25, 2021) notification.

► Data collection was completed in February 2021 to allow time for mailed surveys to arrive. The survey response rate was 70%.

► Also completed data cleaning, recoding, and preparation of a final analytical dataset.

► Completed a Data File User's Manual (DFUM) and codebook in June 2021, and public use dataset (PUDS) was posted on the 9/11healthinfo website in June 2022.

2e: Develop new research resources by assessing the feasibility of matching to additional administrative databases and establishing a sub-cohort of enrollees willing to participate in "rapid research" to provide rapid turnaround of brief, directed surveys implemented with greater frequency

► In December 2019, Registry staff, in coordination with NIOSH, held a scientific WTC Data Linkage Symposium focused on exploring new data sources and methods for linkages to existing administrative and other databases to

further research on WTC-related health conditions. From that symposium, we have: o Published a white paper [Registry publication #139] Asher J, Resnick D, Brite J, Brackbill R, Cone J. An Introduction to Probabilistic Record Linkage with a Focus on Linkage Processing for WTC Registries. Int. J. Environ. Res. Public Health 2020, 17(18), 6937; https://doi.org/10.3390/ijerph17186937.

- » o Formed a cross cohort working group, which includes members from the various WTC cohorts, for the purpose of discussing matching to new data sources. Meetings are held as needed.
- » o Submitted an IRB modification to establish a plan to link to Medicaid and Medicare without additional enrollee consent.
- » o Conducted a data linkage with Health + Hospitals to determine which and how many Registry Survivor enrollees are participants in the H+H WTC Center of Excellence in order to exclude them from future Registry treatment referral outreach and to position the Registry to better plan for collaborative research on Survivors with H+H.

► In Year 12, the Registry finalized work on the feasibility study to create a new cohort of 9/11-exposed children for research based on historical records from the NYC Department of Education (DOE). Key accomplishments include:

- » o Data collection ended in July 2020.
- » o A final report on the feasibility study was submitted and accepted by NIOSH in October 2020.
- » Registry staff continued work on the educational outcomes study using DOE data (1998/99 - 2016/17). In Year 12, Registry staff: o Received feedback from co-authors, revised analyses to focus on the same children over time. Updated tables and figures in preparation for manuscript.
- » o Presented findings via a poster at SER annual meeting in December 2020.
- » o Manuscript preparation continues.

Specific Aims: 3 and 4 below are the research translation components of the Registry.

Specific Aim 3: Conduct community activities to respond to the physical and mental health concerns and specific healthcare needs of enrollees and others exposed to 9/11

3a: Disseminate Registry findings and recommendations to enrollees, the public, WTCHP leadership and policy makers, using formats such as video, social media, and websites

► Employed multiple dissemination channels, including the Registry's 9/11healthinfo website, e-newsletters, press announcements, media interviews, and YouTube videos, including 26

research videos (including a Treatment Referral Program video and a Victim's Compensation Fund informational video) and 20 testimonial videos, including 9 developed in the 12-month no cost extension period. www1.nyc.gov/site/911health/enrollees/testimonial-videos.page

- **Made 17 presentations at scientific conferences.**
- **Maintained a 9/11healthinfo website that is mobile friendly and has better organized content with the goal to enhance user engagement (see section 1b above).**

3b: Provide Registry data resources and other resources to enrollees, the general public, external researchers and WTCHP entities

- **Our 9/11 website provides access to all Waves of survey materials including the Data File Users' Manual (DFUM), questionnaires, and public use datasets with codebooks. Questionnaires are also posted online for many of our in-depth surveys.**
- **www1.nyc.gov/site/911health/researchers/health-data-tools.page. The page had over 3,969 downloads in Year 12.**
- **Responded to about 4 data requests from advisors, researchers, media and others in Year 12.**
- **Developed, tested, and finalized a new online consent app for "New Adult" enrollees (enrollees who were enrolled as children by their parents) to obtain their consent to remain in the Registry as adults.**
- **Completed planning for the 20th anniversary of 9/11, including working with the CDC museum on the proposed WTCHR element for their special 9/11 exhibit.**
- **Held a 20th anniversary DOHMH Townhall with the NYCDOHMH Health Commissioner. Registry staff presented on Registry findings. The Townhall was recorded and posted to the 9/11healthinfo website in full and as a briefer highlight segment.**
- **Completed manuscript which has been cleared by DOHMH for publication and submitted to IJERPH on scientific validity of Registry cohort of persons<18 years of age at 9/11/01 at request of NIOSH.**

3c: Continue to conduct health promotion activities, including health education

- **Create condition-specific physical and mental health fact sheets which**

represent current scientific information and provide answers to common questions received from enrollees and the public. All fact sheets are available in English, Spanish, and traditional and simplified Chinese.

- » o Health materials posted to the Registry website in Year 12 include: Health Education Fact Sheets on Breast and Prostate Cancer.
- » o Health materials in preparation include hearing loss, COPD, and PTSD fact sheets, and a summary of the Registry's autoimmune disease studies. The Registry has developed these materials, and they are pending the Agency's Communications Department's review while the agency is prioritizing COVID-19 related work.
- » o Health educational materials are posted at ***WWW1.NYC.GOV/SITE/911HEALTH/RESEARCHERS/HEALTH-MATERIALS.PAGE***

Specific Aim 4: Maintain the 9/11 Treatment Referral Program (TRP) to help enrollees and others find care for 9/11-related health problems

4a: Inform enrollees of 9/11-related services and resources

► **TRP staff trained in motivational interviewing techniques which helps to identify and address barriers to applying to and utilizing 9/11-related health service.**

► **Personalized communications sent in English and Spanish and traditional and simplified Chinese.**

► **Updated TRP III informational brochures are sent to enrollees who request a WTCHP application.**

► **Posted TRP, VCF and other resource information on the Registry's 9-11HealthInfo website.**

4b: In coordination with the WTCHP, conduct outreach to potentially eligible enrollees in English, Spanish, and Chinese to encourage them to apply to the WTCHP

► **TRP III:**

- » Launched in February 2017 to conduct outreach to about 15,500 responder and survivor enrollees who reported no prior access to the WTCHP on their Wave 4 survey.

► **In Year 12:**

- » o Staff sent out 160 WTCHP applications and provided 143 enrollees with their Wave 1 survey report as documentation of their presence near the WTC site on 9/11 for their WTCHP applications.
- » o 263 Registry-branded applications were received by the WTCHP.
- » o Call vendor completed the remaining TRP III outreach calls to ~3,000 enrollees for whom we obtained updated phone numbers.

4c: Conduct targeted outreach to enroll-

ees with specific conditions or unmet healthcare needs (e.g., poorly controlled asthma, current smokers, or those accepted to the WTCHP but never seen)

► A smoking cessation intervention was launched in October 2018 to approximately 2,000 NYC/NYS residents. In Year 12:

» o Completed follow-up calls with 25 of the enrollees who were previously referred to the NYS Quit Line to track their usage of the nicotine replacement therapy.

» o A manuscript analyzing the findings of the smoking cessation intervention has been delayed.

► An emergency preparedness intervention, launched in February 2019, targets NYC enrollees who completed a Wave 4 survey and has a control group. The intervention will assess if emergency preparedness increases based on a mailing or an enhanced phone intervention.

» o 891 participants who were recruited, of which 709 consented to participate and baseline assessment calls were completed with all 709 participants. Intervention staff completed 278 phone intervention calls and sent mailings of intervention materials to 341 enrollees. 504 post assessment calls were conducted. Outreach efforts concluded in September 2020.

» o A manuscript assessing findings of this initial phase of the emergency preparedness intervention is being prepared.

4d: Evaluate impact of TRP and share findings with the WTCHP

► The TRP-II manuscript, based on the qualitative evaluation of the TRP process after an enrollee submits their WTCHP application, is currently on pause.

Specific Aim 5: Collaborate with other WTCHP entities (Data Centers, Clinical Centers of Excellence) to explore surveillance signals and treatment outcomes as follows: 9/11 linkage with uncommon health conditions, such as cancer and autoimmune and neurological disease (including age at diagnosis), and treatment outcomes for selected conditions related to 9/11

5a: Continue communications and collaborations with WTCHP clinical/data centers, including attending Responder and Survivor Steering Committee, NIOSH scientific advisory and NIOSH PI meetings

► Collaborated on a special issue of a journal:

» o In Year 12, completed editing of a collaborative issue of the International Journal of Environmental Research and Public Health, "9/11 Health Impacts" presenting 13

manuscripts from multiple WTCHP clinical centers and Data Centers (https://www.mdpi.com/journal/ijerph/special_issues/911_Health_Update). The Guest editor was from WTCHR (James Cone), and co-editors were from NIOSH and the General Responder program. Four publications in this collaborative issue were led by Registry authors and another publication included Registry co-authors.

» o The Registry Research Director (Brackbill) served as editor of the next International J. of Environ. Res. and Public Health's special 9/11-themed volume which included papers from Registry and WTCHP researchers; 13 papers published.

► Collaborated or collaborating with FDNY, Einstein and Mount Sinai WTC researchers on WTCHP-funded studies, including:

» o The joint cancer study: a pooled analysis of cancer incidence, latency, and survival across three cohorts of WTC rescue/recovery workers from the Registry, FDNY and Mount Sinai. In Year 12:

» Completed data analysis for the project Aims 1-3. By the end of Year 12 we had a total of 4 publications (manuscript #77and #88-90) which cover areas from how the joint cohort of WTC rescue/recovery workers were combined and deduplicated, to assessing impact of healthcare services on thyroid cancer incidence, change point of incidence in prostate cancer, and cancer survival.

◊ Worked very closely with collaborators and participated in all aspects of the publications including interpretation of the findings, review, and clearance of manuscripts.

◊ A Registry author led the methods paper describing how we pooled all three WTC cohorts of rescue/recovery workers with the help from NYS cancer registry. It was published in IJERPH in early 2021.

◊ The Registry is also responsible for the Aim 1 of the study which assessed cancer incidence and risk associated with WTC exposure. The paper led by Jiehui Li was published in JNCI in Sept. 2021.

» Maintained up to date DUAs/MOUs and IRB approvals

» Worked with FDNY and other collaborators to discuss how to maintain and update the existing combined cohort for future studies. Provided letter of support to FDNY.

» o The joint mortality study: a pooled analysis of overall, cause-specific, and occupational-specific mortality in a combined dataset of WTC rescue/recovery workers from the Registry, FDNY and Mount Sinai cohort. In Year 12 we continued our work as collaborators on the project, including attending meetings and providing input.

» Completed data analysis of Aim

1 of the study which assess excess all-cause and selected cause-specific mortality and its association with WTC exposure among WTC workers. The manuscript is currently under review within collaborators.

» Maintained up to date MOU and IRB approvals.

» Joined regular group meetings and provide input to Aim 2 findings and Aim 3 aggregate occupational cohort data.

» o Worked on single IRB request from DOHMH IRB for a newly proposed project on maintaining and updating the combined cohort of WTC rescue/recovery workers, pooled from 3 existing cohorts in NYC (WTCHR, FDNY and GRC).

► Continued to attend and participate in the WTCHP Responder and Survivor Steering Committee meetings and NIOSH Scientific Forum meetings, including Forum meetings focused on assessment of COVID-19 among the WTC cohorts. NIOSH did not hold PI meetings during this period.

► Communicated with DOHMH general counsel to plan for a BAA between DOHMH and the H+H Data Center to allow for enhanced planning for research. BAA is being worked on by both entities.

► Began monthly research coordination meetings with Travis Kubale and Doug Daniels at NIOSH.

5b: Serve as a platform for external research by providing facilitated recruitment of enrollees and de-identified survey data

► Responded to 3 data requests: from potential external researchers (Cozza (n=2) and Daniels) and provided three letters of support for 3 Zadroga grant applications (Cozza (n=2), Health+Hospitals). Provided de-identified survey data to one external researcher for their approved projects (Shen).

► Worked with 14 active approved external research projects, including 4 with federal WTCHP funding: (Marmor, Hall, Boffetta, Zeig-Owens), 2 with DOHMH's Division of Epidemiology (Lim, Liu), and 8 others (Adams, Mancini, Sembajwe, Shen (n=2), Wyka (n=2), and Cycowitz)

Appendix 1, Section 6

WTC Health Registry Key Accomplishments July 2021–June 2022

World Trade Center Health Registry Key Accomplishments July 2021–June 2022

NIOSH GRANT YEAR 13

This study is currently supported by Cooperative Agreement U50/OH009739 from the National Institute for Occupational Safety and Health (NIOSH) of the U.S. Centers for Disease Control and Prevention (CDC) and the New York City Department of Health and Mental Hygiene (NYC DOHMH). Support prior to April 2009 was provided by Cooperative Agreement U50/ATU272750 from the Agency for Toxic Substances and Disease Registry (ATSDR), which included support from the National Center for Environmental Health (NCEH), and the New York City Department of Health and Mental Hygiene (NYC DOHMH).

Specific Aim 1: Maintain the Registry as a valuable public health resource to allow health professionals to track and investigate possible trends in illness and recovery

1a: Maximize the number of enrollees with valid, updated contact information through ongoing communications with enrollees and conduct tracing to locate enrollees with invalid or missing contact information

- Maintained multiple communication channels (i.e., phone, fax, email, mail, secure web app) for enrollees to use to contact the Registry with questions or to provide updated contact information
- Obtained consent from new young adults - child enrollees who have aged into adulthood
- Children: approximately 2,625 children were under age 18 years at time of enrollment in 2003-2004; about 377 enrollees are children as of June 2017
- Among new young adults, approximately 1,192 have consented to remain in the Registry as adults (including 144 in Year 8), sixty-two have withdrawn and approximately nine are deceased. Staff is conducting outreach to the remaining new young adults

- Registry enrollees remain committed and engaged with the Registry nearly sixteen years after 9/11
  - » Over 9,700 enrollee contact information updates received in Year 8
  - » Few withdrawals (thirty-five in Year 8; a total of 1,059, or about 1.48 percent of all enrollees)
  - » LexisNexis used to trace approximately 2,000 to 5,000 enrollees per year with missing or invalid contact information
  - » Very few enrollees currently lost to follow-up (about 54)

1b: Keep enrollees engaged and interested in participating in future research by maintaining timely, accurate and professional communications and providing feedback to address enrollee concerns

- Responded to approximately 50 incoming communications from enrollees and the public per day
- Prepared all key written communications in English, Spanish, and traditional and simplified Chinese
- Staff available to speak with enrollees and the public in English, Spanish, Mandarin and Cantonese
- Provided core communications to all enrollees, including an Annual Report of findings and Annual Card
- Maintained an active website to report Registry and other 9/11 research findings and resources with approximately three thousand unique visitors per month from about forty-nine countries at: http://www1.nyc.gov/site/911health/index.page. The Research Videos page receives nearly eight thousand views per month at: ***HTTP://WWW1.NYC.GOV/SITE/911HEALTH/UPDATES/NEWS-VIDEOS.PAGE***
- Disseminated quarterly e-newsletter with 9/11-related news to approximately 50,000, including enrollees and the public
- Collaborated with the federal 9/11 Victim's Compensation Fund (VCF) to identify applicants who are enrollees. Provided 1,380 enrollees to-date, including twenty-two in Year 8, with their Wave 1 survey report as supporting eligibility documentation for their VCF application
- High enrollee participation rates in follow-up and in-depth surveys
- In May 2017, conducted 10 focus groups with targeted groups of enrollees including: young adults (four groups); separate groups for Mandarin, Cantonese and Spanish language speakers; a group of enrollees who completed all W1-4 survey waves; and a group of enrollees who completed only a W1 survey and an external or in-depth survey. A total of seventy-eight enrollees participated in these focus groups. Findings will be used to enhance our communication strategies to better engage and inform enrollees of findings and resources

1c: Conduct outreach to boost response to Registry studies, as needed

- ► Sent key communications including multiple paper surveys, email invitations with a link to an online survey, and email and postcard reminders
- ► Conducted social media outreach, door-to-door outreach and telephone reminders

Specific Aim 2: Expand knowledge about the long-term health effects of 9/11 by facilitating medical, public health or emergency preparedness research, or other scientific research relevant to the WTC Health Program (WTCHP) – with special emphasis on impacts to those who lived, worked or attended school in the disaster area (i.e.,non-"responders")

2a: Assess the contribution of 9/11 exposure and other risk factors to the course of health conditions and unmet healthcare needs 15 years post-9/11 by analyzing the 2015-16 Wave 4 survey, other Registry surveys and hospital discharge and other data linked to the Registry

- ► Made a substantial scientific contribution to the 9/11 physical and mental health literature
  - » Twenty-three publications, including fourteen articles, two letters, and two conference abstracts in peer-reviewed journals and five publications in-press
  - » Forty-three presentations at scientific conferences and meetings
- ► Conducted public health training
  - » Two MPH degrees completed using Registry data under the guidance of Registry senior staff
  - » Conducted periodic multi-mode health surveys

◊ See section 2c below

2b: Extend assessment of cancer and mortality incidence through 15 years post-9/11

- ► Conduct periodic links to NYC Vital Statistics death files, the National Death Index (NDI), NYS SPARCS hospitalization records, and eleven state cancer registries
- ► Cancer incidence completed through 10 years post-9/11
  - » Li J, Brackbill RM, Liao TS, Qiao B, Cone JE, Farfel MR, Hadler JL, Kahn AR, Konty KJ, Stayner LT, Stellman SD. Ten-year cancer incidence in rescue/recovery workers and civilians exposed to the September 11, 2001 terrorist attacks on the World Trade Center. Am J Ind Med. 2016 Sep;59(9):709-721. ***HTTPS://DOI.ORG/10.1002/AJIM.22638***
  - » Mortality incidence through ten years post-9/11 (manuscript under clearance as of 6/30/2017)

2c: Conduct independent or collaborative surveillance and in-depth stud-

ies to identify and investigate potential emerging health conditions and treatment outcomes on topics important to the WTCHP Published additional quantitative analysis findings

► Staten Island landfill and barge workers: Published additional quantitative analysis findings

» Cone JE, Osahan S, Ekenga CC, Miller-Archie SA, Stellman SD, Fairclough M, Friedman SM, Farfel MR. Asthma among Staten Island fresh kills landfill and barge workers following the September 11, 2001 World Trade Center terrorist attacks. Am J Ind Med. 2016 Sep;59(9):795-804. ***HTTPS://DOI.ORG/10.1002/AJIM.22645***

► Autoimmune disease survey:

(2014-2017)

» Phase I: Assess incidence of physician verified rheumatoid arthritis and other autoimmune diseases (AD) among enrollees who reported post-9/11 autoimmune disease at Wave 3 and examine 9/11-risk factors; 2,042 enrollee surveys completed; with about a seventy-three percent response rate (RR). Physician surveys or medical records received for 732 enrollees, with about a seventy percent RR out of the 1,042 enrollees who provided authorization to contact their physician. Medical record vendor to obtain these remaining medical records.

» Phase II: Assess incidence of physician verified MS and ALS among approximately 580 additional enrollees who reported post-9/11 MS or ALS at Waves 3 or 4 and examine 9/11-risk factors. Received 394 enrollee surveys to-date; for an approximate sixty-eight percent RR to-date. Physician verification/ medical record review pending.

► Health and quality of life (Injury) study:

» Phase I (Qualitative): In 2015, completed qualitative interviews with thirty-nine enrollees who sustained a 9/11 injury. Findings published in Year 08. Analysis informed development of a Phase II survey

◊ Gargano LM, Gershon RR, Brackbill RM. Quality of life of persons injured on 9/11: Qualitative analysis from the World Trade Center Health Registry. PLOS Currents Disasters. 2016 Oct 27. Edition 1. ***HTTP://DOI.ORG/10.1371/CURRENTS.DIS.7C70F66C1E6C5F41B43C797CB2A04793***

» Phase II (Quantitative): Launched in March 2017 to approximately 8,500 enrollees to better understand the long-term mental and physical health consequences of 9/11 injuries. Data collection to end in mid-July 2017. Preliminary: About 6,000 surveys received to-date; for an approximate seventy-one percent RR.

► Early Labor Force Exit Study:

» Analysis of W1-W3 findings (Yu et al., 2016) informed the development of this in-depth study.

» Yu S, Brackbill RM, Locke S, Stellman SD, Gargano LM. Impact of 9/11-related chronic conditions

and PTSD comorbidity on early retirement and job loss among World Trade Center disaster rescue and recovery workers. Am J Ind Med. 2016 Sep;59(9):731-741.

◊ HTTPS://DOI.ORG/10.1002/AJIM.22640

» Finalized content and developed paper and web surveys in Year 8. Survey planned to launch August 2017. The study will examine the impact of 9/11-related health on early retirement and job loss among approximately 24,500 responders and survivors and further investigate the interrelationship of income, health, and premature labor force exit

2d: Develop and conduct a Wave 5 survey to ascertain cohort health status 18-19 years after 9/11

► Conducted planning for a Request for Proposal (RFP) to select a Wave 5 survey vendor to be released later in 2017

2e: Develop new research resources by assessing the feasibility of matching to additional administrative databases and establishing a sub-cohort of enrollees willing to participate in "rapid research" to provide rapid turnaround of brief, directed surveys implemented with greater frequency

► We discussed the proposal to establish a sub-cohort of enrollees for rapid research with the NYC DOHMH IRB chair. The IRB chair advised the Registry that she was not receptive to approving this proposal because of potential bias in the research outcomes if enrollees with less rapid survey response times were excluded. No further steps are planned

► Conducted an initial assessment of NYC DOHMH or NYC Dept of Education (DoE) administrative databases that may provide: (1) information about the health effects of 9/11 on children; and/or (2) a sampling frame to establish a new children's cohort. Registry staff recommended focus on using administrative databases for expanded research on children because it is likely to be more feasible, timely and cost-effective than establishing a new cohort. Presented to the Survivor Steering Committee and sent NIOSH an initial briefing paper on the assessment. Discussions are ongoing

SPECIFIC AIMS 3 AND 4 BELOW ARE THE RESEARCH TRANSLATION COMPONENTS OF THE REGISTRY.

Specific Aim 3: Conduct community activities to respond to the physical and mental health concerns and specific healthcare needs of enrollees and others exposed to 9/11

3a: Disseminate Registry findings and

recommendations to enrollees, the public, WTCHP leadership and policy makers, using formats such as video, social media, and websites

- Employed multiple dissemination channels, including the Registry's 9/11healthinfo website, annual reports, press announcements, media interviews, and YouTube videos, including ten research videos and nine testimonial videos http://www1.nyc.gov/site/911health/enrollees/testimonial-videos.page (five of the videos were posted in Year 8 and two more are in production)

- Made forty-three presentations at scientific conferences; meetings of the WTCHP STAC, Survivor steering committee and Outreach committee meeting; and to community groups, hospitals, and local health departments

- Completed a redesign of the 9/11healthinfo website to better organize the content with the goal to enhance user engagement and to ensure that it was mobile friendly

- Conducted ten focus groups (see section 1b above)

3b: Provide Registry data resources and other resources to enrollees, the general public, external researchers and WTCHP entities

- Posted Wave 4 survey materials, including the Data File Users' Manual (DFUM) and the questionnaires for the Wave 4 Core and Asthma Surveys. The Wave 4 public use dataset with codebook is complete and pending posting on the 9/11 website

- ***HTTP://WWW1.NYC.GOV/SITE/911HEALTH/RESEARCHERS/HEALTH-DATA-TOOLS.PAGE***

- Our interactive 9/11 Health Online Data Tool that permits users to query de-identified Wave 1 survey data has been accessed by over 800 unique users outside of NYC DOHMH in Year 8

- Responded to approximately sixteen data requests from advisors, researchers, media and others in Year 8

3c: Continue to conduct health promotion activities, including health education

- Create condition-specific physical and mental health fact sheets which represent current scientific information and provide answers to common questions received from enrollees and the public. All fact sheets are available in English, Spanish, and traditional and simplified Chinese
  - In April 2017, sent GERD Fact Sheet to nearly 25,000 enrollees who reported GERD on their W4 survey
  - Fact sheets in-preparation: sleep apnea, sinusitis, hearing loss, anxiety, PTSD and others
  - Posted related health educational materials on
  - ***www.nyc.gov/9-11HealthInfo***

Specific Aim 4: Maintain the 9/11 Treatment Referral Program (TRP) to help enrollees and others find care for 9/11-related health problems

4a: Inform enrollees of 9/11-related services and resources

- TRP staff trained in motivational interviewing techniques which helps to identify and address barriers to applying to and utilizing 9/11-related health service; TRP informational brochures sent to all enrollees
- Personalized communications sent in English, Spanish and traditional and simplified Chinese
- Updated TRP III brochures created and printed in 2017
- Posted TRP, VCF and other resource information on the Registry's 9-11HealthInfo website

4b: In coordination with the WTCHP, conduct outreach to potentially eligible enrollees in English, Spanish, and Chinese to encourage them to apply to the WTCHP

- TRP II: Identified approximately 23,000 enrollees for outreach; conducted outreach to nearly all of these enrollees. TRP staff made contact with about 7,417 enrollees with nearly 6,000 requesting a WTCHP application
- TRP II ended on 12/31/2016. By then, approximately 4,351 Registry-branded applications had been received by the WTCHP, and approximately 5,257 enrollees had been provided with their Wave 1 report as documentation of their presence near the WTC site on 9/11 for their WTCHP application
- On average, three to five contacts with staff were needed before an enrollee completed the outreach process
- TRP III: Launched in January 2017 to enrollees residing in and outside of the NYC area, including English (approximately 15,000), Spanish, Mandarin and Cantonese (together about 500) language speakers
- The outreach sample was drawn from responder and survivor enrollees who reported no prior access to the WTCHP on their Wave 4 survey. Survivors also needed to report least one of the following symptoms (uncontrolled asthma, COPD, RADS, GERS, probable 9/11-related PTSD, or depression on their Wave 4 survey or generalized anxiety disorder on their Wave 3 survey) to be included in the sample targeted for TRP III outreach
- In Year 8, approximately 1,121 enrollees requested a WTCHP application, all under TRP III outreach
- In Year 8, over 880 Registry-branded applications had been received by the WTCHP including 517 under TRP II. In May 2017, TRP

received the highest number of applications ever in a month (212), which was 40 percent of all WTCHP applications received that month

► In Year 8, provided approximately 2,235 enrollees with their Wave 1 survey report as documentation of their presence near the WTC site on 9/11 for their WTCHP application, with 1,595 reports provided under TRP III

4c: Conduct targeted outreach to enrollees with specific conditions or unmet healthcare needs (e.g.,poorly controlled asthma, current smokers, or those accepted to the WTCHP but never seen

► Targeted outreach based on specific medical conditions is planned to begin with uncontrolled asthma

4d: Evaluate impact of TRP and share findings with the WTCHP

► TRP-II evaluation under analysis, including two manuscripts in-prep: analysis on pre- and post-application submission outcomes

Specific Aim 5: Collaborate with other WTCHP entities (Data Centers, Clinical Centers of Excellence) to explore surveillance signals and treatment outcomes as follows: 9/11 linkage with uncommon health conditions, such as cancer and autoimmune and neurological disease (including age at diagnosis), and treatment outcomes for selected conditions related to 9/11

5a.: Continue communications and collaborations with WTCHP clinical/data centers, including attending Responder and Survivor Steering Committee, NIOSH scientific advisory and NIOSH PI meetings

► Published four manuscripts with WTCHP co-authors

► Respiratory studies in collaboration with NYU/Bellevue: Completed the follow-up study (2013-14; 545 enrollees completed interviews and PFTs; with about a seventy-four percent RR) to assess longer-term persistent lower respiratory symptoms. Published follow-up findings in Year 8.

» Jordan HT, Friedman SM, Reibman J, Goldring RM, Miller-Archie SA, Ortega F, Alper H, Yongzhao S, Maslow CB, Cone JE, Farfel MR, Berger KI. Risk factors for persistence of lower respiratory symptoms among community members exposed to the 2001 World Trade Center terrorist attacks. Occup Environ Med. 2017 March; 74(6): 449-455.

» ***HTTP://DOI.ORG/10.1136/OEMED-2016-104157***

► Hearing loss study in collaboration with FDNY:

» Using existing, longitudinal FDNY audiometric surveillance data, we are examining the role of 9/11-re-

lated exposures on change in hearing over time among approximately 15,000 FDNY personnel active on 9/11. In collaboration with FDNY, audiometric data has been recovered and cleaned and we are in the process of defining change in hearing status

► Collaborated or collaborating with FDNY, Einstein and Mount Sinai WTC researchers on WTCHP-funded studies, including:

» A review of cancer in WTC rescue/recovery workers from the Registry, FDNY and Mount Sinai cohorts:

◊ Boffeta, P, Zeig-Owens R, Wallenstein S, Li J, Brackbill RM, Cone JE, Farfel MR, Holden W, Lucchini R, Webber MP, Prezant D, Stellman SD, Hall CB. Response to Soskolne [2017]. Am J Ind Med. 2017 April; 60(5): 512. ***HTTPS://DOI.ORG/10.1002/AJIM.22713*** [Letter]

» A study to conduct a pooled analysis of cancer incidence, latency and survival across three cohorts of WTC rescue/recovery workers from the Registry, FDNY and Mount Sinai.

► Developed and executed NYC DOHMH Data Use Agreements (DUAs) or a Memo of Understanding (MOU) with study partners (Mount Sinai, FDNY, NYS Cancer Registry) and six of the targeted thirteen state cancer registries (CA,CT,MA,NC,NJ, and NY)

► Submitted a National Death Index (NDI) application for the joint cancer project. Approval pending

► Will continue to outreach to the remaining seven state cancer registries to obtain DUAs

» Participated in an application for a WTCHP-funded study to conduct a pooled analysis of overall, cause-specific and occupational-specific mortality in a combined dataset from these three WTC rescue/recovery workers cohorts

► Continued to attend and participate in the WTCHP Responder and Survivor Steering Committee meetings, the NIOSH scientific advisory meeting, the NIOSH PI meetings and the NIOSH Scientific Forum meetings.

5b: Serve as a platform for external research by providing facilitated recruitment of enrollees and de-identified survey data

► Co-authored another six publications with researchers outside of NYC DOHMH

► At least another four publications authored by principal investigators from external research studies facilitated by the Registry

► Responded to thirteen data requests from potential external researchers

► Reviewed applications from six external researchers; approved five applications and provided de-identified data to four external research-

ers (one data release pending implementation of a DUA)

► In August 2016, completed facilitated recruitment of Registry enrollees into a WTCHP-funded study of the mental health of children and young adults (Hoven, Columbia)

► Under the guidance of an external researcher using Registry **data,** one graduate degree (MPH) completed

► Worked with nine active approved external research projects, including two with federal WTCHP funding (Kung, Marmor), one other CDC project (Pallos), and six others (Bowler, Mancini, Shen, Wyka (n=2) and Todd).

Appendix 2, Section 1

WTC Health Program • Research Portfolio Project Publications

Year Published 2011 (3)

Caplan-Shaw CE, Yee H, Rogers L, et al. 2011. Lung pathologic findings in a local residential and working community exposed to World Trade Center dust, gas, and fumes. J Occup Environ Med. 53 (9):981–991.

HTTPS://DOI.ORG/10.1097/JOM.0B013E31822FFF60

OBJECTIVE: To describe pathologic findings in symptomatic World Trade Center-exposed local workers, residents, and cleanup workers enrolled in a treatment program.

METHODS: Twelve patients underwent surgical lung biopsy for suspected interstitial lung disease (group 1, n = 6) or abnormal pulmonary function tests (group 2, n = 6). High-resolution computed axial tomography and pathologic findings were coded. Scanning electron microscopy with energy-dispersive x-ray spectroscopy was performed.

RESULTS: High-resolution computed axial tomography showed reticular findings (group 1) or normal or airway-related findings (group 2). Pulmonary function tests were predominantly restrictive. Interstitial fibrosis, emphysematous change, and small airway abnormalities were seen. All cases had opaque and birefringent particles within macrophages, and examined particles contained silica, aluminum silicates, titanium dioxide, talc, and metals.

CONCLUSIONS: In symptomatic World Trade Center-exposed individuals, pathologic findings suggest a common exposure resulting in alveolar loss and a diverse response to injury.

Friedman SM, Maslow CB, Reibman J, et al. 2011. Case-control study of lung function in World Trade Center Health Registry area residents and workers. Am J Respir Crit Care Med. 184 (5):582–589.

HTTPS://DOI.ORG/10.1164/RCCM.201011-19090C

RATIONALE: Residents and area workers who inhaled dust and fumes from the World Trade Center disaster reported lower respiratory symptoms in two World Trade Center Health Registry surveys (2003-2004 and 2006-2007), but lung function data were lacking.

OBJECTIVES: To examine the relationship between persistent respiratory symptoms and pulmonary function in a nested case-control study of exposed adult residents and area workers 7-8 years after September 11, 2001.

METHODS: Registrants reporting post September 11th onset of a lower respiratory symptom in the first survey and the same symptom in the second survey were solicited as potential cases. Registrants without lower respiratory symptoms in either Registry survey were solicited as potential control subjects. Final

case-control status was determined by lower respiratory symptoms at a third interview (the study), when spirometry and impulse oscillometry were also performed.

MEASUREMENTS AND MAIN RESULTS: We identified 180 cases and 473 control subjects. Cases were more likely than control subjects to have abnormal spirometry (19% vs. 11%; $P < 0.05$), and impulse oscillometry measurements of elevated airway resistance (R5; 68% vs. 27%; $P < 0.0001$) and frequency dependence of resistance (R(5)(-)(2)(0); 36% vs. 7%; $P < 0.0001$). When spirometry was normal, cases were more likely than control subjects to have elevated R(5) and R(5)(-)(2)(0) (62% vs. 25% and 27% vs. 6%, respectively; both $P < 0.0001$). Associations between symptoms and oscillometry held when factors significant in bivariate comparisons (body mass index, spirometry, and exposures) were analyzed using logistic regression.

CONCLUSIONS: This study links persistent respiratory symptoms and oscillometric abnormalities in World Trade Center-exposed residents and area workers. Elevated R(5) and R(5)(-)(2)(0) in cases despite normal spirometry suggested distal airway dysfunction as a mechanism for symptoms.

Zeig-Owens R, Webber MP, Hall CB, et al. 2011. Early assessment of cancer outcomes in New York City firefighters after the 9/11 attacks: An observational cohort study. Lancet. 378 (9794):898-905.

HTTPS://DOI.ORG/10.1016/S0140-6736(11)60989-6

BACKGROUND: The attacks on the World Trade Center (WTC) on Sept 11, 2001 (9/11) created the potential for occupational exposure to known and suspected carcinogens. We examined cancer incidence and its potential association with exposure in the first 7 years after 9/11 in firefighters with health information before 9/11 and minimal loss to follow-up.

METHODS: We assessed 9853 men who were employed as firefighters on Jan 1, 1996. On and after 9/11, person-time for 8927 firefighters was classified as WTC-exposed; all person-time before 9/11, and person-time after 9/11 for 926 non-WTC-exposed firefighters, was classified as non-WTC exposed. Cancer cases were confirmed by matches with state tumour registries or through appropriate documentation. We estimated the ratio of incidence rates in WTC-exposed firefighters to non-exposed firefighters, adjusted for age, race and ethnic origin, and secular trends, with the US National Cancer Institute Surveillance Epidemiology and End Results (SEER) reference population. CIs were estimated with overdispersed Poisson models. Additional analyses included corrections for potential surveillance bias and modified cohort inclusion criteria.

FINDINGS: Compared with the general male population in the USA with a similar demographic mix, the standardised incidence ratios (SIRs) of the cancer incidence in WTC-exposed firefighters was 1.10 (95% CI 0.98-1.25). When compared with non-exposed firefighters, the SIR of cancer incidence in WTC-exposed firefighters was 1.19 (95% CI 0.96-1.47) corrected for possible surveillance bias and 1.32 (1.07-1.62) without correction

for surveillance bias. Secondary analyses showed similar effect sizes.

INTERPRETATION: We reported a modest excess of cancer cases in the WTC-exposed cohort. We remain cautious in our interpretation of this finding because the time since 9/11 is short for cancer outcomes, and the reported excess of cancers is not limited to specific organ types. As in any observational study, we cannot rule out the possibility that effects in the exposed group might be due to unidentified confounders. Continued follow-up will be important and should include cancer screening and prevention strategies.

FUNDING: National Institute for Occupational Safety and Health.

Published 2012 (1)

Liu M, Qian M, Cheng Q, et al. 2012. Longitudinal spirometry among patients in a treatment program for community members with World Trade Center-related illness. J Occup Environ Med. 54 (10):1208–1213.

HTTPS://DOI.ORG/10.1097/JOM.0B013E31826BB78E

OBJECTIVE: The course of lung function in community members exposed to World Trade Center (WTC) dust and fumes remains undefined. We studied longitudinal spirometry among patients in the WTC Environmental Health Center (WTCEHC) treatment program.

METHODS: Observational study of 946 WTCEHC patients with repeated spirometry measures analyzed on the population as a whole and stratified by smoking status, initial spirometry pattern, and WTC-related exposure category.

RESULTS: Improvement in forced vital capacity (54.4 mL/yr; 95% confidence interval, 45.0 to 63.8) and forced expiratory volume in 1 second (36.8 mL/yr; 95% confidence interval, 29.3 to 44.3) was noted for the population as a whole. Heavy smokers did not improve. Spirometry changes differed depending on initial spirometry pattern and exposure category.

CONCLUSION: These data demonstrate spirometry improvement in select populations suggesting reversibility in airway injury and reinforcing the importance of continued treatment.

Year Published 2013 (4)

Berger KI, Reibman J, Oppenheimer BW, et al. 2013. Lessons from the World Trade Center disaster: Airway disease presenting as restrictive dysfunction. Chest. 144 (1):249–257.

HTTPS://DOI.ORG/10.1378/CHEST.12-1411

BACKGROUND: The present study (1) characterizes a physiologic phenotype of restrictive dysfunction due to airway injury and (2) compares this phenotype to the phenotype of interstitial lung disease (ILD).

METHODS: This is a retrospective study of 54 persistently symptomatic subjects following World Trade Center (WTC) dust exposure. Inclusion criteria were reduced vital capacity (VC), FEV1/VC>77%, and normal chest roentgenogram. Measurements included spirometry, plethysmography, diffusing capacity of lung for carbon monoxide (Dlco), impulse oscillometry (IOS), inspiratory/expiratory CT scan, and lung compliance (n=16).

RESULTS: VC was reduced (46% to 83% predicted) because of the reduction of expiratory reserve volume (43%+/-26% predicted) with preservation of inspiratory capacity (IC) (85%+/-16% predicted). Total lung capacity (TLC) was reduced, confirming restriction (73%+/-8% predicted); however, elevated residual volume to TLC ratio (0.35+/-0.08) suggested air trapping (AT). Dlco was reduced (78%+/-15% predicted) with elevated Dlco/alveolar volume (5.3+/-0.8 [mL/mm Hg/min]/L). IOS demonstrated abnormalities in resistance and/or reactance in 50 of 54 subjects. CT scan demonstrated bronchial wall thickening and/or AT in 40 of 54 subjects; parenchymal disease was not evident in any subject. Specific compliance at functional residual capacity (FRC) (0.07+/-0.02 [L/cm H2O]/L) and recoil pressure (Pel) at TLC (27+/-7 cm H2O) were normal. In contrast to patients with ILD, lung expansion was not limited, since IC, Pel, and inspiratory muscle pressure were normal. Reduced TLC was attributable to reduced FRC, compatible with airway closure in the tidal range.

CONCLUSIONS: This study describes a distinct physiologic phenotype of restriction due to airway dysfunction. This pattern was observed following WTC dust exposure, has been reported in other clinical settings (eg, asthma), and should be incorporated into the definition of restrictive dysfunction.

Kazeros A, Maa MT, Patrawalla P, et al. 2013. Elevated peripheral eosinophils are associated with new-onset and persistent wheeze and airflow obstruction in World Trade Center-exposed individuals. J Asthma. 50 (1):25–32.

HTTPS://DOI.ORG/10.3109/02770903.2012.743149

BACKGROUND: Exposure to World Trade Center (WTC) dust and fumes is associated with the onset of asthma-like respiratory symptoms in rescue and recovery workers and exposed community members. Eosinophilic inflammation with increased lung and peripheral eosinophils has been described in subpopulations with asthma. We hypothesized that persistent asthma-like symptoms in WTC-exposed individuals would be associated with systemic inflammation characterized by peripheral eosinophils.

METHODS: The WTC Environmental Health Center (WTC EHC) is a treatment program for local residents, local workers, and cleanup workers with presumed WTC-related symptoms. Patients undergo a standardized evaluation including questionnaires and complete blood count. Between September 2005 and March 2009, 2462 individuals enrolled in the program and were available for analysis. Individuals with preexisting respiratory symptoms or lung disease diagnoses prior to September 2001 and current or significant tobacco use were excluded.

RESULTS: One thousand five hundred and seventeen individuals met the inclusion criteria. Patients had a mean age of 47 years, were mostly female (51%), and had a diverse race/ethnicity. Respiratory symptoms that developed after WTC dust/fume exposure and remained persistent included dyspnea on exertion (68%), cough (57%), chest tightness (47%), and wheeze (33%). A larger percentage of patients with wheeze had elevated peripheral eosinophils compared with those without wheeze (21% vs. 13%, $p < .0001$). Individuals with elevated peripheral eosinophils were more likely to have airflow obstruction on spirometry (16% vs. 7%, $p = .0003$).

CONCLUSION: Peripheral eosinophils were associated with wheeze and airflow obstruction in a diverse WTC-exposed population. These data suggest that eosinophils may participate in lung inflammation in this population with symptoms consistent with WTC-related asthma.

Ruggero CJ, Kotov R, Callahan JL, et al. 2013. PTSD symptom dimensions and their relationship to functioning in World Trade Center responders. Psychiatry Res. 210 (3):1049–1055.

HTTPS://DOI.ORG/10.1016/J.PSYCHRES.2013.08.052

BACKGROUND: Post-traumatic stress disorder (PTSD) symptoms are common among responders to the 9/11 attacks on the World Trade Center and can lead to impairment, yet it is unclear which symptom dimensions are responsible for poorer functioning. Moreover, how best to classify PTSD symptoms remains a topic of controversy. The present study tested competing models of PTSD dimensions and then assessed which were most strongly associated with social/occupational impairment, depression, and alcohol abuse. World Trade Center responders (n=954) enrolled in the Long Island site of the World Trade Center Health Program between 2005 and 2006 were administered standard self-report measures. Confirmatory factor analysis confirmed the superiority of four-factor models of PTSD over the DSM-IV three-factor model. In selecting between four-factor models, evidence was mixed, but some support emerged for a broad dysphoria dimension mapping closely onto depression and contributing strongly to functional impairment. This study confirmed in a new population the need to revise PTSD symptom classification to reflect four dimensions, but raises questions about how symptoms are categorized. Results suggest that targeted treatment of symptoms may provide the most benefit, and that treatment of dysphoria-related symptoms in disaster relief workers may have the most benefit for social and occupational functioning.

Solan S, Wallenstein S, Shapiro M, et al. 2013. Cancer incidence in World Trade Center rescue and recovery workers, 2001–2008. Environ Health Perspect. 121 (6):699–704.

HTTPS://DOI.ORG/10.1289/EHP.1205894

BACKGROUND: World Trade Center (WTC) rescue and recovery workers were exposed to a complex mix of pollutants and carcinogens. OBJECTIVE: The purpose of this investigation was to evaluate cancer

incidence in responders during the first 7 years after 11 September 2001.

METHODS: Cancers among 20,984 consented participants in the WTC Health Program were identified through linkage to state tumor registries in New York, New Jersey, Connecticut, and Pennsylvania. Standardized incidence ratios (SIRs) were calculated to compare cancers diagnosed in responders to predicted numbers for the general population. Multivariate regression models were used to estimate associations with degree of exposure.

RESULTS: A total of 575 cancers were diagnosed in 552 individuals. Increases above registry-based expectations were noted for all cancer sites combined (SIR = 1.15; 95% CI: 1.06, 1.25), thyroid cancer (SIR = 2.39; 95% CI: 1.70, 3.27), prostate cancer (SIR = 1.21; 95% CI: 1.01, 1.44), combined hematopoietic and lymphoid cancers (SIR = 1.36; 95% CI: 1.07, 1.71), and soft tissue cancers (SIR = 2.26; 95% CI: 1.13, 4.05). When restricted to 302 cancers diagnosed >/= 6 months after enrollment, the SIR for all cancers decreased to 1.06 (95% CI: 0.94, 1.18), but thyroid and prostate cancer diagnoses remained greater than expected. All cancers combined were increased in very highly exposed responders and among those exposed to significant amounts of dust, compared with responders who reported lower levels of exposure.

CONCLUSION: Estimates should be interpreted with caution given the short follow-up and long latency period for most cancers, the intensive medical surveillance of this cohort, and the small numbers of cancers at specific sites. However, our findings highlight the need for continued follow-up and surveillance of WTC responders.

Year Published 2014 (5)

Glaser MS, Webber MP, Zeig-Owens R, et al. 2014. Estimating the time interval between exposure to the World Trade Center disaster and incident diagnoses of obstructive airway disease. Am J Epidemiol. 180 (3):272–279.

HTTPS://DOI.ORG/10.1093/AJE/KWU137

BACKGROUND: Respiratory disorders are associated with occupational and environmental exposures. The latency period between exposure and disease onset remains uncertain. The World Trade Center (WTC) disaster presents a unique opportunity to describe the latency period for obstructive airway disease (OAD) diagnoses. This prospective cohort study of New York City firefighters compared the timing and incidence of physician-diagnosed OAD relative to WTC exposure. Exposure was categorized by WTC arrival time as high (on the morning of September 11, 2001), moderate (after noon on September 11, 2001, or on September 12, 2001), or low (during September 13-24, 2001). We modeled relative rates and 95% confidence intervals of OAD incidence by exposure over the first 5 years after September 11, 2001, estimating the times

of change in the relative rate with change point models. We observed a change point at 15 months after September 11, 2001. Before 15 months, the relative rate for the high- versus low-exposure group was 3.96 (95% confidence interval: 2.51, 6.26) and thereafter, it was 1.76 (95% confidence interval: 1.26, 2.46). Incident OAD was associated with WTC exposure for at least 5 years after September 11, 2001. There were higher rates of new-onset OAD among the high-exposure group during the first 15 months and, to a lesser extent, throughout follow-up. This difference in relative rate by exposure occurred despite full and free access to health care for all WTC-exposed firefighters, demonstrating the persistence of WTC-associated OAD risk.

Litcher-Kelly L, Lam Y, Broihier JA, et al. 2014. Longitudinal study of the impact of psychological distress symptoms on new-onset upper gastrointestinal symptoms in World Trade Center responders. Psychosom Med. 76 (9):686–693.

HTTPS://DOI.ORG/10.1097/PSY.0000000000000116

OBJECTIVES: Research on the health of workers involved in the cleanup after the attack on the World Trade Center (WTC) on September 11, 2001, has documented high rates of psychological distress and upper gastrointestinal (GI) symptoms. The current article examines the concurrent and longitudinal associations of psychological distress with development of new-onset upper GI symptoms in a large sample of WTC responders.

METHODS: A cohort of 10,953 WTC responders monitored by the WTC Health Program participated in the study. Two occupational groups were examined, police and nontraditional responders. The cohort was free of upper GI symptoms or diagnoses at their first visit (3 years after September 11, 2001). Logistic regression was used to analyze the relationships between concurrent and preceding psychological distress symptoms of depression, generalized anxiety, panic, and probable posttraumatic stress disorder with the development of new-onset upper GI symptoms at 3-year follow-up (6 years after September 11, 2001).

RESULTS: Across both occupation groups, psychological distress symptoms at Visit 1 were significantly related to the development of GI symptoms by Visit 2 (odd ratios ranging from 1.9 to 5.4). The results for the concurrent relationships were similar. In addition, there were significant dose-response relationships between the number of co-occurring psychological distress symptoms at Visits 1 and 2, and increased new-onset upper GI symptoms at Visit 2.

CONCLUSIONS: In this large sample of WTC responders, psychological distress symptoms assessed at 3 years after 9/11 are related to reporting upper GI symptoms 6 years after 9/11.

Liu B, Tarigan LH, Bromet EJ, et al. 2014. World Trade Center disaster exposure-related probable posttraumatic stress disorder among responders and civilians: A meta-analysis. PLoS One. 9 (7):e101491.

HTTPS://DOI.ORG/10.1371/JOURNAL.PONE.0101491

The World Trade Center (WTC) disaster on September 11, 2001 was an unprecedented traumatic event with long-lasting health consequences among the affected populations in the New York metropolitan area. This meta-analysis aimed to

estimate the risk of probable posttraumatic stress disorder (PTSD) associated with specific types of WTC exposures. Meta-analytical findings from 10 studies of 3,271 to 20,294 participants yielded 37 relevant associations. The pooled summary odds ratio (OR) was 2.05 (95% confidence interval (CI): 1.82, 2.32), with substantial heterogeneity linked to exposure classification, cohort type, data source, PTSD assessment instrument/criteria, and lapse time since 9/11. In general, responders (e.g. police, firefighters, rescue/recovery workers and volunteers) had a lower probable PTSD risk (OR = 1.61; 95% CI: 1.39, 1.87) compared to civilians (e.g. residents, office workers, and passersby; OR = 2.71, 95% CI: 2.35, 3.12). The differences in ORs between responders and civilians were larger for physical compared to psychosocial exposure types. We also found that injury, lost someone, and witnessed horror were the three (out of six) most pernicious exposures. These findings suggest that these three exposures should be a particular focus in psychological evaluation and treatment programs in WTC intervention and future emergency preparedness efforts.

Pietrzak RH, Feder A, Schechter CB, et al. 2014. Dimensional structure and course of post-traumatic stress symptomatology in World Trade Center responders. Psychol Med. 44 (10):2085–2098.

HTTPS://DOI.ORG/10.1017/S0033291713002924

BACKGROUND: Post-traumatic stress disorder (PTSD) in response to the World Trade Center (WTC) disaster of 11 September 2001 (9/11) is one of the most prevalent and persistent health conditions among both professional (e.g. police) and non-traditional (e.g. construction worker) WTC responders, even several years after 9/11. However, little is known about the dimensionality and natural course of WTC-related PTSD symptomatology in these populations.

METHOD: Data were analysed from 10 835 WTC responders, including 4035 police and 6800 non-traditional responders who were evaluated as part of the WTC Health Program, a clinic network in the New York area established by the National Institute for Occupational Safety and Health. Confirmatory factor analyses (CFAs) were used to evaluate structural models of PTSD symptom dimensionality; and autoregressive cross-lagged (ARCL) panel regressions were used to examine the prospective interrelationships among PTSD symptom clusters at 3, 6 and 8 years after 9/11.

RESULTS: CFAs suggested that five stable symptom clusters best represent PTSD symptom dimensionality in both police and non-traditional WTC responders. This five-factor model was also invariant over time with respect to factor loadings and structural parameters, thereby demonstrating its longitudinal stability. ARCL panel regression analyses revealed that hyperarousal symptoms had a prominent role in predicting other symptom clusters of PTSD, with anxious arousal symptoms primarily driving re-experiencing symptoms, and dysphoric arousal symptoms primarily driving emotional numbing symptoms over time.

CONCLUSIONS: Results of this study suggest that disaster-related PTSD symptomatology in WTC responders is best

represented by five symptom dimensions. Anxious arousal symptoms, which are characterized by hypervigilance and exaggerated startle, may primarily drive re-experiencing symptoms, while dysphoric arousal symptoms, which are characterized by sleep disturbance, irritability/anger and concentration difficulties, may primarily drive emotional numbing symptoms over time. These results underscore the importance of assessment, monitoring and early intervention of hyperarousal symptoms in WTC and other disaster responders.

Pietrzak RH, Feder A, Singh R, et al. 2014. Trajectories of PTSD risk and resilience in World Trade Center responders: An 8-year prospective cohort study. Psychol Med. 44 (1):205–219.

HTTPS://DOI.ORG/10.1017/S0033291713000597

BACKGROUND: Longitudinal symptoms of post-traumatic stress disorder (PTSD) are often characterized by heterogeneous trajectories, which may have unique pre-, peri- and post-trauma risk and protective factors. To date, however, no study has evaluated the nature and determinants of predominant trajectories of PTSD symptoms in World Trade Center (WTC) responders.

METHOD: A total of 10835 WTC responders, including 4035 professional police responders and 6800 non-traditional responders (e.g. construction workers) who participated in the WTC Health Program (WTC-HP), were evaluated an average of 3, 6 and 8 years after the WTC attacks.

RESULTS: Among police responders, longitudinal PTSD symptoms were best characterized by four classes, with the majority (77.8%) in a resistant/resilient trajectory and the remainder exhibiting chronic (5.3%), recovering (8.4%) or delayed-onset (8.5%) symptom trajectories. Among non-traditional responders, a six-class solution was optimal, with fewer responders in a resistant/resilient trajectory (58.0%) and the remainder exhibiting recovering (12.3%), severe chronic (9.5%), subsyndromal increasing (7.3%), delayed-onset (6.7%) and moderate chronic (6.2%) trajectories. Prior psychiatric history, Hispanic ethnicity, severity of WTC exposure and WTC-related medical conditions were most strongly associated with symptomatic trajectories of PTSD symptoms in both groups of responders, whereas greater education and family and work support while working at the WTC site were protective against several of these trajectories.

CONCLUSIONS: Trajectories of PTSD symptoms in WTC responders are heterogeneous and associated uniquely with pre-, peri- and post-trauma risk and protective factors. Police responders were more likely than non-traditional responders to exhibit a resistant/resilient trajectory. These results underscore the importance of prevention, screening and treatment efforts that target high-risk disaster responders, particularly those with prior psychiatric history, high levels of trauma exposure and work-related medical morbidities.

Year Published 2015 (10)

Ayappa I, Sunderram J, Black K, et al. 2015. A comparison of cpap and cpapflex in the treatment of obstructive sleep apnea in World Trade Center responders: Study protocol for a randomized controlled trial. Trials. 16 (1):403.

HTTPS://DOI.ORG/10.1186/S13063-015-0907-7

BACKGROUND: Following the World Trade Center disaster, a large number of individuals involved in rescue and recovery activity were exposed to significant amounts of dust, and reported symptoms of chronic nasal and sinus inflammation. An unusually high prevalence of obstructive sleep apnea (OSA) has also been observed in this World Trade Center Responder population. This aims to examine the relationship between nasal pathology and OSA. Our hypothesis is that increased nasal resistance due to nasal inflammation predisposes to OSA in this population. Continuous Positive Airway Pressure (CPAP) is the standard therapy for OSA but despite its efficacy has poor adherence. Subjects with high nasal resistance may have greater difficulty in tolerating this therapy than those who do not have high nasal resistance. Reduction of excess expiratory positive pressure by the modality known as Cflex() during Continuous Positive Airway Pressure therapy (CPAP(Flex)) has been suggested to improve comfort without compromising efficacy. We will compare CPAP to CPAP(Flex) in subjects with OSA.

STUDY DESIGN: Subjects with new onset habitual snoring will be screened for OSA using home sleep studies and rhinomanometry will be used to determine nasal resistance. In 400 subjects with OSA we will perform a randomized double blind cross-over study comparing CPAP to CPAP(flex), and relate nasal resistance to adherence to CPAP therapy.

DISCUSSION: This is the first multicenter trial designed to test the hypothesis that adherence to CPAP therapy relates to nasal resistance and CPAP(Flex) will improve adherence to CPAP in those subjects with high nasal resistance. We anticipate the following results from this trial: 1. Increased nasal resistance is associated with decreased adherence to CPAP therapy. 2. Use of CPAP(Flex) improves adherence with CPAP therapy in subjects with high nasal resistance, but not in those with low nasal resistance. 3. The benefit of CPAP(Flex) on adherence is greatest when offered at CPAP therapy initiation rather than as a "rescue" therapy in subjects with high nasal resistance.

TRIAL REGISTRATION: *CLINICALTRIALS.GOV* Identifier: NCT01753999, Date: 12 December 2012.

Berger KI, Turetz M, Liu M, et al. 2015. Oscillometry complements spirometry in evaluation of subjects following toxic inhalation. ERJ Open Res. 1 (2)

HTTPS://DOI.ORG/10.1183/23120541.00043-2015

BACKGROUND: The World Trade Center (WTC) destruction released dust and fumes into the environment. Although many community members developed respiratory symptoms, screening spi-

rometry was usually normal. We hypothesised that forced oscillation testing would identify functional abnormalities undetected by spirometry and that symptom severity would relate to magnitude of abnormalities measured by oscillometry. A symptomatic cohort (n=848) from the Bellevue Hospital WTC Environmental Health Center was evaluated and compared to an asymptomatic cohort (n=475) from the New York City Department of Health WTC Health Registry. Spirometry and oscillometry were performed. Oscillometry measurements included resistance (R5) and frequency dependence of resistance (R5-20). Spirometry was normal for the majority of subjects (73.2% symptomatic versus 87.6% asymptomatic, p<0.0001). In subjects with normal spirometry, R5 and R5-20 were higher in symptomatic versus asymptomatic subjects (median (interquartile range) R5 0.436 (0.206) versus 0.314 (0.129) kPa.L-1.s-1, p<0.001; R5-20 0.075 (0.085) versus 0.004 (0.042) kPa.L-1.s-1, p<0.0001). In symptomatic subjects, R5 and R5-20 increased with increasing severity and frequency of wheeze (p<0.05). Measurement of R5-20 correlated with the presence and severity of symptoms even when spirometry was within normal limits. These findings are in accord with small airway abnormalities as a potential explanation of the respiratory symptoms.Farris SG, Paulus DJ, Gonzalez A, et al. 2015. Anxiety sensitivity mediates the association between post-traumatic stress symptom severity and interoceptive threat-related smoking abstinence expectancies among World Trade Center disaster-exposed smokers. Addict Behav. 51:204–210.

HTTPS://DOI.ORG/10.1016/J.ADDBEH.2015.07.031

INTRODUCTION: Anxiety sensitivity (fear of internal anxiety-relevant bodily sensations) is an individual difference variable that is associated with the development and maintenance of posttraumatic stress disorder (PTSD) and is also involved in the maintenance/relapse of smoking. Abstinence expectancies are crucial to smoking maintenance, yet, past work has not explored how PTSD symptom severity and anxiety sensitivity contribute to them.

METHOD: Participants were 122 treatment-seeking daily smokers (36.1% female; Mage=49.2, SD=9.7; cigarettes per day: M=18.3, SD=15.2) who were exposed to the World Trade Center disaster on September 11, 2001 and responded to an advertisement for a clinical smoking cessation trial. The indirect effect of anxiety sensitivity was tested in terms of the effect of PTSD symptom severity on smoking abstinence expectancies (i.e., anxiety sensitivity as a statistical mediator).

RESULTS: PTSD symptom severity was positively associated with interoceptive threat-related smoking abstinence expectancies: expecting harmful consequences (beta=.33, p<.001) and somatic symptoms (beta=.26, p=.007). PTSD symptom severity was also significantly associated with anxiety sensitivity (beta=.27, p=.003). Anxiety sensitivity mediated the association between PTSD symptom severity and expectancies about the harmful consequences (beta=.09, CI95%=.02-.21; DeltaR(2)=.076) and somatic symptoms (beta=.11, CI95%=.02-.24; DeltaR(2)=.123) from smoking abstinence, with medium effect sizes (Kappa(2)=.08 and .10, respectively).

CONCLUSIONS: These data document the role of PTSD symptoms in threat-based expectancies about smoking abstinence and suggest anxiety sensitivity may underlie the associations between PTSD symptom severity and abstinence expectancies.

Kazeros A, Zhang E, Cheng X, et al. 2015. Systemic inflammation associated with World Trade Center dust exposures and airway abnormalities in the local community. J Occup Environ Med. 57 (6):610–616.

HTTPS://DOI.ORG/10.1097/JOM.0000000000000458

BACKGROUND: Destruction of the World Trade Center (WTC) towers on September 11, 2001, released massive dust, gas, and fumes with environmental exposures for community members. Many community members have lower respiratory symptoms (LRSs) that began after September 11, 2001, and remain persistent. We evaluated whether systemic inflammation measured by C-reactive protein was associated with WTC dust exposures, persistent LRS, and lung function.

METHODS: Community members self-referred for the treatment of symptoms related to September 11, 2001. C-reactive protein and lung function measurements, including spirometry and forced oscillation tests (impulse oscillometry system), were included as routine analyses in patients (2007 to 2012).

RESULTS: Increased C-reactive protein levels were associated with the type of WTC dust exposure, LRS, reduced spirometry, and increased forced oscillation measurements (n = 724).

CONCLUSIONS: Ongoing systemic inflammation measured years after the event was associated with WTC dust exposures, persistent LRS, and abnormal lung function in a community cohort. These findings have implications for treatment and surveillance.

Kotov R, Bromet EJ, Schechter C, et al. 2015. Posttraumatic stress disorder and the risk of respiratory problems in World Trade Center responders: Longitudinal test of a pathway. Psychosom Med. 77 (4):438–448.

HTTPS://DOI.ORG/10.1097/PSY.0000000000000179

OBJECTIVE: Posttraumatic stress disorder (PTSD) is associated with high medical morbidity, but the nature of this association remains unclear. Among responders to the World Trade Center (WTC) disaster, PTSD is highly comorbid with lower respiratory symptoms (LRS), which cannot be explained by exposure alone. We sought to examine this association longitudinally to establish the direction of the effects and evaluate potential pathways to comorbidity.

METHODS: 18,896 responders (8466 police and 10,430 nontraditional responders) participating in the WTC-Health Program were first evaluated between 2002 and 2010 and assessed again 2.5 years later. LRS were ascertained by medical staff, abnormal pulmonary function by spirometry, and probable WTC-related PTSD with a symptom inventory.

RESULTS: In both groups of responders, initial PTSD (standardized regression coefficient: beta = 0.20 and 0.23) and abnor-

mal pulmonary function (beta = 0.12 and 0.12) predicted LRS 2.5 years later after controlling for initial LRS and covariates. At follow-up, LRS onset was 2.0 times more likely and remission 1.8 times less likely in responders with initial PTSD than in responders without. Moreover, PTSD mediated, in part, the association between WTC exposures and development of LRS ($p < .0001$). Initial LRS and abnormal pulmonary function did not consistently predict PTSD onset.

CONCLUSIONS: These analyses provide further evidence that PTSD is a risk factor for respiratory symptoms and are consistent with evidence implicating physiological dysregulation associated with PTSD in the development of medical conditions. If these effects are verified experimentally, treatment of PTSD may prove helpful in managing physical and mental health of disaster responders.

Loupasakis K, Berman J, Jaber N, et al. 2015. Refractory sarcoid arthritis in World Trade Center-exposed New York City firefighters: A case series. J Clin Rheumatol. 21 (1):19–23.

HTTPS://DOI.ORG/10.1097/RHU.0000000000000185

OBJECTIVE: The objective of this study was to describe cases of sarcoid arthritis in firefighters from the Fire Department of the City of New York (FDNY) who worked at the World Trade Center (WTC) site.

METHODS: All WTC-exposed FDNY firefighters with sarcoidosis and related chronic inflammatory arthritis (n = 11) are followed jointly by the FDNY-WTC Health Program and the Rheumatology Division at the Hospital for Special Surgery. Diagnoses of sarcoidosis were based on clinical, radiographic, and pathological criteria. Patient characteristics, WTC exposure information, smoking status, date of diagnosis, and pulmonary findings were obtained from FDNY-WTC database. Joint manifestations (symptoms and duration, distribution of joints involved), radiographic findings, and treatment responses were obtained from chart review.

RESULTS: Nine of 60 FDNY firefighters who developed sarcoidosis since 9/11/2001 presented with polyarticular arthritis. Two others diagnosed pre-9/11/2001 developed sarcoid arthritis after WTC exposure. All 11 were never cigarette smokers, and all performed rescue/recovery at the WTC site within 3 days of the attacks. All had biopsy-proven pulmonary sarcoidosis, and all required additional disease-modifying antirheumatic drugs for adequate control (stepwise progression from hydroxychloroquine to methotrexate to anti-tumor necrosis factor alpha agents) of their joint manifestations.

CONCLUSIONS: Chronic inflammatory polyarthritis appears to be an important manifestation of sarcoidosis in FDNY firefighters with sarcoidosis and WTC exposure. Their arthritis is chronic and, unlike arthritis in non-WTC-exposed sarcoid patients, inadequately responsive to conventional oral disease-modifying antirheumatic drugs, often requiring anti-tumor necrosis factor alpha agents. Further studies are needed to determine the generalizability of these findings to other groups with varying levels of WTC exposure or with other occupational/environmental exposures.

Webber MP, Moir W, Zeig-Owens R, et al. 2015. Nested case-control study of selected systemic autoimmune diseases in World Trade Center rescue/recovery workers. Arthritis Rheumatol. 67 (5):1369–1376.

HTTPS://DOI.ORG/10.1002/ART.39059

OBJECTIVE: To test the a priori hypothesis that acute and chronic work exposures to the World Trade Center (WTC) site on or after September 11, 2001 were associated with risk of new-onset systemic autoimmune diseases.

METHODS: A nested case-control study was performed in WTC rescue/recovery workers who had received a rheumatologist-confirmed systemic autoimmune disease diagnosis between September 12, 2001 and September 11, 2013 (n = 59), each of whom was individually matched to 4 randomly selected controls (n = 236) on the basis of year of hire (+/-1 year), sex, race, and work assignment (firefighter or emergency medical service). Acute exposure was defined according to the earliest time of arrival (morning of 9/11 versus later) at the WTC site, and chronic exposure was defined as duration (number of months) of WTC site-related work. Rheumatologists were blinded with regard to each subject's exposure status. The conditional odds ratios (CORs) with 95% confidence intervals (95% CIs) for incident autoimmune disease were derived from exact conditional logistic regression models.

RESULTS: Rheumatoid arthritis was the most common autoimmune diagnosis (37% of subjects), followed by spondyloarthritis (22%), inflammatory myositis (14%), systemic lupus erythematosus (12%), systemic sclerosis (5%), Sjogren's syndrome (5%), antiphospholipid syndrome (3%), and granulomatosis with polyangiitis (Wegener's) (2%). The COR for incident autoimmune disease increased by 13% (COR 1.13, 95% CI 1.02-1.26) for each additional month worked at the WTC site. These odds were independent of the association between high acute exposure (working during the morning of 9/11) and disease outcome, which conveyed an elevated, but not statistically significant, risk (COR 1.85, 95% CI 0.86-3.89).

CONCLUSION: Prolonged work at the WTC site, independent of acute exposure, was an important predictor of post-9/11 systemic autoimmune diseases. The WTC Health Program should expand surveillance efforts for those with extended exposures, as early detection can facilitate early treatment, which has been shown to minimize organ damage and improve quality of life.

Zvolensky MJ, Farris SG, Kotov R, et al. 2015. Posttraumatic stress symptoms and smoking among World Trade Center disaster responders: A longitudinal investigation. Comprehensive Psychiatry. 63:46–54.

HTTPS://DOI.ORG/10.1016/J.COMPPSYCH.2015.08.006

PURPOSE: The current longitudinal study examined posttraumatic stress disorder (PTSD) symptom severity in relation to smoking abstinence and reduction over time among responders to the World Trade Center (WTC) disaster. Method: Participants were 763 police and 1881 non-traditional (e.g., construction work-

ers) WTC responders who reported being smokers at an initial examination obtained between July 2002 and July 2011 at the WTC Health Program (WTC-HP). WTC responders were reassessed, on average, 2.5years later.

RESULTS: For police WTC responders, higher levels of WTC-related PTSD symptoms at the initial visit were associated with a decreased likelihood of smoking abstinence (OR = 0.98, p = .002) and with decreased smoking reduction (beta = -.06, p = .012) at the follow-up visit. WTC-related PTSD symptom severity was not related to likelihood of smoking abstinence or change in number of cigarettes smoked among non-traditional responders. Post hoc analyses suggested that for police, hyperarousal PTSD symptoms were predictive of decreased abstinence likelihood at the follow-up visit (OR = 0.56, p = .006).

DISCUSSION: The present findings suggest that PTSD symptoms may be differentially related to smoking behavior among police and non-traditional WTC responders in a naturalistic, longitudinal investigation. Future work may benefit from exploring further which aspects of PTSD (as compared to each other and to common variance) explain smoking maintenance.

Zvolensky MJ, Farris SG, Kotov R, et al. 2015. World Trade Center disaster and sensitization to subsequent life stress: A longitudinal study of disaster responders. Prev Med. 75:70–74.

HTTPS://DOI.ORG/10.1016/J.YPMED.2015.03.017

PURPOSE: The current study examined the role of World Trade Center (WTC) disaster exposure (hours spent working on the site, dust cloud exposure, and losing friend/loved one) in exacerbating the effects of post-disaster life stress on posttraumatic stress disorder (PTSD) symptoms and overall functioning among WTC responders.

METHOD: Participants were 18,896 responders (8466 police officers and 10,430 non-traditional responders) participating in the WTC Health Program who completed an initial examination between July, 2002 and April, 2010 and were reassessed an average of two years later.

RESULTS: Among police responders, there was a significant interaction, such that the effect of post-disaster life stress on later PTSD symptoms and overall functioning was stronger among police responders who had greater WTC disaster exposure (beta's=.029 and .054, respectively, for PTSD symptoms and overall functioning). This moderating effect was absent in non-traditional responders. Across both groups, post-disaster life stress also consistently was related to the dependent variables in a more robust manner than WTC exposure.

DISCUSSION: The present findings suggest that WTC exposure may compound post-disaster life stress, thereby resulting in a more chronic course of PTSD symptoms and reduced functioning among police responders.

Zvolensky MJ, Kotov R, Schechter CB, et al. 2015. Post-disaster stressful life events and WTC-related posttraumatic stress, depressive symptoms, and overall

functioning among responders to the World Trade Center disaster. J Psychiatr Res. 61:97–105.

HTTPS://DOI.ORG/10.1016/J.JPSYCHIRES.2014.11.010

BACKGROUND: The current study examined contributions of post-disaster stressful life events in relation to the maintenance of WTC-related posttraumatic stress, depressive symptoms, and overall functioning among rescue, recovery, and clean-up workers who responded to the September 11, 2001 World Trade Center (WTC) terrorist attacks.

METHODS: Participants were 18,896 WTC responders, including 8466 police officers and 10,430 non-traditional responders (85.8% male; 86.4% Caucasian; M(age) = 39.5, SD = 8.8) participating in the WTC Health Program who completed an initial examination between July, 2002 and April, 2010 and who were reassessed, on average, 2.5 years later.

RESULTS: Path analyses were conducted to evaluate contributions of life events to the maintenance of WTC-related posttraumatic stress, depressive symptoms, and overall functioning. These analyses were stratified by police and non-traditional responder groups and adjusted for age, sex, time from 9/11 to initial visit, WTC exposures (three WTC contextual exposures: co-worker, friend, or a relative died in the disaster; co-worker, friend, or a relative injured in the disaster; and responder was exposed to the dust cloud on 9/11), and interval from initial to first follow-up visit. In both groups, WTC-related posttraumatic stress, depressive symptoms, and overall functioning were stable over the follow-up period. WTC exposures were related to these three outcomes at the initial assessment. WTC-related posttraumatic stress, depressive symptoms, and overall functioning, at the initial assessment each predicted the occurrence of post-disaster stressful life events, as measured by Disaster Supplement of the Diagnostic Interview Schedule. Post-disaster stressful life events, in turn, were associated with subsequent mental health, indicating partial mediation of the stability of observed mental health.

CONCLUSIONS: The present findings suggest a dynamic interplay between exposure, post-disaster stressful life events, and WTC-related posttraumatic stress, depressive symptoms, and overall functioning among WTC disaster responders.

Year Published 2016 (24)

Aldrich TK, Weakley J, Dhar S, et al. 2016. Bronchial reactivity and lung function after World Trade Center exposure. Chest. 150 (6):1333–1340.

HTTPS://DOI.ORG/10.1016/J.CHEST.2016.07.005

BACKGROUND: World Trade Center (WTC)-exposed rescue/recovery workers endured massive respiratory insult from inhalation of particulate matter and gases, resulting in respiratory symptoms, loss of lung function, and, for many, bronchial hyperreactivity (BHR). The persistence of respiratory symptoms and lung function

abnormalities has been well-documented, whereas persistence of BHR has not been investigated.

METHODS: A total of 173 WTC-exposed firefighters with bronchial reactivity measured within 2 years after September 11, 2001 (9/11) (baseline methacholine challenge test), were reevaluated in 2013 and 2014 (follow-up methacholine challenge test). FEV1 measurements were obtained from the late pre-9/11, early post-9/11, and late post-9/11 periods. Respiratory symptoms and corticosteroid treatment were recorded.

RESULTS: Bronchial reactivity remained stable (within 1 doubling dilution) for most (n = 101, 58%). Sixteen of 28 (57%) with BHR (provocative concentration of methacholine producing a 20% decline in FEV1 <8 mg/mL) at baseline had BHR at follow-up, and an additional 27 of the 145 (19%) without BHR at baseline had BHR at follow-up. In multivariable models, we found that BHR baseline was strongly associated with BHR follow-up (OR, 6.46) and that BHR at follow-up was associated with an estimated 15.4 mL/y greater FEV1 decline than experienced by those without BHR at follow-up. Annual FEV1 decline was moderated by corticosteroid use.

CONCLUSIONS: Persistent BHR and its deleterious influence on lung function suggest a role for airway inflammation in perpetuation of WTC-associated airway disease. In future massive occupational exposure to inorganic dust/gases, we recommend early and serial pulmonary function testing, including measurements of bronchial reactivity, when possible, and inhaled corticosteroid therapy for those with symptoms or pulmonary function tests consistent with airway disease.Berger KI, Kalish S, Shao Y, et al. 2016. Isolated small airway reactivity during bronchoprovocation as a mechanism for respiratory symptoms in WTC dust-exposed community members. Am J Ind Med. 59 (9):767–776.

HTTPS://DOI.ORG/10.1002/AJIM.22639

INTRODUCTION: Small airway dysfunction occurs following WTC dust exposure, but its role in producing symptoms is unclear.

METHODS: Methacholine challenge (MCT) was used to assess the relationship between onset of respiratory symptoms and small airway abnormalities in 166 symptomatic WTC dust-exposed patients. Forced oscillation testing (FOT) and respiratory symptoms were assessed during MCT. FOT parameters included resistance at 5 and 20 Hz (R5 and R20) and the R5 minus R20 (R5-20).

RESULTS: Baseline spirometry was normal in all (mean FEV1 100 + 13% predicted, mean FEV1 /FVC 80 + 4%). MCT revealed bronchial hyperreactivity by spirometry in 67 patients. An additional 24 patients became symptomatic despite minimal FEV1 change (<5%); symptom onset coincided with increased R5 and R5-20 ($P > 0.001$ vs. baseline). The dose-response of FOT (reactivity) was greater compared with subjects that remained asymptomatic ($P < 0.05$).

CONCLUSIONS: FOT during MCT uncov-

ered reactivity in small airways as a mechanism for respiratory symptoms in subjects with inhalational lung injury.Boffetta P, Zeig-Owens R, Wallenstein S, et al. 2016. Cancer in World Trade Center responders: Findings from multiple cohorts and options for future study. Am J Ind Med. 59 (2):96–105.

HTTPS://DOI.ORG/10.1002/AJIM.22555

BACKGROUND: Three longitudinal studies of cancer incidence in varied populations of World Trade Center responders have been conducted.

METHODS: We compared the design and results of the three studies.

RESULTS: Separate analyses of these cohorts revealed excess cancer incidence in responders for all cancers combined and for cancers of the thyroid and prostate. Methodological dissimilarities included recruitment strategies, source of cohort members, demographic characteristics, overlap between cohorts, assessment of WTC and other occupational exposures and confounders, methods and duration of follow-up, approaches for statistical analysis, and latency analyses.

CONCLUSIONS: The presence of three cohorts strengthens the effort of identifying and quantifying the cancer risk; the heterogeneity in design might increase sensitivity to the identification of cancers potentially associated with exposure. The presence and magnitude of an increased cancer risk remains to be fully elucidated. Continued long-term follow up with minimal longitudinal dropout is crucial to achieve this goal.

Bromet EJ, Hobbs MJ, Clouston SA, et al. 2016. DSM-IV post-traumatic stress disorder among World Trade Center responders 11–13 years after the disaster of 11 September 2001 (9/11). Psychol Med. 46 (4):771–783.

HTTPS://DOI.ORG/10.1017/S0033291715002184

BACKGROUND: Post-traumatic symptomatology is one of the signature effects of the pernicious exposures endured by responders to the World Trade Center (WTC) disaster of 11 September 2001 (9/11), but the long-term extent of diagnosed Diagnostic and Statistical Manual of Mental Disorders, 4th edition (DSM-IV) post-traumatic stress disorder (PTSD) and its impact on quality of life are unknown. This study examines the extent of DSM-IV PTSD 11-13 years after the disaster in WTC responders, its symptom profiles and trajectories, and associations of active, remitted and partial PTSD with exposures, physical health and psychosocial well-being.

METHOD: Master's-level psychologists administered sections of the Structured Clinical Interview for DSM-IV and the Range of Impaired Functioning Tool to 3231 responders monitored at the Stony Brook University World Trade Center Health Program. The PTSD Checklist (PCL) and current medical symptoms were obtained at each visit.

RESULTS: In all, 9.7% had current, 7.9% remitted, and 5.9% partial WTC-PTSD. Among those with active PTSD, avoidance and hyperarousal symptoms were most commonly, and flashbacks least commonly, reported. Trajectories of symptom severity across monitoring

visits showed a modestly increasing slope for active and decelerating slope for remitted PTSD. WTC exposures, especially death and human remains, were strongly associated with PTSD. After adjusting for exposure and critical risk factors, including hazardous drinking and co-morbid depression, PTSD was strongly associated with health and well-being, especially dissatisfaction with life.

CONCLUSIONS: This is the first study to demonstrate the extent and correlates of long-term DSM-IV PTSD among responders. Although most proved resilient, there remains a sizable subgroup in need of continued treatment in the second decade after 9/11.

Caplan-Shaw C, Kazeros A, Pradhan D, et al. 2016. Improvement in severe lower respiratory symptoms and small airway function in World Trade Center dust exposed community members. Am J Ind Med. 59 (9):777–787.

HTTPS://DOI.ORG/10.1002/AJIM.22642

OBJECTIVE: Longitudinal assessment of lower respiratory symptoms (LRS) in community members with World Trade Center (WTC) exposures.

METHODS: Adult members of a treatment program with complete standardized visits were evaluated (n = 798). Association of demographic characteristics, mental health symptoms and lung function with trajectory of LRS between initial and monitoring visit was evaluated.

RESULTS: Severe LRS were present in 70% at initial and 63% at monitoring visit. Initial severe LRS were associated with WTC dust cloud exposure and mental health symptoms. Spirometry measures were not associated with LRS severity or trajectory; improvement in LRS was associated with improved lung function measured with forced oscillometry techniques.

CONCLUSION: Many community patients in a WTC treatment program had severe LRS associated with exposures and mental health symptoms. Improvement in LRS was associated with improvement in measures of small airway function.

Clouston SA, Kotov R, Pietrzak RH, et al. 2016. Cognitive impairment among World Trade Center responders: Long-term implications of re-experiencing the 9/11 terrorist attacks. Alzheimers Dement (Amst). 4 (1):67–75.

HTTPS://DOI.ORG/10.1016/J.DADM.2016.08.001

INTRODUCTION: During the World Trade Center (WTC) attacks, responders who helped in search, rescue, and recovery endured multiple traumatic and toxic exposures. One-fifth subsequently developed post-traumatic stress disorder (PTSD). PTSD has been linked to dementia in veterans. This study examined the association between WTC-related PTSD and cognitive impairment (CI) in WTC responders.

METHODS: A one-third sample of responders (N = 818) reporting for annual monitoring visits were screened for cognitive impairment and dementia using the Montreal Cognitive Assessment from January 2014-April 2015. Concurrent diagnoses of PTSD and major depressive disorder (MDD), as well as serial PTSD

and depressive symptom inventories, collected since 2002, were examined in relation to current CI.

RESULTS: Approximately 12.8% and 1.2% of responders in this sample respectively had scores indicative of CI and possible dementia. Current PTSD and MDD were associated with CI. Longitudinal results revealed that re-experiencing symptoms were consistently associated with CI (aRR = 2.88, 95% confidence interval = 1.35-6.22), whereas longitudinal increases in other PTSD and depressive symptoms in the years before screening were evident only among those with CI.

CONCLUSIONS: Analyses replicated results from Veterans studies and further highlighted the importance of re-experiencing symptoms, a major component of PTSD that was consistently predictive of CI 14 years later. Clinicians should monitor CI when treating individuals with chronic PTSD.

de la Hoz RE, Jeon Y, Miller GE, et al. 2016. Post-traumatic stress disorder, bronchodilator response, and incident asthma in World Trade Center rescue and recovery workers. Am J Respir Crit Care Med. 194 (11):1383–1391.

HTTPS://DOI.ORG/10.1164/RCCM.201605-1067OC

RATIONALE: Post-traumatic stress disorder (PTSD) has been associated with asthma in cross-sectional studies. Whether PTSD leads to clinically significant bronchodilator response (BDR) or new-onset asthma is unknown.

OBJECTIVES: We sought to determine the relationship between probable PTSD and both BDR and incident asthma in a high-risk cohort of World Trade Center workers in New York (NY).

METHODS: This study was conducted on data from a high-risk cohort of 11,481 World Trade Center workers in New York, including 6,133 never smokers without a previous diagnosis of asthma. Of the 6,133 never smokers without asthma, 3,757 (61.3%) completed a follow-up visit several years later (mean = 4.95 yr, interquartile range = 3.74-5.90 yr). At the baseline visit, probable PTSD was defined as a score 44 points or greater in the PTSD Checklist questionnaire, and BDR was defined as both a change of 12% or greater and an increment of 200 ml or greater in FEV1 after bronchodilator administration. Incident asthma was defined as a self-report of new physician-diagnosed asthma after the baseline visit. Multivariable logistic regression was used for the analysis of probable PTSD and baseline BDR or incident asthma.

MEASUREMENTS MAIN AND RESULTS: At baseline, probable PTSD was associated with BDR among all participants (adjusted odds ratio = 1.43; 95% confidence interval = 1.19-1.72), with similar results among never smokers without asthma. Among 3,757 never smokers, probable PTSD at baseline was associated with incident asthma, even after adjustment for baseline BDR (odds ratio = 2.41; 95% confidence interval = 1.85-3.13). This association remained significant in a confirmatory analysis after excluding 195 subjects with baseline BDR.

CONCLUSIONS: In a cohort of adult workers exposed to a severe traumatic event,

probable PTSD is significantly associated with BDR at baseline and predicts incident asthma.

Farris SG, Paulus DJ, Gonzalez A, et al. 2016. Posttraumatic stress symptoms and body mass index among World Trade Center disaster-exposed smokers: A preliminary examination of the role of anxiety sensitivity. Psychiatry Research. 241:135–140.

HTTPS://DOI.ORG/10.1016/J.PSYCHRES.2016.04.074

Among individuals exposed to the World Trade Center (WTC) disaster on September 11, 2001, posttraumatic stress disorder (PTSD) and symptoms are both common and associated with increased cigarette smoking and body mass. However, there is little information on the specific processes underlying the relationship of PTSD symptoms with body mass. The current study is an initial exploratory test of anxiety sensitivity, the fear of internal bodily sensations, as a possible mechanism linking PTSD symptom severity and body mass index (BMI). Participants were 147 adult daily smokers (34.0% female) exposed to the WTC disaster (via rescue/recovery work or direct witness). The direct and indirect associations between PTSD symptom severity and BMI via anxiety sensitivity (total score and subscales of physical, cognitive, and social concerns) were examined. PTSD symptom severity was related to BMI indirectly via anxiety sensitivity; this effect was specific to physical concerns about the meaning of bodily sensations. Interventions focusing on anxiety sensitivity reduction (specifically addressing physical concerns about bodily sensations) may be useful in addressing elevated BMI among trauma-exposed persons.

Feder A, Mota N, Salim R, et al. 2016. Risk, coping and PTSD symptom trajectories in World Trade Center responders. J Psychiatr Res. 82:68–79.

HTTPS://DOI.ORG/10.1016/J.JPSYCHIRES.2016.07.003

Trajectories of disaster-related posttraumatic stress disorder (PTSD) symptoms are often heterogeneous, and associated with common and unique risk factors, yet little is known about potentially modifiable psychosocial characteristics associated with low-symptom and recovering trajectories in disaster responders. A total of 4487 rescue and recovery workers (1874 police and 2613 non-traditional responders) involved during and in the aftermath of the unprecedented World Trade Center (WTC) attacks, were assessed an average of 3, 6, 8, and 12 years post-9/11/2001. Among police responders, WTC-related PTSD symptoms were characterized by four trajectories, including no/low-symptom (76.1%), worsening (12.1%), improving (7.5%), and chronic (4.4%) trajectories. In non-traditional responders, a five-trajectory solution was optimal, with fewer responders in a no/low-symptom trajectory (55.5%), and the remainder in subtly worsening (19.3%), chronic (10.8%), improving (8.5%), and steeply worsening (5.9%) trajectories. Consistent factors associated with symptomatic PTSD trajectories across responder groups included Hispanic ethnicity, pre-9/11 psychiatric history, greater WTC exposure, greater medical illness burden, life stressors and post-9/11 traumas, and maladaptive coping (e.g., substance use, avoidance coping). Higher perceived preparedness, greater sense of purpose in life, and positive emotion-focused coping (e.g., positive reframing,

acceptance) were negatively associated with symptomatic trajectories. Findings in this unique cohort indicate considerable heterogeneity in WTC-related PTSD symptom trajectories over 12 years post-9/11/2001, with lower rates of elevated PTSD symptoms in police than in non-traditional responders. They further provide a comprehensive risk prediction model of PTSD symptom trajectories, which can inform prevention, monitoring, and treatment efforts in WTC and other disaster responders.

Friedberg F, Adamowicz JL, Caikauskaite I, et al. 2016. Fatigue severity in World Trade Center (9/11) responders: A preliminary study. Fatigue: Biomedicine, Health and Behavior. 4 (2):70–79.

HTTPS://DOI.ORG/10.1080/21641846.2016.1169726

PURPOSE: To assess fatigue severity in World Trade Center (9/11) responders 13 years later.

METHODS: The participant pool consisted of male 9/11 responders enrolled in the Stony Brook World Trade Center Health Program (WTC-HP), one of five centers of excellence established by the Centers for Disease Control and Prevention. Fatigue severity was assessed with the Fatigue Severity Scale. WTC-related medical conditions were certified by a physician and diagnoses of 9/11-related post-traumatic stress disorder (PTSD) and major depressive disorder (MDD) were determined with the Structured Clinical Interview for DSM-IV (SCID).

RESULTS: High fatigue severity was reported by 20.8% of the sample (N = 1079) and was significantly associated with PTSD, major depressive disorder, sleep apnea, gastro-esophageal reux disease, upper respiratory disease, and lower respiratory disease. These associations remained significant for PTSD, major depressive disorder and lower respiratory disease when adjusted for medications, age and BMI. Only 17.3% of the high fatigue subgroup did not have an identified medical or psychiatric diagnosis. Fewer fatigued (21.1%) than non-fatigued (72.0%) responders rated their physical health as 'good' or 'very good.' Also fewer fatigued (33.9%) than non-fatigued (54.1%) responders were employed full-time (p <.0001).

CONCLUSIONS: This study found clinically elevated fatigue in a high percentage of a male WTC responder cohort that prior to 9/11/2001 would be considered a 'healthy worker cohort.' To better understand the pathophysiology of fatigue, newer methodologies such as symptom provocation (e.g. exercise) designs may be useful.

Guffanti G, Geronazzo-Alman L, Fan B, et al. 2016. Homogeneity of severe posttraumatic stress disorder symptom profiles in children and adolescents across gender, age, and traumatic experiences related to 9/11. J Trauma Stress. 29 (5):430–439.

HTTPS://DOI.ORG/10.1002/JTS.22134

BACKGROUND: Patients with a posttraumatic stress disorder (PTSD) diagnosis according to the Diagnostic and Statistical Manual of Mental Disorders (4th ed., DSM-IV; American Psychiatric Association, 1994) will very likely not share all of the same symptoms, a consequence of the polythetic approach used in the DSM.

We examined heterogeneity in the latent structure of PTSD symptoms using data from a previously published sample of 8,236 youth a subset of which had been exposed to the September 11, 2001 attacks (N = 6,670; Hoven et al., 2005). Latent class analysis was applied (a) to PTSD symptoms alone, (b) to symptoms in combination with impairment indicators, and (c) to PTSD symptoms when stratified by age and gender, as well as by empirically defined classes of exposure. We identified 4 symptom classes: no disturbance (49.4%), intermediate disturbance (2 classes; 21.5% and 18.6%, respectively), and severe disturbance (10.5%). These classes varied not only in the severity of symptoms, but also in the configuration of symptoms. We observed a high probability of endorsing both PTSD symptoms and indicators of impairment only in the severe disturbance class. A similar 4-class structure was found when the data were stratified by age, gender, and exposure classes. There were no significant differences as a function of age, gender, or exposure in the presence of severe PTSD. Heterogeneity was observed at intermediate levels of PTSD symptom severity. The specific PTSD symptoms that defined the severe PTSD profile could constitute the pathogenic aspects of a largely invariant and clinically meaningful PTSD syndrome.

Hall CB, Liu X, Zeig-Owens R, et al. 2016. The duration of an exposure response gradient between incident obstructive airways disease and work at the World Trade Center site: 2001–2011. PLoS Curr. 7

HTTPS://DOI.ORG/10.1371/CURRENTS.DIS.8A93E7682624698558A76A1FA8C5893F

BACKGROUND: Adverse respiratory effects of World Trade Center (WTC) exposure have been widely documented, but the length of time that exposure remains associated with disease is uncertain. We estimate the incidence of new cases of physician-diagnosed obstructive airway disease (OAD) as a function of time since 9/11/2001 in WTC-exposed firefighters.

METHODS: Exposure was categorized by first WTC arrival time: high (9/11/2001 AM); moderate (9/11/2001 PM or 9/12/2001); or low (9/13-24/2001). We modeled relative rates (RR) and 95% confidence intervals (CI) of OAD incidence by exposure over the first 10 years post-9/11/2001, estimating the time(s) of change in the RR with change point models. We further examined the relationship between self-reported lower respiratory symptoms and physician diagnoses.

RESULTS: Change points were observed at 15 and 84 months post-9/11/2001, with relative incidence rates for the high versus low exposure group of 4.02 (95% CI 2.62-6.16) prior to 15 months, 1.90 (95% CI 1.49-2.44) from months 16 to 84, and 1.20 (95% CI 0.92-1.56) thereafter. Incidence in all exposure groups increased after the WTC health program began to offer free coverage of OAD medications in month 63. Self-reported lower respiratory symptoms in the first 15 months had 80.6% sensitivity, but only 35.9% specificity, for eventual OAD diagnoses.

CONCLUSIONS: New OAD diagnoses are associated with WTC exposure for at least seven years. Some portion of the extended duration of that association may be due to delayed diagnoses. Nevertheless,

our results support recognizing OAD among rescue workers as WTC-related even when diagnosed years after exposure.

Horn SR, Pietrzak RH, Schechter C, et al. 2016. Latent typologies of posttraumatic stress disorder in World Trade Center responders. J Psychiatr Res. 83:151–159.

HTTPS://DOI.ORG/10.1016/J.JPSYCHIRES.2016.08.018

Posttraumatic stress disorder (PTSD) is a debilitating and often chronic psychiatric disorder. Following the 9/11/2001 World Trade Center (WTC) attacks, thousands of individuals were involved in rescue, recovery and clean-up efforts. While a growing body of literature has documented the prevalence and correlates of PTSD in WTC responders, no study has evaluated predominant typologies of PTSD in this population. Participants were 4352 WTC responders with probable WTC-related DSM-IV PTSD. Latent class analyses were conducted to identify predominant typologies of PTSD symptoms and associated correlates. A 3-class solution provided the optimal representation of latent PTSD symptom typologies. The first class, labeled "High-Symptom (n = 1,973, 45.3%)," was characterized by high probabilities of all PTSD symptoms. The second class, "Dysphoric (n = 1,371, 31.5%)," exhibited relatively high probabilities of emotional numbing and dysphoric arousal (e.g., sleep disturbance). The third class, "Threat (n = 1,008, 23.2%)," was characterized by high probabilities of re-experiencing, avoidance and anxious arousal (e.g., hypervigilance). Compared to the Threat class, the Dysphoric class reported a greater number of life stressors after 9/11/2001 (OR = 1.06). The High-Symptom class was more likely than the Threat class to have a positive psychiatric history before 9/11/2001 (OR = 1.7) and reported a greater number of life stressors after 9/11/2001 (OR = 1.1). The first class, labeled "High-Symptom (n = 1,973, 45.3%)," was characterized by high probabilities of all PTSD symptoms. The second class, "Dysphoric (n = 1,371, 31.5%)," exhibited relatively high probabilities of emotional numbing and dysphoric arousal (e.g., sleep disturbance). The third class, "Threat (n = 1,008, 23.2%)," was characterized by high probabilities of re-experiencing, avoidance and anxious arousal (e.g., hypervigilance).

Jurek AM and Maldonado G. 2016. Quantitative bias analysis in an asthma study of rescue-recovery workers and volunteers from the 9/11 World Trade Center attacks. Ann Epidemiol. 26 (11):794–801.

HTTPS://DOI.ORG/10.1016/J.ANNEPIDEM.2016.09.002

PURPOSE: When learning bias analysis, epidemiologists are taught to quantitatively adjust for multiple biases by correcting study results in the reverse order of the error sequence. To understand the error sequence for a particular study, one must carefully examine the health study's epidemiologic data-generating process. In this article, we describe the unique data-generating process of a man-made disaster epidemiologic study.

METHODS: We described the data-generating process and conducted a bias analysis for a study associating September 11, 2001 dust cloud exposure and self-reported newly physician-diagnosed asthma among rescue-recovery workers and

volunteers. We adjusted an odds ratio (OR) estimate for the combined effect of missing data, outcome misclassification, and nonparticipation.

RESULTS: Under our assumptions about systematic error, the ORs adjusted for all three biases ranged from 1.33 to 3.84. Most of the adjusted estimates were greater than the observed OR of 1.77 and were outside the 95% confidence limits (1.55, 2.01).

CONCLUSIONS: Man-made disasters present some situations that are not observed in other areas of epidemiology. Future epidemiologic studies of disasters could benefit from a proactive approach that focuses on the technical aspect of data collection and gathers information on bias parameters to provide more meaningful interpretations of results.

Kwon S, Putman B, Weakley J, et al. 2016. Blood eosinophils and World Trade Center exposure predict surgery in chronic rhinosinusitis. A 13.5-year longitudinal study. Ann Am Thorac Soc. 13 (8):1253–1261.

HTTPS://DOI.ORG/10.1513/ANNALSATS.201511-742OC

RATIONALE: The World Trade Center (WTC) collapse generated caustic airborne particulates that caused chronic rhinosinusitis in exposed Fire Department of New York firefighters. Surgery was performed when symptoms remained uncontrolled despite medical management. OBJECTIVES: To identify predictors of surgical intervention for chronic rhinosinusitis in firefighters exposed to airborne irritants at the WTC collapse site.

METHODS: We assessed in 8,227 firefighters with WTC exposure between September 11, 2001 (9/11), and September 25, 2001, including WTC-site arrival time, months of rescue and recovery work, and eosinophil concentration measured between 9/11 and March 10, 2003. We assessed the association of serum cytokines and immunoglobulins with eosinophil concentration and surgery for rhinosinusitis in 112 surgical cases and 376 control subjects with serum available from the first 6 months after exposure to the WTC collapse site.

MEASUREMENTS AND MAI. RESULTS: Between 9/11 and March 10, 2015, the surgery rate was 0.47 cases per 100 person-years. In the first 18 months post-9/11, surgical patients had higher mean blood eosinophil levels than study cohort patients (219 +/- 155 vs. 191 +/- 134; $P < 0.0001$). Increased surgery risk was associated with increasing blood eosinophil counts (hazard ratio [HR], 1.12 per 100 cells/mul; 95% confidence interval [CI], 1.07-1.17; $P < 0.001$); arriving at the WTC site on 9/11 or September 12, 2001 (HR, 1.43; 95% CI, 1.04-1.99; $P = 0.03$); and working 6 months or longer at the WTC site (HR, 1.48; 95% CI, 1.14-1.93; $P < 0.01$). Median blood eosinophil levels for surgical patients were above levels for the cohort in all 18-month intervals March 11, 2000, through March 10, 2015, using 51,163 measurements representing 97,733 person-years of observation. Increasing age, increasing IL-17A, and low IgA in serum from 2001 to 2002 predicted blood eosinophil concentration in surgical patients but not in control subjects ($R(2) = 0.26$, $P < 0.0001$; vs. $R(2) = 0.008$, $P = 0.56$).

CONCLUSIONS: Increasing blood eosinophil concentration predicts surgical intervention for chronic rhinosinusitis, particularly in those with intense acute and prolonged exposure to airborne irritants. WTC-exposed Fire Department of New York firefighters who underwent irritant-associated sinus surgery are immunologically different from the cohort. Surgical patients have a higher blood eosinophil levels that is associated with mediators of mucosal immunity.

Mahaffey BL, Gonzalez A, Farris SG, et al. 2016. Smoking to regulate negative affect: Disentangling the relationship between posttraumatic stress and emotional disorder symptoms, nicotine dependence, and cessation-related problems. Nicotine Tob Res. 18 (6):1471–1478.

HTTPS://DOI.ORG/10.1093/NTR/NTV175

INTRODUCTION: Posttraumatic stress disorder (PTSD) is associated with various aspects of cigarette smoking, including higher levels of nicotine dependence and cessation difficulties. Affect-regulatory smoking motives are thought to, in part, underlie the association between emotional disorders such as PTSD and smoking maintenance, although few studies have empirically tested this possibility.

METHODS: Data were analyzed from 135 treatment-seeking smokers who were directly exposed to the World Trade Center disaster on September 11, 2001. We modeled the direct effect of 9/11 PTSD symptom severity on nicotine dependence, perceived barriers to smoking cessation, and severity of problematic symptoms experienced during prior cessation attempts. We also examined the indirect effect of PTSD on these outcomes via negative affect reduction smoking motives. Parallel models were constructed for additional emotional disorder symptoms, including panic and depressive symptoms.

RESULTS: PTSD symptom severity was associated with nicotine dependence and perceived barriers to cessation, but not problems during prior quit attempts indirectly via negative affect reduction smoking motives. Panic and depressive symptoms both had significant indirect effects, via negative affect reduction smoking motives, on all three criterion variables.

CONCLUSIONS: Affect-regulatory smoking motives appear to underlie associations between the symptoms of emotional disorders such as PTSD, panic, and depression in terms of smoking dependence and certain cessation-related criterion variables.

IMPLICATIONS: Overall, this investigation suggests negative affect reduction smoking motives help to explain the relationship of PTSD, depression, and panic symptoms to nicotine dependence, severity of problems experienced during prior quit attempts and perceived barriers to cessation. These results highlight the importance of assessing motivations for smoking in the context of cessation treatment, especially among those with emotional disorder symptoms. Future interventions might seek to utilize motivational interviewing and cognitive restructuring techniques to address

coping-oriented motives for smoking, in addition to skills for managing negative affect, as a means of improving quit outcomes.

Moir W, Zeig-Owens R, Daniels RD, et al. 2016. Post–9/11 cancer incidence in World Trade Center-exposed New York City firefighters as compared to a pooled cohort of firefighters from San Francisco, Chicago and Philadelphia (9/11/2001–2009). Am J Ind Med. 59 (9):722–730.

HTTPS://DOI.ORG/10.1002/AJIM.22635

BACKGROUND: We previously reported a modest excess of cancer in World Trade Center (WTC)-exposed firefighters versus the general population. This study aimed to separate the potential carcinogenic effects of firefighting and WTC exposure by comparing to a cohort of non-WTC-exposed firefighters.

METHODS: Relative rates (RRs) for all cancers combined and individual cancer subtypes from 9/11/2001 to 12/31/2009 were modeled using Poisson regression comparing 11,457 WTC-exposed firefighters to 8,220 urban non-WTC-exposed firefighters.

RESULTS: Compared with non-WTC-exposed firefighters, there was no difference in the RR of all cancers combined for WTC-exposed firefighters (RR = 0.96, 95%CI: 0.83-1.12). Thyroid cancer was significantly elevated (RR = 3.82, 95%CI: 1.07-20.81) from 2001 to 2009; this was attenuated (RR = 3.43, 95%CI: 0.94-18.94) and non-significant when controlling for possible surveillance bias. Prostate cancer was elevated during the latter half (2005-2009; RR = 1.38, 95%CI: 1.01-1.88).

CONCLUSIONS: Further follow-up is needed to assess the relationship between WTC exposure and cancers with longer latency periods.

Reibman J, Levy-Carrick N, Miles T, et al. 2016. Destruction of the World Trade Center towers. Lessons learned from an environmental health disaster. Ann Am Thorac Soc. 13 (5):577–583.

HTTPS://DOI.ORG/10.1513/ANNALSATS.201509-572PS

BACKGROUND: The assault and subsequent collapse of the World Trade Center towers in New York City on September 11, 2001 (9/11), released more than a million tons of debris and dust into the surrounding area, engulfing rescue workers as they rushed to aid those who worked in the towers, and the thousands of nearby civilians and children who were forced to flee. In December 2015, almost 15 years after the attack, and 5 years after first enactment, Congress reauthorized the James Zadroga 9/11 Health and Compensation Act, a law designed to respond to the adverse health effects of the disaster. This reauthorization affords an opportunity to review human inhalation exposure science in relation to the World Trade Center collapse. In this Special Article, we compile observations regarding the collective medical response to the environmental health disaster with a focus on efforts to address the adverse health effects experienced by nearby community members including local residents and workers. We also analyze approaches to understanding the potential for health risk, characterization of hazardous materials, identification of populations at risk, and shortfalls in the medical response on behalf of the local community. Our overarching goal is to communicate lessons learned from

the World Trade Center experience that may be applicable to communities affected by future environmental health disasters. The World Trade Center story demonstrates that communities lacking advocacy and preexisting health infrastructures are uniquely vulnerable to health disasters. Medical and public health personnel need to compensate for these vulnerabilities to mitigate long-term illness and suffering.

Weakley J, Hall CB, Liu X, et al. 2016. The effect of World Trade Center exposure on the latency of chronic rhinosinusitis diagnoses in New York City firefighters: 2001–2011. Occup Environ Med. 73 (4):280–283.

HTTPS://DOI.ORG/10.1136/OEMED-2015-103094

OBJECTIVE: To assess how the effect of World Trade Center (WTC) exposure on physician-diagnosed chronic rhinosinusitis (CRS) in firefighters changed during the decade following the attack on 9/11 (11 September 2001 to 10 September 2011).

METHODS: We examined temporal effects on the relation between WTC exposure and the incidence of physician diagnosed CRS in firefighters changed during the decade following the attack on 9/11 (11 September 2001 to 10 September 2011). Exposure was grouped by time of arrival at the WTC site as follows: (high) morning 11 September 2001 (n=1623); (moderate) afternoon 11 September 2001 or 12 September 2001 (n=7025); or (low) 13-24 September 2001 (n=1200). Piecewise exponential survival models were used to estimate incidences by exposure group, with change points in the relative incidences estimated by maximum likelihood.

RESULTS: Incidences dramatically increased after 2007 due to a programmatic change that provided free medical treatment, but increases were similar in all exposure groups. For this reason, we observed no change point during the study period, meaning the relative incidence by exposure group (high vs moderate vs low) of CRS disease did not significantly change over the study period. The relative rate of developing CRS was 1.99 (95% CI=1.64 to 2.41) for high versus low exposure, and 1.52 (95% CI=1.28 to 1.80) for moderate versus low exposure during the 10-year follow-up period.

CONCLUSIONS: The risk of CRS in FDNY firefighters appears increased with WTC-exposure, and has not diminished by time since exposure.

Webber MP, Moir W, Crowson CS, et al. 2016. Post-September 11, 2001, incidence of systemic autoimmune diseases in World Trade Center-exposed firefighters and emergency medical service workers. Mayo Clin Proc. 91 (1):23–32.

HTTPS://DOI.ORG/10.1016/J.MAYOCP.2015.09.019

OBJECTIVE: To estimate the incidence of selected systemic autoimmune diseases (SAIDs) in approximately 14,000 male rescue/recovery workers enrolled in the Fire Department of the City of New York (FDNY) World Trade Center (WTC) Health Program and to compare FDNY incidence to rates from demographically similar men in the Rochester Epidemiology (REP), a population-based database in Olmsted County, Minnesota.

PATIENTS AND METHODS: We calculated

incidence for specific SAIDs (rheumatoid arthritis, psoriatic arthritis, systemic lupus erythematosus, and others) and combined SAIDs diagnosed from September 12, 2001, through September 11, 2014, and generated expected sex- and age-specific rates based on REP rates. Rates were stratified by level of WTC exposure (higher vs lower). Standardized incidence ratios (SIRs), which are the ratios of the observed number of cases in the FDNY group to the expected number of cases based on REP rates, and 95% CIs were calculated.

RESULTS: We identified 97 SAID cases. Overall, FDNY rates were not significantly different from expected rates (SIR, 0.97; 95% CI, 0.77-1.21). However, the lower WTC exposure group had 9.9 fewer cases than expected, whereas the higher WTC exposure group had 7.7 excess cases.

CONCLUSION: Most studies indicate that the healthy worker effect reduces the association between exposure and outcome by about 20%, which we observed in the lower WTC exposure group. Overall rates masked differences in incidence by level of WTC exposure, especially because the higher WTC exposure group was relatively small. Continued surveillance for early detection of SAIDs in high WTC exposure populations is required to identify and treat exposure-related adverse effects.

Weiden MD, Kwon S, Caraher E, et al. 2016. Biomarkers of World Trade Center particulate matter exposure: Physiology of distal airway and blood biomarkers that predict fev(1) decline. Semin Respir Crit Care Med. 36 (3):323–333.

HTTPS://DOI.ORG/10.1055/S-0035-1547349

Biomarkers can be important predictors of disease severity and progression. The intense exposure to particulates and other toxins from the destruction of the World Trade Center (WTC) overwhelmed the lung's normal protective barriers. The Fire Department of New York (FDNY) cohort not only had baseline pre-exposure lung function measures but also had serum samples banked soon after their WTC exposure. This well-phenotyped group of highly exposed first responders is an ideal cohort for biomarker discovery and eventual validation. Disease progression was heterogeneous in this group in that some individuals subsequently developed abnormal lung function while others recovered. Airflow obstruction predominated in WTC-exposed patients who were symptomatic. Multiple independent disease pathways may cause this abnormal FEV1 after irritant exposure. WTC exposure activates one or more of these pathways causing abnormal FEV1 in an individual. Our hypothesis was that serum biomarkers expressed within 6 months after WTC exposure reflect active disease pathways and predict subsequent development or protection from abnormal FEV1 below the lower limit of normal known as WTC-Lung Injury (WTC-LI). We utilized a nested case-cohort control design of previously healthy never smokers who sought subspecialty pulmonary evaluation to explore predictive biomarkers of WTC-LI. We have identified biomarkers of inflammation, metabolic derangement, protease/antiprotease balance, and vascular injury expressed in serum within 6 months of WTC exposure that were predictive of their FEV1 up to

7 years after their WTC exposure. Predicting future risk of airway injury after particulate exposures can focus monitoring and early treatment on a subset of patients in greatest need of these services.

Xu KY, Goodman E, Goswami R, et al. 2016. Determinants of asthma morbidity in World Trade Center rescue and recovery workers. Ann Allergy Asthma Immunol. 117 (5):568–570.

HTTPS://DOI.ORG/10.1016/J.ANAI.2016.08.033

BACKGROUND: Asthma is one the most common chronic conditions affecting World Trade Center (WTC) rescue and recovery workers in the aftermath of the terrorist attacks on September 11, 2001. While exposure-response gradients between asthma risk and duration of work at the WTC site, exposure to the dust cloud, and work in the Ground Zero pit, compounded by inadequate protection have been described, there is limited knowledge about how exposure and other factors affect long-term asthma outcomes among WTC rescue and recovery workers. In this study, we used data from a cohort of WTC workers with a physician diagnosis of asthma to study factors associated with worse asthma control, acute asthma-related outpatient and inpatient resource utilization, and poor quality of life. We collected data on asthma history, levels of WTC exposures (categorized based on established criteria), and comorbidities from a prospective cohort of 218 WTC workers with physician-diagnosed asthma who were enrolled in the WTC Health Program (WTCHP). Structured clinical interviews assessed for post-traumatic stress disorder (PTSD) and major depression. A validated questionnaire was used to measure gastroesophageal reflux disease (GERD) symptoms.5 Outcomes included asthma control,6 self-report resource utilization, and quality of life. We performed multiple regression analyses to identify factors associated with increased morbidity. Our study revealed that WTC-related asthma is frequently poorly controlled and results in substantial impairment in quality of life. Furthermore, we found that lower income and physical and mental health comorbidities were independently associated with increased asthma morbidity in the WTC rescue and recovery worker populations.

RESULTS: highlight the medical needs of WTC workers with asthma and suggest potential targets for future interventions. Our findings are consistent with a study conducted among members of the WTC Health Registry, encompassing both local residents and rescue and recovery workers, which found participants to have low levels of asthma control. A potential reason for the high levels of asthma morbidity in WTC rescue and recovery workers is the high prevalence of comorbid GERD, estimated to affect almost 40% of WTC workers and identified as an important exacerbating factor in patients with poorly controlled asthma.4 In addition, our finding of a strong association between PTSD and worse asthma morbidity in adjusted analysis is consistent with some community-based studies that reported associations between mental health comorbidities and poor asthma control. In summary, we found high levels of asthma morbid-

ity among WTC rescue and recovery workers over 15 years after exposure. Our finding that GERD symptom and PTSD are associated with worse asthma outcomes can help identify high-risk WTC workers and guide development of highly needed interventions.

Zeig-Owens R, Kablanian A, Webber MP, et al. 2016. Agreement between self-reported and confirmed cancer diagnoses in New York City firefighters and ems workers, 2001–2011. Public Health Rep. 131 (1):153–159.

HTTPS://DOI.ORG/10.1177/003335491613100122

OBJECTIVES: Because of the delay in availability of cancer diagnoses from state cancer registries, self-reported diagnoses may be valuable in assessing the current cancer burden in many populations. We evaluated agreement between self-reported cancer diagnoses and state cancer registry-confirmed diagnoses among 21,437 firefighters and emergency medical service workers from the Fire Department of the City of New York. We also investigated the association between World Trade Center (WTC) exposure and other characteristics in relation to accurate reporting of cancer diagnoses.

METHODS: Participants self-reported cancer status in questionnaires from October 2, 2001, to December 31, 2011. We obtained data on confirmed cancer diagnoses from nine state cancer registries, which we used as our gold standard. We calculated sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV), comparing self-reported cancer diagnoses with confirmed cancer diagnoses. We used multivariable logistic regression models to assess the association between WTC exposure and correct self-report of cancer status, false-positive cancer reports, and false-negative cancer reports.

RESULTS: Sensitivity and specificity for all cancers combined were 90.3% and 98.7%, respectively. Specificities and NPVs remained high in different cancer types, while sensitivities and PPVs varied considerably. WTC exposure was not associated with accurate reporting. CONCLUSION: We found high specificities, NPVs, and general concordance between self-reported cancer diagnoses and registry-confirmed diagnoses. Given the low population prevalence of cancer, self-reported cancer diagnoses may be useful for determining non-cancer cases. Because of the low sensitivities and PPVs for some individual cancers, however, case confirmation with state cancer registries or medical records remains critically important.

Zeig-Owens R, Nolan A, Putman B, et al. 2016. Biomarkers of patient intrinsic risk for upper and lower airway injury after exposure to the World Trade Center atrocity. Am J Ind Med. 59 (9):788–794.

HTTPS://DOI.ORG/10.1002/AJIM.22643

BACKGROUND: High rates of upper and lower airways disease have occurred in Fire Department of the City of New York (FDNY) workers exposed to the World Trade Center (WTC) disaster site. Most experienced acute declines in pulmonary function, and some continued to experience decline over 14 years of follow-up. Similarly, some with rhinosinusitis had symptoms requiring sinus surgery. AIM: To increase generalizability of biomarker investigation, we describe biomarkers

of risk for upper and lower airway injury that do not require stored serum.

METHODS: We review WTC biomarker literature.

RESULTS: Cytokines expressed in stored serum from the first 6 months post-9/11 can identify individuals at higher risk for future abnormal pulmonary function.

CONCLUSION: This research will help identify individuals at high risk of lung and sinus disease that develop after these, or future, irritant exposures for intensive monitoring and treatment. It may also identify targets for effective therapeutic interventions.

Year Published 2017 (16)

Bromet EJ, Clouston S, Gonzalez A, et al. 2017. Hurricane sandy exposure and the mental health of World Trade Center responders. J Trauma Stress. 30 (2):107–114.

HTTPS://DOI.ORG/10.1002/JTS.22178

BACKGROUND: The psychological consequences of a second disaster on populations exposed to an earlier disaster have rarely been studied prospectively. Using a pre- and postdesign, we examined the effects of Hurricane Sandy on possible World Trade Center (WTC) related posttraumatic stress disorder (PTSD Checklist score of >/= 50) and overall depression (major depressive disorder [MDD]; Patient Health Questionnaire depression score of >/= 10) among 870 WTC responders with a follow-up monitoring visit at the Long Island WTC Health Program during the 6 months post-Hurricane Sandy. The Hurricane Sandy exposures evaluated were damage to home (8.3%) and to possessions (7.8%), gasoline shortage (24.1%), prolonged power outage (42.7%), and filing a Federal Emergency Management Agency claim (11.3%). A composite exposure score also was constructed. In unadjusted analyses, Hurricane Sandy exposures were associated with 1.77 to 5.38 increased likelihood of PTSD and 1.58 to 4.13 likelihood of MDD; odds ratios for >/= 3 exposures were 6.47 for PTSD and 6.45 for MDD. After adjusting for demographic characteristics, WTC exposure, pre-Hurricane Sandy mental health status, and time between assessments, reporting >/= 3 Hurricane Sandy exposures was associated with a 3.29 and 3.71 increased likelihood of PTSD and MDD, respectively. These findings underscore the importance of assessing the impact of a subsequent disaster in ongoing responder health surveillance programs.

Gonzalez A, Friedberg F, Li X, et al. 2017. Trauma-focused smoking cessation for smokers exposed to the World Trade Center disaster: A randomized clinical trial. Nicotine and Tobacco Research. 19 (8):968–975.

HTTPS://DOI.ORG/10.1093/NTR/NTW384

INTRODUCTION: The main objective was to evaluate the efficacy of an 8-session, group-based comprehensive smoking cessation and trauma management (CSC-T) treatment among daily smokers (≥ 5 cigarettes/day) exposed to the World

Trade Center (WTC) disaster with elevated WTC-related post-traumatic stress disorder (PTSD) symptoms.

METHODS: Participants (N = 90) were randomly assigned to CSC-T (N = 44; 63.6% white; 27.3% female; mean age = 51.32 ± 7.87) or comprehensive smoking cessation (CSC) alone (N = 46; 71.7% white; 28.3% female; mean age = 48.74 ± 10.66), which was comparable in length and time. Assessments included a diagnostic clinical interview and self-report measures of PTSD and respiratory symptoms, and smoking behavior, and biologically confirmed smoking abstinence. Evaluations occurred at a baseline visit, each treatment session, and at 1-, 2-, 4-, 12-, and 26-weeks post-treatment.

RESULTS: The two treatments did not differ in regard to PTSD symptom improvement. After quit day (week 6), the two groups had similar 7-day (~15%) and 6-month (~20%) abstinence rates as well as average number of cigarettes smoked, and PTSD and respiratory symptoms.

CONCLUSIONS: It is possible that the Cognitive Behavioral Therapy skills specific to quitting smoking, group-based support, and degree of therapist contact, that were available in both treatments may have played a role in equalizing the abstinence rates between the two conditions. Although the current study found no evidence that the CSC-T was superior to the CSC alone treatment, the abstinence rates observed were high relative to previous trials of smokers with diagnosed PTSD. Further development of smoking cessation programs tailored to the needs of smokers with PTSD symptoms continues to be needed.

IMPLICATIONS: This study suggests that a CSC program aids in smoking abstinence for smokers with PTSD symptoms and that incorporating trauma management skills, may not add additional benefits for abstinence and PTSD and respiratory symptom relief. Further work is needed to improve smoking cessation efforts for smokers with PTSD symptoms.

Kim H, Baron S, Baidwan NK, et al. 2017. New onset of asthma and job status change among World Trade Center responders and workers. American Journal of Industrial Medicine. 60 (12):1039–1048.

HTTPS://DOI.ORG/10.1002/AJIM.22774

BACKGROUND: Despite the high rates, the consequences of new onset asthma among the World Trade Center (WTC) responders in terms of the change in job status have not been studied.

METHODS: This study consists of a cohort of 8132 WTC responders out of the total 25787 responders who held a full-time job at the baseline visit, and participated in at least one follow-up visit.

RESULTS: Overall, 34% of the study cohort changed their job status from full-time at a follow-up visit. Multivariable models showed that asthmatics were respectively 27% and 47% more likely to have any job status change and get retired, and twice as likely to become disabled as compared to non-asthmatics.

CONCLUSIONS: With asthma incidence from WTC exposure, negative job status change should be considered as a potential long-term consequence of WTC exposure.

Koshy TT, Attina TM, Ghassabian A, et al. 2017. Serum perfluoroalkyl substances and cardiometabolic consequences in adolescents exposed to the World Trade Center disaster and a matched comparison group. Environ Int. 109:128–135.

HTTPS://DOI.ORG/10.1016/J.ENVINT.2017.08.003

BACKGROUND: Large amounts of various chemical contaminants, including perfluoroalkyl substances (PFASs), were released at the time of the World Trade Center (WTC) disaster. Thousands of children who lived and/or attended school near the disaster site were exposed to these substances but few studies have examined the possible consequences related to these exposures.

OBJECTIVES: To examine the relationship of PFASs serum levels with cardiometabolic profile in children and adolescents enrolled in the World Trade Center Health Registry (WTCHR) and a matched comparison group.

METHODS: We evaluated WTCHR enrollees who resided in New York City and were born between September 11, 1993 and September 10, 2001, and a matched comparison group consisting of individuals who were ineligible for WTCHR participation upon distance of their home, school or work from the WTC and lack of participation in rescue and recovery activities. Matching was based on date of birth, sex, race, ethnicity, and income. We assessed exposure to PFASs, as measured by serum levels and association with cardiometabolic profile as measured by arterial wall stiffness, body mass index, insulin resistance, fasting total cholesterol, HDL, LDL and triglycerides.

RESULTS: A total of 402 participants completed the study and serum samples were analyzed from 308 participants, 123 in the WTCHR group and 185 in the comparison group. In multivariable regression analysis, after adjusting for relevant confounders, we observed a significant, positive association of perfluorooctanoic acid (PFOA) with triglycerides (beta coefficient=0.14, 95% CI: 0.02, 0.27, 15.1% change), total cholesterol (beta coefficient=0.09, 95% CI: 0.04, 0.14, 9.2% change), and LDL cholesterol (beta coefficient=0.11, 95% CI: 0.03, 0.19, 11.5% change). Perfluorohexanesulfonic acid levels were associated with decreased insulin resistance (beta coefficient=-0.09, 95% CI: -0.18, -0.003, -8.6% change); PFOA and perfluorononanoic acid were associated with increased brachial artery distensibility.

CONCLUSIONS: This research adds to our knowledge of the physical health impacts in a large group of children exposed to the WTC disaster. Abnormal lipid levels in young adults might be an early marker of atherosclerosis and cardiovascular diseases and our findings highlight the importance of conducting longitudinal studies in this population.

Kuan PF, Waszczuk MA, Kotov R, et al. 2017. Gene expression associated with PTSD in World Trade Center responders: An rna sequencing study. Transl Psychiatry. 7 (12):1297.

HTTPS://DOI.ORG/10.1038/S41398-017-0050-1

BACKGROUND: The gene expression approach has provided promising insights into the pathophysiology of posttraumatic stress disorder (PTSD). However, few

studies used hypothesis-free transcriptome-wide approach to comprehensively understand gene expression underpinning PTSD. A transcriptome-wide expression study using RNA sequencing of whole blood was conducted in 324 World Trade Center responders (201 with never, 81 current, 42 past PTSD). Samples from current and never PTSD reponders were randomly split to form discovery (N = 195) and replication (N = 87) cohorts. Differentially expressed genes were used in pathway analysis and to create a polygenic expression score. There were 448 differentially expressed genes in the discovery cohort, of which 99 remained significant in the replication cohort, including FKBP5, which was found to be up-regulated in current PTSD regardless of the genotypes.

RESULTS: Several enriched biological pathways were found, including glucocorticoid receptor signaling and immunity-related pathways, but these pathways did not survive FDR correction. The polygenic expression score computed by aggregating 30 differentially expressed genes using the elastic net algorithm achieved sensitivity/specificity of 0.917/0.508, respectively for identifying current PTSD in the replication cohort. Polygenic scores were similar in current and past PTSD, with both groups scoring higher than trauma-exposed controls without any history of PTSD. Together with the pathway analysis results, these findings point to HPA-axis and immune dysregulation as key biological processes underpinning PTSD. A novel polygenic expression aggregate that differentiates PTSD patients from trauma-exposed controls might be a useful screening tool for research and clinical practice, if replicated in other populations.

Kuan PF, Waszczuk MA, Kotov R, et al. 2017. An epigenome-wide DNA methylation study of PTSD and depression in World Trade Center responders. Transl Psychiatry. 7 (6):e1158.

HTTPS://DOI.ORG/10.1038/TP.2017.130

BACKGROUND: Previous epigenome-wide association studies (EWAS) of posttraumatic stress disorder (PTSD) and major depressive disorder (MDD) have been inconsistent. This may be due to small sample sizes, and measurement and tissue differences. The current two EWA analyses of 473 World Trade Center responders are the largest to date for both PTSD and MDD. These analyses investigated DNA methylation patterns and biological pathways influenced by differentially methylated genes associated with each disorder. Methylation was profiled on blood samples using Illumina 450 K Beadchip. Two EWA analyses compared current versus never PTSD, and current versus never MDD, adjusting for cell types and demographic confounders. Pathway and gene set enrichment analyses were performed to understand the complex biological systems of PTSD and MDD. No significant epigenome-wide associations were found for PTSD or MDD at an FDR P<0.05. The majority of genes with differential methylation at a suggestive threshold did not overlap between the two disorders. Pathways significant in PTSD included a regulator of synaptic plasticity, oxytocin signaling, cholinergic synapse and inflammatory disease pathways, while only phosphatidylinositol signaling and cell cycle

pathways emerged in MDD. The failure of the current EWA analyses to detect significant epigenome-wide associations is in contrast with disparate findings from previous, smaller EWA and candidate gene studies of PTSD and MDD. Enriched gene sets involved in several biological pathways, including stress response, inflammation and physical health, were identified in PTSD, supporting the view that multiple genes play a role in this complex disorder.

Lin IH. 2017. Associations of major and trace elements in lung tissues with World Trade Center exposures and subsequent respiratory symptoms. Dissertation Abstracts International: Section B: The Sciences and Engineering. 77 (0):No Pagination Specified.

OBJECTIVE: To investigate associations of major and trace elements in lung tissues with self-reported World Trade Center (WTC) exposures, and with respiratory symptoms developed after September 11th, 2001 in order to evaluate whether elements characteristic of WTC exposure have been retained and might be constituents of biomarkers of WTC exposures.

METHODS STUDY SUBJECTS :. Study subjects (n=130) were decedents autopsied by the Office of Chief Medical Examiner (OCME) of the City of New York during 2007--2011. Among 71,437 members of World Trade Center Health Registry (WTCHR), we obtained 75 peripheral lung and 61central lung tissue samples from 75 decedent enrollees. We also obtained 55 peripheral lung and 43 central lung tissue samples from 55 decedent NYC reference individuals. Materials

ASSESSED TISSUE SAMPLES: were dried, weighed, homogenized, and acid-digested. Inductively-coupled magnetic sector plasma mass spectrometry (ICP-MS) was performed to measure levels (ppm;microg/g) of 34 major and trace elements known to be enriched in WTC dust. We excluded 7 elements from the final analyses due to poor recovery percentages or concentrations under the limits of detection. WTC exposure histories (rescue/recovery exposure and non-rescue/recovery exposure) were assessed at Wave 1 of WTCHR enrollment (2003--2004). Respiratory symptoms (wheezing, shortness of breath, persistent cough and throat irritation) were assessed at Wave 1 and Wave 2 (2006--2008).

STATISTICAL METHODS: We used the Mann-Whitney-Wilcoxon test to evaluate differences in elemental concentrations between the WTCHR enrollees and NYC reference individuals after creating a merged estimate of both rescue/recovery and non-rescue/recovery exposures. The chi-square test or Fisher's exact test was used to compare the frequencies of categorical variables, including demographic characteristics, disease and symptom status between autopsied WTCHR enrollees and all other enrollees in the original WTCHR cohort; elemental concentrations in lung tissues dichotomized at ≥ median vs. < median among WTCHR enrollees and NYC reference individuals; and among WTCHR enrollees who reported post-9/11 respiratory symptoms (wheezing, shortness of breath, persistent cough and throat irritations) and those who did not. We used multivariable logistic

regression analysis to assess the associations of elemental concentrations in lung tissues with WTCHR membership compared to memberships in the NYC reference group after controlling for age, gender, race/ethnicity, and year of death. We also used unconditional logistic regression analysis to evaluate the associations of major and trace elements in lung tissues with both self-reported WTC exposure histories and post-9/11 respiratory symptoms, after adjusting for race/ethnicity, smoking status and year of death.

RESULTS: With the exception of smoking status, place of residence on September 11th, 2001, and race/ethnicity, all other demographic variables, post-9/11 diseases and symptoms were similar between the autopsied WTCHR enrollees in the present study and all other enrollees in the original WTCHR cohort. The distribution of gender, race/ethnicity, education, marital status, borough of residence, lung diseases, chronic diseases, substances abuse and metal concentrations in lung tissues also were similar in the WTCHR enrollee group and the NYC reference group. After adjusting for age, gender, race/ethnicity, year of death, the majority of elemental concentrations in lung tissue did not differ between the WTCHR enrollee groups. However, significant differences were found for Ag and U. Aluminum in central lung was associated with rescue/recovery exposure among all WTCHR enrollees [adjusted OR=4.78 (95% C.I.= 1.01--29.27)] after adjustment for age on September 11th, 2001, gender, race/ethnicity, smoking and year of death.

Liu X, Yip J, Zeig-Owens R, et al. 2017. The effect of World Trade Center exposure on the timing of diagnoses of obstructive airway disease, chronic rhinosinusitis, and gastroesophageal reflux disease. Front Public Health. 5:2.

HTTPS://DOI.ORG/10.3389/FPUBH.2017.00002

OBJECTIVES: In a cohort of rescue/recovery workers exposed to the dust that resulted from the collapse of the World Trade Center (WTC), we assessed how a diagnosis of obstructive airways disease (OAD) affected the likelihood of a subsequent diagnosis of chronic rhinosinusitis (CRS) or gastroesophageal reflux disease (GERD). We also assessed whether OAD acted as a mediator of the association between exposure to the WTC rescue/recovery effort and CRS and GERD diagnoses.

METHODS: In this prospective cohort study, we analyzed Fire Department of the City of New York physician diagnoses of OAD, CRS, and GERD that were first documented between September 11, 2001, and September 10, 2011, among 8,968 WTC-exposed firefighters. We used piecewise exponential survival models to evaluate whether OAD was a risk factor for either CRS or GERD and to assess OAD as a possible mediator.

RESULTS: An OAD diagnosis significantly increased the risks for subsequent CRS [relative rate (RR), 4.24; 95% CI, 3.78-4.76] and GERD (RR, 3.21; 95% CI, 2.93-3.52) diagnoses. Further, 21% of the WTC exposure effect (high vs. low intensity) on GERD and 13% of the effect (high vs. low intensity) on CRS were mediated by a prior OAD diagnosis.

CONCLUSION: Individuals with an OAD diagnosis had elevated risks for subsequent diagnoses of CRS or GERD. Part of the effect of WTC exposure on CRS and GERD diagnoses is mediated by prior diagnoses of OAD; this mediation effect of OAD may reflect biological pathways or healthcare utilization practices.

Mahaffey BL, Gonzalez A, Farris SG, et al. 2017. Understanding the connection between posttraumatic stress symptoms and respiratory problems: Contributions of anxiety sensitivity. Journal of Traumatic Stress. 30 (1):No Pagination Specified.

HTTPS://DOI.ORG/10.1002/JTS.22159

BACKGROUND: Respiratory problems and posttraumatic stress disorder (PTSD) are the signature health consequences associated with the September 11, 2001 (9/11), World Trade Center disaster and frequently co-occur. The reasons for this comorbidity, however, remain unknown. Anxiety sensitivity is a transdiagnostic trait that is associated with both PTSD and respiratory symptoms. The present study explored whether anxiety sensitivity could explain the experience of respiratory symptoms in trauma-exposed smokers with PTSD symptoms. Participants (N = 135; Mage = 49.18 years, SD = 10.01) were 9/11-exposed daily smokers. Cross-sectional self-report measures were used to assess PTSD symptoms, anxiety sensitivity, and respiratory symptoms. After controlling for covariates and PTSD symptoms, anxiety sensitivity accounted for significant additional variance in respiratory symptoms (DELTAR2 = .04 to .08). This effect was specific to the somatic concerns dimension (beta = .29, p = .020); somatic concerns contributed significantly to accounting for the overlap between PTSD and respiratory symptoms, b = 0.03, 95% CI [0.01, 0.07]. These findings suggest that the somatic dimension of anxiety sensitivity is important in understanding respiratory symptoms in individuals with PTSD symptoms. These findings also suggest that it may be critical to address anxiety sensitivity when treating patients with comorbid respiratory problems and PTSD.

Marmor M, Shao Y, Bhatt DH, et al. 2017. Paresthesias among community members exposed to the World Trade Center disaster. J Occup Environ Med. 59 (4):389–396.

HTTPS://DOI.ORG/10.1097/JOM.0000000000000966

OBJECTIVE: Paresthesias can result from metabolic disorders, nerve entrapment following repetitive motions, hyperventilation pursuant to anxiety, or exposure to neurotoxins. We analyzed data from community members exposed to the World Trade Center (WTC) disaster of September 11, 2001, to evaluate whether exposure to the disaster was associated with paresthesias.

METHODS: Analysis of data from 3141 patients of the WTC Environmental Health Center.

RESULTS: Fifty-six percent of patients reported paresthesias at enrollment 7 to 15 years following the WTC disaster. After controlling for potential confounders, paresthesias were associated with severity of exposure to the WTC dust cloud and working in a job requiring cleaning of WTC dust.

CONCLUSIONS: This study suggests that paresthesias were commonly associated with WTC-related exposures or post-WTC cleaning work. Further studies should objectively characterize these paresthesias and seek to identify relevant neurotoxins or paresthesia-inducing activities.This is an open access article distributed under the terms of the Creative Commons Attribution-Non Commercial-No Derivatives License 4.0 (CCBY-NC-ND), where it is permissible to download and share the work provided it is properly cited. The work cannot be changed in any way or used commercially without permission from the journal.

HTTP://CREATIVECOMMONS.ORG/LICENSES/BY-NC-ND/4.0.

Mindlis I, Morales-Raveendran E, Goodman E, et al. 2017. Post-traumatic stress disorder dimensions and asthma morbidity in World Trade Center rescue and recovery workers. Journal of Asthma. 54 (7):723–731.

HTTPS://DOI.ORG/10.1080/02770903.2016.1263650

OBJECTIVE: Using data from a cohort of World Trade Center (WTC) rescue and recovery workers with asthma, we assessed whether meeting criteria for post-traumatic stress disorder (PTSD), sub-threshold PTSD, and for specific PTSD symptom dimensions are associated with increased asthma morbidity.

METHODS: Participants underwent a Structured Clinical Interview for Diagnostic and Statistical Manual to assess the presence of PTSD following DSM-IV criteria during in-person interviews between December 2013 and April 2015. We defined sub-threshold PTSD as meeting criteria for two of three symptom dimensions: re-experiencing, avoidance, or hyper-arousal. Asthma control, acute asthma-related healthcare utilization, and asthma-related quality of life data were collected using validated scales. Unadjusted and multiple regression analyses were performed to assess the relationship between sub-threshold PTSD and PTSD symptom domains with asthma morbidity measures.

RESULTS: Of the 181 WTC workers with asthma recruited into the study, 28% had PTSD and 25% had sub-threshold PTSD. Patients with PTSD showed worse asthma control, higher rates of inpatient healthcare utilization, and poorer asthma quality of life than those with sub-threshold or no PTSD. After adjusting for potential confounders, among patients not meeting the criteria for full PTSD, those presenting symptoms of re-experiencing exhibited poorer quality of life ($p = 0.003$). Avoidance was associated with increased acute healthcare use ($p = 0.05$). Sub-threshold PTSD was not associated with asthma morbidity ($p > 0.05$ for all comparisons).

CONCLUSIONS: There may be benefit in assessing asthma control in patients with sub-threshold PTSD symptoms as well as those with full PTSD to more effectively identify ongoing asthma symptoms and target management strategies.

Rosen RL, Levy-Carrick N, Reibman J, et al. 2017. Elevated c-reactive protein and posttraumatic stress pathology among survivors of the 9/11 World Trade Center attacks. J Psychiatr Res. 89:14–21.

HTTPS://DOI.ORG/10.1016/J.JPSYCHIRES.2017.01.007

BACKGROUND: Systemic inflammation has emerged as a promising marker and potential mechanism underlying post-traumatic stress disorder (PTSD). The relationship between posttraumatic stress pathology and systemic inflammation has not, however, been consistently replicated and is potentially confounded by comorbid illness or injury, common complications of trauma exposure.

METHODS: We analyzed a large naturalistic cohort sharing a discrete physical and mental health trauma from the destruction of the World Trade Center (WTC) towers on September 11, 2001 (n = 641). We evaluated the relationship between multiple physical and mental health related indices collected through routine evaluations at the WTC Environmental Health Center (WTC EHC), a treatment program for community members exposed to the disaster. C-Reactive Protein (CRP), a marker of systemic inflammation, was examined in relation to scores for PTSD, PTSD symptom clusters (re-experiencing, avoidance, negative cognitions/mood, arousal), depression and anxiety, while controlling for WTC exposures, lower respiratory symptoms, age, sex, BMI and smoking as potential risks or confounders.

RESULTS: CRP was positively associated with PTSD severity ($p < 0.001$), trending toward association with depression ($p = 0.06$), but not with anxiety ($p = 0.27$). CRP was positively associated with re-experiencing ($p < 0.001$) and avoidance ($p < 0.05$) symptom clusters, and trended toward associations with negative cognitions/mood ($p = 0.06$) and arousal ($p = 0.08$).

CONCLUSIONS: In this large study of the relationship between CRP and posttraumatic stress pathology, we demonstrated an association between systemic inflammation and stress pathology (PTSD; trending with depression), which remained after adjusting for potentially confounding variables. These results contribute to research findings suggesting a salient relationship between inflammation and posttraumatic stress pathology.

Trasande L, Koshy TT, Gilbert J, et al. 2017. Serum perfluoroalkyl substances in children exposed to the World Trade Center disaster. Environ Res. 154:212–221.

HTTPS://DOI.ORG/10.1016/J.ENVRES.2017.01.008

BACKGROUND: The World Trade Center (WTC) disaster released large amounts of various chemical substances into the environment, including perfluoroalkyl substances (PFASs). Yet, no studies have examined exposures in children living or attending schools near the disaster site. We measured serum PFASs in WTC Health Registry (WTCHR) respondents who were </=8 years of age on September 11, 2001 and a sociodemographically-matched comparison group. We also examined the relationship of PFASs levels with dust cloud exposure; home dust exposure, and with traumatic exposure, the latter to take into account

differences related to possible mental health consequences and associated behavioral problems.

METHOLDS:Serum samples, collected between 2014 and 2016, were analyzed from 123 WTCHR participants and from 185 participants in the comparison group. In the WTCHR group, median perfluorooctanoic acid (PFOA) and perfluorooctanesulfonic acid (PFOS) levels were 1.81ng/mL and 3.72ng/mL, respectively. Controlling for sex, caloric intake, race/ethnicity, and date of birth, significant increases among WTCHR participants compared with the matched comparison group were detected for perfluorohexanesulfonate (0.23ng/mL increase or 0.24log unit increase, p=0.006); PFOS (0.86ng/mL increase or 0.16log unit increase, p=0.011); PFOA (0.35ng/mL increase or 0.18log unit increase, p<0.001); perfluorononanoic acid (0.12ng/mL increase or 0.17log unit increase, p=0.003); perfluorodecanoic acid (0.06ng/mL increase or 0.42log unit increase, p<0.001); and perfluoroundecanoic acid (0.03ng/mL increase or 0.32log unit increase, p=0.019).

RESULTS: Stronger associations were identified for home dust exposures and traumatic exposures than dust cloud. These findings highlight the importance of conducting longitudinal studies in this population to assess possible cardiometabolic and renal consequences related to these exposures.

Trasande L, Koshy TT, Gilbert J, et al. 2017. Cardiometabolic profiles of adolescents and young adults exposed to the World Trade Center disaster. Environ Res. 160:107–114.

HTTPS://DOI.ORG/10.1016/J.ENVRES.2017.09.026

BACKGROUND AND OBJECTIVE: Few studies have examined the possible cardiometabolic consequences of World Trade Center-related exposures on children who lived and/or attended school near the disaster site. Our objective was to compare cardiometabolic profiles of participants in the World Trade Center Health Registry (WTCHR) with a matched comparison group.

METHODS: We evaluated WTCHR enrollees who resided in New York City and were born between September 11, 1993 and September 10, 2001, and a matched comparison group. We assessed exposure to dust cloud, home dust, as well as traumatic exposure, and associations with blood pressure, arterial wall stiffness, body mass index (BMI), total cholesterol, triglycerides, HDL, and LDL.

RESULTS: A total of 402 participants completed the study, 222 in the comparison group and 180 in the WTCHR group. In multivariable regression analysis, after adjusting for relevant confounders we detected a weak association between participation in the WTCHR group and lower BMI (-1.12kg/m2, 95% CI -2.11, -0.12; p = 0.03), which became non-significant after adjusting for multiple comparisons. With respect to traumatic and psychosocial exposures, the only association that persisted in our multivariable model, below our predefined level of significance, was between post-traumatic stress disorder and higher BMI (2.06kg/m2, 95% CI 0.37, 3.74; p = 0.02).

CONCLUSIONS: Our findings do not support an association between self-reported exposures to the WTC disaster and adverse cardiometabolic profile. However, further longitudinal studies may better inform the full extent of WTC-related conditions associated with exposure to the disaster.

Waszczuk MA, Li X, Bromet EJ, et al. 2017. Pathway from PTSD to respiratory health: Longitudinal evidence from a psychosocial intervention. Health Psychol. 36 (5):429–437.

HTTPS://DOI.ORG/10.1037/HEA0000472

OBJECTIVE: Respiratory illness and posttraumatic stress disorder (PTSD) are common debilitating conditions that frequently co-occur. Observational studies indicate that PTSD, independently of smoking, is a major risk and maintenance factor for lower respiratory symptoms (LRS). The current study experimentally tested this etiologic pathway by investigating whether LRS can be reduced by treating PTSD symptoms.

METHOD: Ninety daily smokers exposed to the World Trade Center (WTC) disaster (mean age 50 years, 28% female; 68% White) completed 8-session group-based weekly comprehensive trauma management and smoking cessation treatment that focused on skills to alleviate PTSD symptoms. LRS, PTSD symptoms, and smoking were assessed weekly. Data was analyzed using multilevel models of within-person associations between LRS, PTSD symptoms, smoking, and treatment dose across 8 weekly sessions with concurrent and lagged outcomes.

RESULTS: LRS improved significantly with treatment (reduction of .50 standard deviations). Reduction in PTSD symptoms uniquely predicted improvement in LRS at consecutive sessions 1 week apart and fully accounted for the treatment effect on LRS. The effect of PTSD symptoms was stronger than that of smoking, and the only effect to remain significant when both entered the model. Notably, reduction in LRS did not predict future improvement in PTSD symptoms.

CONCLUSIONS: The results are in line with the etiologic pathway suggesting that PTSD symptoms are a risk and maintenance factor for chronic LRS and that treatment of PTSD can help to alleviate LRS in trauma-exposed populations. PTSD is emerging as a novel and important treatment target for chronic respiratory problems. (PsycINFO Database Record

Zvolensky MJ, Rodriguez-Cano R, Paulus DJ, et al. 2017. Respiratory problems and anxiety sensitivity in smoking lapse among treatment seeking smokers. Addict Behav. 75:25–29.

HTTPS://DOI.ORG/10.1016/J.ADDBEH.2017.06.015

PURPOSE: The current study examined whether the interaction of lower respiratory symptoms and anxiety sensitivity is related to smoking lapse in the context of smoking cessation.

METHOD: Participants were adult daily smokers (N=60) exposed to the World Trade Center (WTC) disaster who were in a smoking cessation treatment program (75.0% male, 50.6years old [SD=9.2], and current smoking rate was 17.6 cigarettes per day (SD=10.6).

RESULTS: Results indicated that the interaction between lower respiratory symptoms and anxiety sensitivity was a significant predictor of greater risk for

lapse (i.e., lower survival time; B=0.005, OR=1.01, p=0.039). Follow-up analysis showed that greater respiratory symptoms were a significant predictor of lapse risk among those with high (B=0.116, OR=1.12, p=0.025), but not those with low (B=-0.048, OR=0.95, p=0.322), levels of anxiety sensitivity.

DISCUSSION: The findings from the current study suggest that smokers with greater respiratory symptoms and higher levels of anxiety sensitivity may be associated with early lapse to smoking following smoking cessation treatment. Future work has the potential to inform the development of tailored cessation interventions for smokers who experience varying levels of lower respiratory symptoms and anxiety sensitivity.

Year Published 2018 (24)

Crowley G, Kwon S, Haider SH, et al. 2018. Metabolomics of World Trade Center-lung injury: A machine learning approach. BMJ Open Respir Res. 5 (1):e000274.

HTTPS://DOI.ORG/10.1136/BMJRESP-2017-000274

INTRODUCTION: Biomarkers of metabolic syndrome expressed soon after World Trade Center (WTC) exposure predict development of WTC Lung Injury (WTC-LI). The metabolome remains an untapped resource with potential to comprehensively characterise many aspects of WTC-LI. This case-control study identified a clinically relevant, robust subset of metabolic contributors of WTC-LI through comprehensive high-dimensional metabolic profiling and integration of machine learning techniques.

METHODS: Never-smoking, male, WTC-exposed firefighters with normal pre-9/11 lung function were segregated by post-9/11 lung function. Cases of WTC-LI (forced expiratory volume in 1s <lower limit of normal, n=15) and controls (n=15) were identified from previous cohorts. The metabolome of serum drawn within 6 months of 9/11 was quantified. Machine learning was used for dimension reduction to identify metabolites associated with WTC-LI.

RESULTS: 580 metabolites qualified for random forests (RF) analysis to identify a refined metabolite profile that yielded maximal class separation. RF of the refined profile correctly classified subjects with a 93.3% estimated success rate. 5 clusters of metabolites emerged within the refined profile. Prominent subpathways include known mediators of lung disease such as sphingolipids (elevated in cases of WTC-LI), and branched-chain amino acids (reduced in cases of WTC-LI). Principal component analysis of the refined profile explained 68.3% of variance in five components, demonstrating class separation.

CONCLUSION: Analysis of the metabolome of WTC-exposed 9/11 rescue workers has identified biologically plausible pathways associated with loss of lung function.

Since metabolites are proximal markers of disease processes, metabolites could capture the complexity of past exposures and better inform treatment. These pathways warrant further mechanistic research.

de la Hoz RE, Liu X, Doucette JT, et al. 2018. Increased airway wall thickness is associated with adverse longitudinal first-second forced expiratory volume trajectories of former World Trade Center workers. Lung. 196 (4):481–489.

HTTPS://DOI.ORG/10.1007/S00408-018-0125-7

RATIONALE: Occupational exposures at the WTC site after September 11, 2001 have been associated with several presumably inflammatory lower airway diseases. In this study, we describe the trajectories of expiratory air flow decline, identify subgroups with adverse progression, and investigate the association of a quantitative computed tomography (QCT) imaging measurement of airway wall thickness, and other risk factors for adverse progression.

METHODS: We examined the trajectories of expiratory air flow decline in a group of 799 former WTC workers and volunteers with QCT-measured (with two independent systems) wall area percent (WAP) and at least 3 periodic spirometries. We calculated individual regression lines for first-second forced expiratory volume (FEV1), identified subjects with rapidly declining and increasing ("gainers"), and compared them to subjects with normal and "stable" FEV1 decline. We used multivariate logistic regression to model decliner vs. stable trajectories.

RESULTS: The mean longitudinal FEV1slopes for the entire study population, and its stable, decliner, and gainer subgroups were, respectively, - 35.8, - 8, - 157.6, and + 173.62 ml/year. WAP was associated with "decliner" status (ORadj 1.08, 95% CI 1.02, 1.14, per 5% increment) compared to stable. Age, weight gain, baseline FEV1 percent predicted, bronchodilator response, and pre-WTC occupational exposures were also significantly associated with accelerated FEV1 decline. Analyses of gainers vs. stable subgroup showed WAP as a significant predictor in unadjusted but not consistently in adjusted analyses.

CONCLUSIONS: The apparent normal age-related rate of FEV1 decline results from averaging widely divergent trajectories. WAP is significantly associated with accelerated air flow decline in WTC workers.

Geronazzo-Alman L, Guffanti G, Eisenberg R, et al. 2018. Comorbidity classes and associated impairment, demographics and 9/11-exposures in 8,236 children and adolescents. J Psychiatr Res. 96:171–177.

HTTPS://DOI.ORG/10.1016/J.JPSYCHIRES.2017.10.012

The extensive comorbidity of psychiatric disorders in children and adolescents leads to clinical heterogeneity, and is an often-overlooked issue in etiopathogenic and treatment studies in developmental psychopathology. In a representative sample (N=8236) of New York City public school students assessed six months after 9/11, latent class analysis was applied to 48 symptoms across seven disorders: posttraumatic stress, agoraphobia, sep-

aration anxiety, panic disorder, generalized anxiety (GAD), major depression (MDD) and conduct disorder (CD). Our objective was to identify classes defined by homogenous symptom profiles, and to examine the association between class membership and gender, age, race, different types of exposure to 9/11, and impairment. Eight homogenous comorbidity patterns were identified, including four severe disturbance classes: a multimorbid internalizing class (INT), a class with a high probability of CD, MDD, and GAD symptoms (Distress/EXT), a non-comorbid externalizing class, and a non-comorbid MDD class. Demographic and 9/11-related exposures showed some degree of specificity in their association with severe symptom profiles. Impairment was particularly high in the INT and Distress/EXT classes. A better characterization of phenomic data, that takes comorbidity into account, is essential to understand etiopathogenic processes, and to move psychiatric research forward towards personalized medicine. The high probability of endorsing symptoms of multiple disorders in the INT and Distress/EXT classes supports the use of treatments focusing on multimorbidity. Clinical trials should evaluate the effectiveness of disorder-specific versus transdiagnostic interventions. The association between class membership and demographic and exposure variables suggests that interventions may be improved by considering specific predictors of class membership.Graber JM, Chuang CT, Ward CL, et al. 2018. Head and neck cancer in World Trade Center responders: A case series. J Occup Environ Med. 60 (9):e439-e444.

HTTPS://DOI.ORG/10.1097/JOM.0000000000001386

OBJECTIVE: The aim of this study was to report on cases of head and neck cancer (HNC) among World Trade Center (WTC) responders participating in the WTC Health Program and seen at Rutgers WTC Center of Clinical Excellence.

METHODS: Medical records were abstracted by two clinical reviewers and discrepancies resolved. Cases were defined as WTC responders diagnosed with HNC between December 9, 2005, and December 31, 2016.

RESULTS: Sixteen HNC patients met the case definition, most (13) arrived at the WTC location on 9/11 or within the following 2 days, and half worked in law enforcement during the 9/1 response.

CONCLUSION: An association between HNC and WTC exposure is biologically plausible and should be further investigated. Research to enumerate the risk factor profile for these cancers may contribute to understanding mechanisms by which WTC exposure can contribute to carcinogenesis and to prevention and early detection strategies.

Gumb T, Twumasi A, Alimokhtari S, et al. 2018. Comparison of two home sleep testing devices with different strategies for diagnosis of osa. Sleep Breath. 22 (1):139–147.

HTTPS://DOI.ORG/10.1007/S11325-017-1547-9

PURPOSE: Home sleep testing devices are being widely used in diagnosis/screening for obstructive sleep apnea (OSA). We examined differences in OSA metrics obtained from two devices with divergent home monitoring strategies, the

Apnea Risk Evaluation System (ARES, multiple signals plus forehead reflectance oximetry) and the Nonin WristOx2 (single channel finger transmission pulse oximeter), compared to differences from night-night variability of OSA.

METHODS: One hundred fifty-two male/26 female subjects (BMI = 30.3 +/- 5.6 kg/m(2), age = 52.5 +/- 8.9 years) were recruited without regard to OSA symptoms and simultaneously wore both ARES and Nonin WristOx2 for two nights (n = 351 nights). Automated analysis of the WristOx2 yielded oxygen desaturation index (ODIOx2, >/=4% O2 dips/h), and automated analysis with manual editing of ARES yielded AHI4ARES (apneas + hypopneas with >/=4% O2 dips/h) and RDIARES (apneas + hypopneas with >/=4% O2 dips/h or arousal surrogates). Baseline awake oxygen saturation, percent time < 90% O2 saturation (%time < 90%O2Sat), and O2 signal loss were compared between the two methods.

RESULTS: Correlation between AHI4ARES and ODIOx2 was high (ICC = 0.9, 95% CI = 0.87-0.92, p < 0.001, bias +/- SD = 0.7 +/- 6.1 events/h). Agreement values for OSA diagnosis (77-85%) between devices were similar to those seen from night-to-night variability of OSA using a single device. Awake baseline O2 saturation was significantly higher in the ARES (96.2 +/- 1.6%) than WristOx2 (92.2 +/- 2.1%, p < 0.01). There was a significantly lower %time < 90%O2Sat reported by the ARES compared to WristOx2 (median (IQR) 0.5 (0.0, 2.6) vs. 2.1 (0.3, 9.7), p < 0.001), and the correlation was low (ICC = 0.2).

CONCLUSIONS: OSA severity metrics predominantly dependent on change in oxygen saturation and metrics used in diagnosis of OSA (AHI4 and ODI) correlated well across devices tested. However, differences in cumulative oxygen desaturation measures (i.e., %time < 90%O2Sat) between the devices suggest that caution is needed when interpreting this metric particularly in populations likely to have significant hypoxia.

Haider SH, Kwon S, Lam R, et al. 2018. Predictive biomarkers of gastroesophageal reflux disease and barrett's esophagus in World Trade Center exposed firefighters: A 15 year longitudinal study. Scientific Reports. 8 (1):3106.

HTTPS://DOI.ORG/10.1038/S41598-018-21334-9

Gastroesophageal reflux disease (GERD) and Barrett's Esophagus (BE), which are prevalent in the World Trade Center (WTC) exposed and general populations, negatively impact quality of life and cost of healthcare. GERD, a risk factor of BE, is linked to obstructive airways disease (OAD). We aim to identify serum biomarkers of GERD/BE, and assess the respiratory and clinical phenotype of a longitudinal cohort of never-smoking, male, WTC-exposed rescue workers presenting with pulmonary symptoms. Biomarkers collected soon after WTC-exposure were evaluated in optimized predictive models of GERD/BE. In the WTC-exposed cohort, the prevalence of BE is at least 6 times higher than in the general population. GERD/BE cases had similar lung function, D LCO, bronchodilator response and long-acting β-agonist use compared to controls. In confounder-adjusted regression models, TNF-α ≥ 6 pg/mL pre-

dicted both GERD and BE. GERD was also predicted by C-peptide ≥ 360 pg/mL, while BE was predicted by fractalkine ≥ 250 pg/mL and IP-10 ≥ 290 pg/mL. Finally, participants with GERD had significantly increased use of short-acting β-agonist compared to controls. Overall, biomarkers sampled prior to GERD/BE presentation showed strong predictive abilities of disease development. This study frames future investigations to further our understanding of aerodigestive pathology due to particulate matter exposure.

Hashim D, Boffetta P, Galsky M, et al. 2018. Prostate cancer characteristics in the World Trade Center cohort, 2002–2013. Eur J Cancer Prev. 27 (4):347–354.

HTTPS://DOI.ORG/10.1097/CEJ.0000000000000315

An increased incidence of prostate cancer was reported in three cohorts of World Trade Center (WTC) respondents. It is uncertain whether this increase is because of WTC-related exposures or enhanced surveillance. Prostate cancer cases (2002-2013) were obtained from the WTC Health Program. Age, race, and Gleason score distribution were compared with New York State Cancer Registry cases from the same time period. Multivariate models were adjusted for age and race. Analyses of clinical characteristics of prostate cancer cases within the cohort were also carried out, adjusting for age, race, and WTC exposure categories. WTC respondents had a prostate cancer age-standardized rate ratio of 1.65 [95% confidence interval (CI): 1.37-1.93] compared with New York State; age-specific ratios were highest for ages 30-49 (2.28; 95% CI: 1.51-3.43), 70-74 (2.05; 95% CI: 1.03-4.10), and 80-84 years (5.65; 95% CI: 1.41-22.58). High WTC exposure was associated with advanced clinical stage (5.58; 95% CI: 1.05-29.76; Ptrend=0.03). WTC respondents continue to have a higher prostate cancer rate compared with New York State as a whole. Respondents with a higher WTC exposure level may have had more advanced clinical stage of prostate cancer.

Hena KM, Yip J, Jaber N, et al. 2018. Clinical course of sarcoidosis in World Trade Center-exposed firefighters. Chest. 153 (1):114–123.

HTTPS://DOI.ORG/10.1016/J.CHEST.2017.10.014

BACKGROUND: Sarcoidosis is believed to represent a genetically primed, abnormal immune response to an antigen exposure or inflammatory trigger, with both genetic and environmental factors playing a role in disease onset and phenotypic expression. In a population of firefighters with post-World Trade Center (WTC) 9/11/2001 (9/11) sarcoidosis, we have a unique opportunity to describe the clinical course of incident sarcoidosis during the 15 years postexposure and, on average, 8 years following diagnosis.

METHODS: Among the WTC-exposed cohort, 74 firefighters with post-9/11 sarcoidosis were identified through medical records review. A total of 59 were enrolled in follow-up studies. For each participant, the World Association of Sarcoidosis and Other Granulomatous Diseases organ assessment tool was used to categorize the sarcoidosis involvement of each organ system at time

of diagnosis and at follow-up.

RESULTS: The incidence of sarcoidosis post-9/11 was 25 per 100,000. Radiographic resolution of intrathoracic involvement occurred in 24 (45%) subjects. Lung function for nearly all subjects was within normal limits. Extrathoracic involvement increased, most prominently joints (15%) and cardiac (16%) involvement. There was no evidence of calcium dysmetabolism. Few subjects had ocular (5%) or skin (2%) involvement, and none had beryllium sensitization. Most (76%) subjects did not receive any treatment.

CONCLUSIONS: Extrathoracic disease was more prevalent in WTC-related sarcoidosis than reported for patients with sarcoidosis without WTC exposure or for other exposure-related granulomatous diseases (beryllium disease and hypersensitivity pneumonitis). Cardiac involvement would have been missed if evaluation stopped after ECG, 48-h recordings, and echocardiogram. Our results also support the need for advanced cardiac screening in asymptomatic patients with strenuous, stressful, public safety occupations, given the potential fatality of a missed diagnosis.Kahn LG, Han X, Koshy TT, et al. 2018. Adolescents exposed to the World Trade Center collapse have elevated serum dioxin and furan concentrations more than 12years later. Environ Int. 111:267–268.

HTTPS://DOI.ORG/10.1016/J.ENVINT.2017.11.026

BACKGROUND: The collapse of the World Trade Center (WTC) on September 11, 2001 released a dust cloud containing numerous environmental contaminants, including polychlorinated dibenzo-para-dioxins and polychlorinated dibenzofurans (PCDD/Fs). PCDD/Fs are toxic and are associated with numerous adverse health outcomes including cancer, diabetes, and impaired reproductive and immunologic function. Prior studies have found adults exposed to the WTC disaster to have elevated levels of PCDD/Fs. This is the first study to assess PCDD/F levels in WTC-exposed children.

METHODS: This analysis includes 110 participants, a subset of the 2014-2016 WTC Adolescent Health Study, a group of both exposed youths who lived, attended school, or were present in lower Manhattan on 9/11 recruited from the WTC Health Registry (WTCHR) and unexposed youths frequency matched on age, sex, race, ethnicity, and income. Our sample was selected to maximize the contrast in their exposure to dust from the WTC collapse. Questionnaire data, including items about chronic home dust and acute dust cloud exposure, anthropometric measures, and biologic specimens were collected during a clinic visit. Serum PCDD/F concentrations were measured according to a standardized procedure at the New York State Department of Health Organic Analytical Laboratory. We used multivariable linear regression to assess differences in PCCD/Fs between WTCHR and non-WTCHR participants. We also compared mean and median PCDD/F and toxic equivalency (TEQ) concentrations in our cohort to 2003-4 National Health and Nutrition Examination Survey (NHANES) levels for youths age 12-19.

RESULTS: Median PCDD/F levels were statistically significantly higher among WTCHR participants compared to non-WTCHR participants for 16 out of 17 congeners. Mean and median TEQ concentrations in WTCHR participants were >7 times those in non-WTCHR participants (72.5 vs. 10.1 and 25. 3 vs. 3.39pg/g lipid, respectively). Among WTCHR participants, median concentrations of several PCDD/Fs were higher than the NHANES 95th percentiles. After controlling for dust cloud exposure, home dust exposure was significantly associated with higher PCDD/F level.

CONCLUSIONS: Adolescents in lower Manhattan on the day of the WTC attack and exposed to particulate contamination from the WTC collapse had significantly elevated PCDD/F levels >12years later compared to a matched comparison group, driven by chronic home dust exposure rather than acute dust cloud exposure. PCDD/F and TEQ levels substantially exceeded those in similar-aged NHANES participants. Future studies are warranted to explore associations of PCDD/Fs with health and developmental outcomes among individuals exposed to the WTC disaster as children.

Kim H, Baidwan NK, Kriebel D, et al. 2018. Asthma among World Trade Center first responders: A qualitative synthesis and bias assessment. Int J Environ Res Public Health. 15 (6)

HTTPS://DOI.ORG/10.3390/IJERPH15061053

BACKGROUND: The World Trade Center (WTC) disaster exposed the responders to several hazards. Three cohorts i.e., the Fire Department of New York (FDNY), the General Responder Cohort (GRC), and the WTC Health Registry (WTCHR) surveyed the exposed responder population. We searched Pubmed and Web of Science for literature on a well-published association between the WTC exposures and asthma, focusing on new-onset self-reported physician-diagnosed asthma. The resulting five articles were qualitatively assessed for potential biases. These papers were independently reviewed by the co-authors, and conclusions were derived after discussions. While, the cohorts had well-defined eligibility criteria, they lacked information about the entire exposed population. We conclude that selection and surveillance biases may have occurred in the GRC and WTCHR cohorts, but were likely to have been minimal in the FDNY cohort. Health care benefits available to responders may have increased the reporting of both exposure and outcome in the former, and decreased outcome reporting in the FDNY cohort. Irrespective of the biases, the studies showed similar findings, confirming the association between WTC exposure and self-reported physician-diagnosed asthma among responders. This suggests that health data gathered under great duress and for purposes other than epidemiology can yield sound conclusions. Potential biases can, however, be minimized by having validated survey instruments and worker registries in place before events occur.

Kim H, Kriebel D, Liu B, et al. 2018. Standardized morbidity ratios of four chronic health conditions among World Trade Center responders: Comparison to the national health interview survey. Am J Ind Med. 61 (5):413–421.

HTTPS://DOI.ORG/10.1002/AJIM.22825

PURPOSE: We conducted external comparisons for the prevalence of asthma, hypertension, diabetes, and cancer among World Trade Center (WTC) general responders using the National Health Interview Survey (NHIS) as the reference, along with internal comparisons for the incidence of asthma.

METHODS: Standardized Morbidity Ratios (SMRs) were calculated for the prevalence of the health conditions, and risk ratios (RRs) for asthma incidence.

RESULTS: Relative to the NHIS, asthma prevalence was in excess in responders over the study years (age-adjusted SMRs = 1.3-2.8). Hypertension prevalence began to exceed expected from 2006 while diabetes was lower than expected. An upward trend towards excess cancer prevalence was observed. Internal comparisons showed elevated asthma incidence among protective service and utility workers compared to construction workers; while those who arrived at the WTC site in the morning of 9/11 had a lower asthma risk than those who arrived in the afternoon.

CONCLUSIONS: The use of NHIS data as a reference population demonstrates and reconfirms several important patterns of excess risk in WTC responders. External comparisons are an alternative for disaster cohorts without an established comparison group.

Kung WW, Liu X, Goldmann E, et al. 2018. Posttraumatic stress disorder in the short and medium term following the World Trade Center attack among asian americans. J Community Psychol. 46 (8):1075–1091.

HTTPS://DOI.ORG/10.1002/JCOP.22092

BACKGROUND: This study investigated patterns of probable posttraumatic stress disorder (PTSD) and their predictors among 2,431 Asian American and 31,455 non-Hispanic White World Trade Center (WTC) Registry participants 2-3 years and 5-6 years after the WTC attack. Participants were divided into four PTSD pattern groups: resilient, remitted, delayed onset, and chronic. Asians had a lower proportion in the resilient group (76.5% vs. 79.8%), a higher proportion in the chronic (8.6% vs. 7.4%) and remitted (5.9% vs. 3.4%) groups, and a similar proportion in the delayed onset group (about 9%) compared to Whites. In multinomial logistic regression analyses, disaster exposure, immigrant status, lower income, pre-attack depression/anxiety, and lower respiratory symptoms were associated with increased odds of chronic and delayed onset PTSD (vs. resilience) among both races. Education and employment were protective against chronic and delayed onset PTSD among Whites only. These results can inform targeted outreach efforts to enhance prevention and treatment for Asians affected by future events.

Kung WW, Liu X, Huang D, et al. 2018. Factors related to the probable PTSD after the 9/11 World Trade Center attack among asian americans. J Urban Health. 95 (2):255–266.

HTTPS://DOI.ORG/10.1007/S11524-017-0223-5

BACKGROUND: Despite the fact that Asians constituted a sizeable proportion of those exposed to the World Trade Center attack on September 11, 2001 due to its proximity to Chinatown and many South Asians working in the nearby buildings, no study had focused on examining the

mental health impact of the attack in this group. Based on data collected by the World Trade Center Health Registry from a sample of 4721 Asians 2-3 years after the disaster, this study provides a baseline investigation for the prevalence and the risk and protective factors for PTSD among Asian Americans directly exposed to the attack and compared this population against 42,862 non-Hispanic Whites. We found that Asians had a higher prevalence of PTSD compared to Whites (14.6 vs 11.7%). "Race-specific factors" significantly associated to PTSD in the multivariate analyses were noted among sociodemographics: higher education was protective for Whites but a risk factor for Asians; being employed was protective for Whites but had no effect for Asians; and being an immigrant was a risk factor for Whites but had no effect for Asians. However, income was a protective factor for both races. Other "universal factors" significantly increased the odds of PTSD symptoms but showed no racial differences, including exposure to the disaster and the presence of lower respiratory symptoms which intensified odds of PTSD by the greatest magnitude (3.6-3.9 times). Targeted effort to reach out to Asians is essential for prevention and follow up treatment given this group's striking history of underutilization of mental health services.

Landgren O, Zeig-Owens R, Giricz O, et al. 2018. Multiple myeloma and its precursor disease among firefighters exposed to the World Trade Center disaster. JAMA Oncol. 4 (6):821–827.

HTTPS://DOI.ORG/10.1001/JAMAONCOL.2018.0509

IMPORTANCE: The World Trade Center (WTC) attacks on September 11, 2001, created an unprecedented environmental exposure to known and suspected carcinogens suggested to increase the risk of multiple myeloma. Multiple myeloma is consistently preceded by the precursor states of monoclonal gammopathy of undetermined significance (MGUS) and light-chain MGUS, detectable in peripheral blood.

OBJECTIVE: To characterize WTC-exposed firefighters with a diagnosis of multiple myeloma and to conduct a screening study for MGUS and light-chain MGUS.

DESIGN, SETTING, AND PARTICIPANTS: Case series of multiple myeloma in firefighters diagnosed between September 11, 2001, and July 1, 2017, together with a seroprevalence study of MGUS in serum samples collected from Fire Department of the City of New York (FDNY) firefighters between December 2013 and October 2015. Participants included all WTC-exposed FDNY white, male firefighters with a confirmed physician diagnosis of multiple myeloma (n = 16) and WTC-exposed FDNY white male firefighters older than 50 years with available serum samples (n = 781).

EXPOSURES: WTC exposure defined as rescue and/or recovery work at the WTC site between September 11, 2001, and July 25, 2002.

MAIN OUTCOMES AND MEASURES: Multiple myeloma case information, and age-adjusted and age-specific prevalence rates for overall MGUS (ie, MGUS and light-chain MGUS), MGUS, and light-chain MGUS.

RESULTS: Sixteen WTC-exposed white male firefighters received a diagnosis of multiple myeloma after September 11, 2001; median age at diagnosis was 57 years (interquartile range, 50-68 years). Serum/urine monoclonal protein isotype/free light-chain data were available for 14 cases; 7 (50%) had light-chain multiple myeloma. In a subset of 7 patients, myeloma cells were assessed for CD20 expression; 5 (71%) were CD20 positive. In the screening study, we assayed peripheral blood from 781 WTC-exposed firefighters. The age-standardized prevalence rate of MGUS and light-chain MGUS combined was 7.63 per 100 persons (95% CI, 5.45-9.81), 1.8-fold higher than rates from the Olmsted County, Minnesota, white male reference population (relative rate, 1.76; 95% CI, 1.34-2.29). The age-standardized prevalence rate of light-chain MGUS was more than 3-fold higher than in the same reference population (relative rate, 3.13; 95% CI, 1.99-4.93).

CONCLUSIONS AND RELEVANCE: Environmental exposure to the WTC disaster site is associated with myeloma precursor disease (MGUS and light-chain MGUS) and may be a risk factor for the development of multiple myeloma at an earlier age, particularly the light-chain subtype.

Lieberman-Cribbin W, Tuminello S, Gillezeau C, et al. 2018. The development of a biobank of cancer tissue samples from World Trade Center responders. J Transl Med. 16 (1):280.

HTTPS://DOI.ORG/10.1186/S12967-018-1661-X

BACKGROUND: World Trade Center (WTC) responders were exposed to mixture of dust, smoke, chemicals and carcinogens. Studies of cancer incidence in this population have reported elevated risks of cancer compared to the general population. There is a need to supplement current epidemiologic cancer follow-up with a cancer tissue bank in order to better elucidate a possible connection between each cancer and past WTC exposure. This work describes the implementation of a tissue bank system for the WTC newly diagnosed cancers, focused on advancing the understanding of the biology of these tumors. This will ultimately impact the modalities of treatment, and the probability of success and survival of these patients.

METHODS: WTC Responders who participated (as employees or volunteers) in the rescue, recovery and cleanup efforts at the WTC sites have been enrolled at Mount Sinai in the World Trade Center Health Program. Responders with cancer identified and validated through linkages with New York, New Jersey, Pennsylvania, and Connecticut cancer registries were eligible to participate in this biobank. Potential participants were contacted through letters, phone calls, and emails to explain the research study, consent process, and to obtain the location where their cancer procedure was performed. Pathology departments were contacted to identify and request tissue samples.

RESULTS: All the 866 solid cancer cases confirmed by the Data Center at Mount Sinai have been contacted and consent was requested for retrieval and storage of the tissue samples from their cancer. Hospitals and doctors' offices were then contacted to locate and identify the

correct tissue block for each patient. The majority of these cases consist of archival paraffin blocks from surgical patients treated from 2002 to 2015. At the time of manuscript writing, this resulted in 280 cancer samples stored in the biobank.

CONCLUSIONS: A biobank of cancer tissue from WTC responders has been compiled with 280 specimens in storage to date. This tissue bank represents an important resource for the scientific community allowing for high impact studies on environmental exposures and cancer etiology, cancer outcome, and gene-environment interaction in the unique population of WTC responders.

Putman B, Zeig-Owens R, Singh A, et al. 2018. Risk factors for post–9/11 chronic rhinosinusitis in Fire Department of the City of New York workers. Occup Environ Med. 75 (12):884–889.

HTTPS://DOI.ORG/10.1136/OEMED-2018-105297

OBJECTIVES: Chronic rhinosinusitis (CRS) has high socioeconomic burden but underexplored risk factors. The collapse of the World Trade Center (WTC) towers on 11 September 2001 (9/11) caused dust and smoke exposure, leading to paranasal sinus inflammation and CRS. We aim to determine which job tasks are risk factors for CRS in WTC-exposed Fire Department of the City of New York (FDNY) firefighters and emergency medical services (EMS) workers.

METHODS: This cohort study included a 16-year follow-up of 11 926 WTC-exposed FDNY rescue/recovery workers with data on demographics, WTC exposure, job tasks and first post-9/11 complete blood counts. Using multivariable Cox regression, we assessed the associations of WTC exposure, work assignment (firefighter/EMS), digging and rescue tasks at the WTC site and blood eosinophil counts with subsequent CRS, adjusting for potential confounders.

RESULTS: The rate of CRS was higher in firefighters than EMS (1.80/100 person-years vs 0.70/100 person-years; p<0.001). The combination of digging and rescue work was a risk factor for CRS (HR 1.54, 95% CI 1.23 to 1.94, p<0.001) independent of work assignment and WTC exposure.

CONCLUSIONS: Compared with EMS, firefighters were more likely to engage in a combination of digging and rescue work, which was a risk factor for CRS. Chronic irritant exposures associated with digging and rescue work may account for higher post-9/11 CRS rates among firefighters.

Remch M, Laskaris Z, Flory J, et al. 2018. Post-traumatic stress disorder and cardiovascular diseases: A cohort study of men and women involved in cleaning the debris of the World Trade Center complex. Circ Cardiovasc Qual Outcomes. 11 (7):e004572.

HTTPS://DOI.ORG/10.1161/CIRCOUTCOMES.117.004572

BACKGROUND: We sought to determine whether post-traumatic stress disorder (PTSD) is a risk factor for myocardial infarction (MI) and stroke, beyond the expected effects from recognized cardiovascular risk factors and depression.

METHODS AND RESULTS: World Trade Center-Heart is an observational prospective cohort study of 6481 blue-collar

first responders nested within the World Trade Center Health Program in New York City. Baseline measures in 2012 and 2013 included blood pressure, weight and height, and blood lipids. PTSD, depression, smoking, and dust exposure during the 2001 cleanup were self-reported. During the 4-year follow-up, outcomes were assessed through (1) interview-based incident, nonfatal MI, and stroke, validated in medical charts (n=118); and (2) hospitalizations for MI and stroke for New York city and state residents (n=180). Prevalence of PTSD was 19.9% in men and 25.9% in women, that is, at least twice that of the general population. Cumulative incidence of MI or stroke was consistently larger for men or women with PTSD across follow-up. Adjusted hazard ratios (HRs) were 2.22 (95% confidence interval [CI], 1.30-3.82) for MI and 2.51 (95% CI, 1.39-4.57) for stroke. For pooled MI and stroke, adjusted HRs were 2.35 (95% CI, 1.57-3.52) in all and 1.88 (95% CI, 1.01-3.49) in men free of depression. Using hospitalization registry data, adjusted HRs were 2.17 (95% CI, 1.41-3.32) for MI; 3.01 (95% CI, 1.84-4.93) for stroke; and for pooled MI and stroke, the adjusted HR was 2.40 (95% CI, 1.73-3.34) in all, HR was 2.44 (95% CI, 1.05-5.55) in women, and adjusted HR was 2.27 (95% CI, 1.41-3.67) in men free of depression. World Trade Center dust exposure had no effect.

CONCLUSIONS: This cohort study confirms that PTSD is a risk factor for MI and stroke of similar magnitude in men and women, independent of depression.

Singh A, Liu C, Putman B, et al. 2018. Predictors of asthma/COPD overlap in FDNY firefighters with World Trade Center dust exposure: A longitudinal study. Chest. 154 (6):1301–1310.

HTTPS://DOI.ORG/10.1016/J.CHEST.2018.07.002

BACKGROUND: Previously healthy firefighters with World Trade Center (WTC) dust exposure developed airway disease. Risk factors for irritant-associated asthma/COPD overlap are poorly defined.

METHODS: This study included 2,137 WTC-exposed firefighters who underwent a clinically indicated bronchodilator pulmonary function test (BD-PFT) between 9/11/2001 and 9/10/2017. A post-BD FEV1 increase of > 12% and 200 mL from baseline defined asthma, and a post-BD FEV1/FVC ratio < 0.7 identified COPD cases. Participants who met both criteria had asthma/COPD overlap. Eosinophil levels were measured on screening blood tests performed shortly after 9/11/2001 and prior to BD-PFT; a subgroup of participants also had serum IgE and 21 cytokines measured (n = 215). Marginal Cox regression models for multiple events assessed the associations of eosinophil levels or serum biomarkers with subsequent diagnosis, with age, race, smoking, WTC exposure, first post-9/11 FEV1/FVC ratio, and BMI included as covariates.

RESULTS: BD-PFT diagnosed asthma/COPD overlap in 99 subjects (4.6%), isolated-asthma in 202 (9.5%), and isolated-COPD in 215 (10.1%). Eosinophil concentration >/= 300 cells/muL was associated with increased risk of asthma/COPD overlap (hazard ratio [HR], 1.85; 95% CI, 1.16-2.95) but not with isolated-asthma or isolated-COPD. Serum IL-4

also predicted asthma/COPD overlap (HR, 1.51 per doubling of cytokine concentration; 95% CI, 1.17-1.95). Greater IL-21 concentration was associated with both isolated-asthma and isolated-COPD (HRs of 1.73 [95% CI, 1.27-2.35] and 2.06 [95% CI, 1.31-3.23], respectively).

CONCLUSIONS: In WTC-exposed firefighters, elevated blood eosinophil and IL-4 levels are associated with subsequent asthma/COPD overlap. Disease-specific T-helper cell type 2 biomarkers present years before diagnosis suggest patient-intrinsic predisposition to irritant-associated asthma/COPD overlap.

Singh A, Zeig-Owens R, Moir W, et al. 2018. Estimation of future cancer burden among rescue and recovery workers exposed to the World Trade Center disaster. JAMA Oncol. 4 (6):828–831.

HTTPS://DOI.ORG/10.1001/JAMAONCOL.2018.0504

IMPORTANCE: Elevated rates of cancer have been reported in individuals exposed to the World Trade Center (WTC) disaster, including Fire Department of the City of New York (FDNY) rescue and recovery workers.

OBJECTIVE: To the future burden of cancer in WTC-exposed FDNY rescue and recovery workers by estimating the 20-year cancer incidence.

DESIGN, SETTING, AND PARTICIPANTS: A total of 14474 WTC-exposed FDNY employees who were cancer-free on January 1, 2012; subgroup analyses were conducted of the cohort's white male population (n = 12374). In this closed-cohort study, we projected cancer incidence for the January 1, 2012, to December 31, 2031, period. Simulations were run using demographic-specific New York City (NYC) cancer and national mortality rates for each individual, summed for the whole cohort, and performed 1000 times to produce mean estimates. Additional analyses in the subgroup of white men compared case counts produced by using 2007-2011 FDNY WTC Health Program (FDNY-WTCHP) cancer rates vs NYC rates. Average and 20-year aggregate costs of first-year cancer care were estimated using claims data. Exposures: World Trade Center disaster exposure defined as rescue and recovery work at the WTC site at any time from September 11, 2001, to July 25, 2002.

MAIN OUTCOMES AND MEASURES: (1) Projected number of incident cancers in the full cohort, based on NYC cancer rates; (2) cancer incidence estimates in the subgroup projected using FDNY-WTCHP vs NYC rates; and (3) estimated first-year treatment costs of incident cancers.

RESULTS: On January 1, 2012, the cohort was 96.8% male, 87.1% white, and had a mean (SD) age of 50.2 (9.2) years. The projected number of incident cancer cases was 2960 (95% CI, 2883-3037). In our subgroup analyses using FDNY-WTCHP vs NYC cancer rates, the projected number of new cases in white men was elevated (2714 [95% CI, 2638-2786] vs 2596 [95% CI, 2524-2668]). Accordingly, we expect more prostate (1437 [95% CI, 1383-1495] vs 863 [95% CI, 816-910]), thyroid (73 [95% CI, 60-86] vs 57 [95% CI, 44-69]), and melanoma cases (201 [95% CI, 179-223] vs 131 [95% CI, 112-150), but fewer lung (237 [95% CI, 212-262] vs 373 [95% CI, 343-405]), colorectal

(172 [95% CI, 152-191] vs 267 [95% CI, 241-292]), and kidney cancers (66 [95% CI, 54-80] vs 132 [95% CI, 114-152]) (P < .001 for all comparisons). The estimated 20-year cost of first-year treatment was $235835412 (95% CI, $187582227-$284088597).

CONCLUSIONS AND RELEVANCE: We that the FDNY-WTCHP cohort will experience a greater cancer burden than would be expected from a demographically similar population. This underscores the importance of cancer prevention efforts and routine screening in WTC-exposed rescue and recovery workers.

Trye A, Berger KI, Naidu M, et al. 2018. Respiratory health and lung function in children exposed to the World Trade Center disaster. J Pediatr. 201:134–140 e136.

HTTPS://DOI.ORG/10.1016/J.JPEDS.2018.06.009

OBJECTIVES: To compare lung function in a representative sample of World Trade Center (WTC)-exposed children with matched comparisons, and examine relationships with reported exposures.

STUDY DESIGN: Study population consisted of 402 participants. Oscillometry, spirometry, and plethysmography were performed on WTC Health Registry (WTCHR) respondents who were </=8 years of age on September 11, 2001 (n = 180) and a sociodemographically matched group of New York City residents (n = 222). We compared lung function by study arm (WTCHR and comparison group) as well as dust cloud (acute); home dust (subchronic); and other traumatic, nondust exposures.

RESULTS: In multivariable models, post-9/11 risk of incident asthma was higher in the WTCHR participants than in the comparison group (OR 1.109, 95% CI 1.021, 1.206; P = .015). Comparing by exposure rather than by group, dust cloud (OR 1.223, 95% CI 1.095, 1.365; P < .001) and home dust (OR 1.123, 95% CI 1.029, 1.226; P = .009) exposures were also associated with a greater risk of incidence of post-9/11 asthma. No differences were identified for lung function measures.

CONCLUSIONS: Although we cannot exclude an alternative explanation to the null findings, these results may provide some measure of reassurance to exposed children and their families regarding long-term consequences. Further study with bronchodilation and/or methacholine challenge may be needed to identify and further evaluate effects of WTC exposure. Biomarker studies may also be more informative in delineating exposure-outcome relationships.

TRIAL REGISTRATION: *CLINICALTRIALS.GOV:* NCT02068183.

Uchida M, Feng H, Feder A, et al. 2018. Parental posttraumatic stress and child behavioral problems in World Trade Center responders. Am J Ind Med. 61 (6):504–514.

HTTPS://DOI.ORG/10.1002/AJIM.22838

BACKGROUND: We investigated trans-generational associations between Post Traumatic Stress Disorder (PTSD) symptoms in World Trade Center (WTC) responders and behavioral problems in their children.

METHODS: Participants were WTC responders-8034 police and 8352 non-tra-

ditional (eg, construction workers)-with one or more children at the time of their first visit to the World Trade Center Health Program (WTC-HP). Self-report questionnaires were administered approximately 4 years after the 9/11 WTC attack.

RESULTS: A total of 31.4% of non-traditional and 20.0% of police responders reported behavioral problems in their children. Non-traditional responder status, female sex, Hispanic ethnicity, more life stressors, more WTC-related PTSD symptoms, and dysphoric arousal symptoms were significant correlates of behavioral problems in responders' children.

CONCLUSIONS: Specific parental sociodemographic, psychosocial and clinical characteristics, as well as PTSD symptom severity, were significant correlates of child behavior problems.

FINDINGS: encourage monitoring and early intervention for children of disaster responders, particularly those at highest risk.

Uddin M, Ratanatharathorn A, Armstrong D, et al. 2018. Epigenetic meta-analysis across three civilian cohorts identifies NRG1 and HGS as blood-based biomarkers for post-traumatic stress disorder. Epigenomics. 10 (12):1585–1601.

HTTPS://DOI.ORG/10.2217/EPI-2018-0049

AIM: Trauma exposure is a necessary, but not deterministic, contributor to post-traumatic stress disorder (PTSD). Epigenetic factors may distinguish between trauma-exposed individuals with versus without PTSD. MATERIALS .

METHODS: We conducted a meta-analysis of PTSD epigenome-wide association studies in trauma-exposed cohorts drawn from civilian contexts. Whole blood-derived DNA methylation levels were analyzed in 545 study participants, drawn from the three civilian cohorts participating in the PTSD working group of the Psychiatric Genomics Consortium.

RESULTS: Two CpG sites significantly associated with current PTSD in NRG1 (cg23637605) and in HGS (cg19577098).

CONCLUSION: PTSD is associated with differential methylation, measured in blood, within HGS and NRG1 across three civilian cohorts.

Waszczuk MA, Li K, Ruggero CJ, et al. 2018. Maladaptive personality traits and 10-year course of psychiatric and medical symptoms and functional impairment following trauma. Ann Behav Med. 52 (8):697–712.

HTTPS://DOI.ORG/10.1093/ABM/KAX030

BACKGROUND: Personality is a major predictor of many mental and physical disorders, but its contributions to illness course are understudied. Purpose: The current study aimed to explore whether personality is associated with a course of psychiatric and medical illness over 10 years following trauma.

METHODS: World Trade Center (WTC) responders (N = 532) completed the personality inventory for DSM-5, which measures both broad domains and narrow facets. Responders' mental and physical health was assessed in the decade following the WTC disaster during annual mon-

itoring visits at a WTC Health Program clinic. Multilevel modeling was used in an exploratory manner to chart the course of health and functioning, and examine associations of maladaptive personality domains and facets with intercepts (initial illness) and slopes (course) of illness trajectories.

RESULTS: Three maladaptive personality domains-negative affectivity, detachment and psychoticism-were uniquely associated with initial posttraumatic stress disorder (PTSD); detachment and psychoticism were also associated with initial functional impairment. Five facets-emotional lability, anhedonia, callousness, distractibility and perceptual dysregulation-were uniquely associated with initial mental and physical health and functional impairment. Anxiousness and depressivity facets were associated with worse initial levels of psychiatric outcomes only. With regard to illness trajectory, callousness and perceptual dysregulation were associated with the increase in PTSD symptoms. Anxiousness was associated with greater persistence of respiratory symptoms.

CONCLUSIONS: Several personality domains and facets were associated with initial levels and long-term course of illness and functional impairment in a traumatized population. Results inform the role of maladaptive personality in the development and maintenance of chronic mental-physical comorbidity. Personality might constitute a transdiagnostic prognostic and treatment target.

Zeig-Owens R, Singh A, Aldrich TK, et al. 2018. Blood leukocyte concentrations, FEV1 decline, and airflow limitation. A 15-year longitudinal study of World Trade Center-exposed firefighters. Ann Am Thorac Soc. 15 (2):173–183.

HTTPS://DOI.ORG/10.1513/ANNALSATS.201703-276OC

RATIONALE: Rescue/recovery work at the World Trade Center disaster site (WTC) caused a proximate decline in lung function in Fire Department of the City of New York firefighters. A subset of this cohort experienced an accelerated rate of lung function decline over 15 years of post-September 11, 2001 (9/11) follow-up. OBJECTIVES: To determine if early postexposure blood leukocyte concentrations are biomarkers for subsequent FEV1 decline and incident airflow limitation.

METHODS: Individual rates of forced expiratory volume in 1 second (FEV1) change were calculated for 9,434 firefighters using 88,709 spirometric measurements taken between September 11, 2001, and September 10, 2016. We categorized FEV1 change rates into three trajectories: accelerated FEV1 decline (FEV1 loss >64 ml/yr), expected FEV1 decline (FEV1 loss between 0 and 64 ml/yr), and improved FEV1 (positive rate of change >0 ml/yr). Occurrence of FEV1/FVC less than 0.70 after 9/11 defined incident airflow limitation. Using regression models, we assessed associations of post-9/11 blood eosinophil and neutrophil concentrations with subsequent FEV1 decline and airflow limitation, adjusted for age, race, smoking, height, WTC exposure level, weight change, and baseline lung function.

RESULTS: Accelerated FEV1 decline occurred in 12.7% of participants (1,199 of

9,434), whereas post-9/11 FEV1 improvement occurred in 8.3% (780 of 9,434). Higher blood eosinophil and neutrophil concentrations were each associated with accelerated FEV1 decline after adjustment for covariates (odds ratio [OR], 1.10 per 100 eosinophils/mul; 95% confidence interval [CI], 1.05-1.15; and OR, 1.10 per 1,000 neutrophils/mul; 95% CI, 1.05-1.15, respectively). Multivariable-adjusted linear regression models showed that a higher blood neutrophil concentration was associated with a faster rate of FEV1 decline (1.14 ml/yr decline per 1,000 neutrophils/mul; 95% CI, 0.69-1.60 ml/yr; P < 0.001). Higher blood eosinophil concentrations were associated with a faster rate of FEV1 decline in ever-smokers (1.46 ml/yr decline per 100 eosinophils/mul; 95% CI, 0.65-2.26 ml/yr; P < 0.001) but not in never-smokers (P for interaction = 0.004). Higher eosinophil concentrations were also associated with incident airflow limitation (adjusted hazard ratio, 1.10 per 100 eosinophils/mul; 95% CI, 1.04-1.15). Compared with the expected FEV1 decline group, individuals experiencing accelerated FEV1 decline were more likely to have incident airflow limitation (adjusted OR, 4.12; 95% CI, 3.30-5.14).

CONCLUSIONS: Higher post-9/11 blood neutrophil and eosinophil concentrations were associated with subsequent accelerated FEV1 decline in WTC-exposed firefighters. Both higher blood eosinophil concentrations and accelerated FEV1 decline were associated with incident airflow limitation in WTC-exposed firefighters.

Year Published 2019 (37)

Ayappa I, Chen Y, Bagchi N, et al. 2019. The association between health conditions in World Trade Center responders and sleep-related quality of life and sleep complaints. International Journal of Environmental Research and Public Health. 16 (7)

HTTPS://DOI.ORG/10.3390/IJERPH16071229

BACKGROUND: World Trade Center (WTC) dust-exposed subjects have multiple comorbidities that affect sleep. These include obstructive sleep apnea (OSA), chronic rhinosinusitis (CRS), gastro-esophageal-reflux disorder (GERD) and post-traumatic stress disorder (PTSD). We examined the impact of these conditions to sleep-related outcomes.

METHODS: Demographics, co-morbidities and symptoms were obtained from 626 WTC (109F/517M), 33–87years, BMI = 29.96 ± 5.53 kg/m2) subjects. OSA diagnosis was from a 2-night home sleep test (ARESTM). Subjective sleep quality, sleep-related quality of life (QOL, Functional Outcomes of Sleep Questionnaire), excessive daytime sleepiness (Epworth Sleepiness Scale), sleep duration and sleep onset and maintenance complaints were assessed.

RESULTS: Poor sleep quality and complaints were reported by 19–70% of subjects and average sleep duration was 6.4 h. 74.8% of subjects had OSA. OSA diagnosis/severity was not associated with any sleep-related outcomes. Sleep

duration was lower in subjects with all conditions ($p < 0.05$) except OSA. CRS was a significant risk factor for poor sleep-related QOL, sleepiness, sleep quality and insomnia; PTSD for poor sleep-related QOL and insomnia; GERD for poor sleep quality. These associations remained significant after adjustment for, age, BMI, gender, sleep duration and other comorbidities.

CONCLUSIONS: Sleep complaints are common and related to several health conditions seen in WTC responders. Initial interventions in symptomatic patients with both OSA and comorbid conditions may need to be directed at sleep duration, insomnia or the comorbid condition itself, in combination with intervention for OSA.

Bover Manderski MT, Black K, Udasin IG, et al. 2019. Risk factors for head and neck cancer in the World Trade Center Health Program general responder cohort: Results from a nested case-control study. Occup Environ Med. 76 (11):854–860.

HTTPS://DOI.ORG/10.1136/OEMED-2019-105890

OBJECTIVES: Head and neck cancers (HNCs) may be among the health consequences of involvement in the World Trade Center (WTC) response on and after 11 September 2001. We conducted a nested case-control study of WTC Health Program (WTCHP) general responders to examine the effects of WTC exposures and behavioural risk factors on HNC.

METHODS: We enrolled 64 cases and 136 controls, matched on age, sex and race/ethnicity within risk sets. We assessed tobacco and alcohol use, sexual activity, and occupational exposures prior to, during and after WTC exposure until case diagnosis via questionnaire. We obtained WTC exposure information (duration (first to last day), total days and location of work) from the WTCHP General Responder Data Center. We assessed associations with HNC, and interaction among exposures, using conditional logistic regression.

RESULTS: Responders in protective services versus other occupations had increased odds (OR: 2.51, 95% CI 1.09 to 5.82) of HNC. Among those in non-protective services occupations, arriving to the WTC effort on versus after 11 September 2001 was significantly associated with HNC (OR: 3.77, 95% CI 1.00 to 14.11). Duration of work was not significantly associated with HNC. Lifetime and post-WTC years of cigarette smoking and post-WTC number of sex partners were positively and significantly associated with HNC, while alcohol consumption was not.

CONCLUSIONS: These findings suggest opportunities for HNC risk factor mitigation (eg, smoking cessation, human papillomavirus vaccination) and contribute to a risk factor profile which may assist WTCHP clinicians with identifying high-risk responders and improve detection and treatment outcomes in this population.

Citron J, Willcocks E, Crowley G, et al. 2019. Genomics of particulate matter exposure associated cardiopulmonary disease: A narrative review. Int J Environ Res Public Health. 16 (22)

HTTPS://DOI.ORG/10.3390/IJERPH16224335

BACKGROUND: Particulate matter (PM) exposure is associated with the development of cardiopulmonary disease. Our group has studied the adverse health effects of World Trade Center particulate matter (WTC-PM) exposure on firefighters. To fully understand the complex interplay between exposure, organism, and resultant disease phenotype, it is vital to analyze the underlying role of genomics in mediating this relationship.

METHOD:A PubMed search was performed focused on environmental exposure, genomics, and cardiopulmonary disease. We included original research published within 10 years, on epigenetic modifications and specific genetic or allelic variants. The initial search resulted in 95 studies. We excluded manuscripts that focused on work-related chemicals, heavy metals and tobacco smoke as primary sources of exposure, as well as reviews, prenatal research, and secondary research studies. Seven full-text articles met pre-determined inclusion criteria, and were reviewed. The effects of air pollution were evaluated in terms of methylation (n = 3), oxidative stress (n = 2), and genetic variants (n = 2). There is evidence to suggest that genomics plays a meditating role in the formation of adverse cardiopulmonary symptoms and diseases that surface after exposure events. Genomic modifications and variations affect the association between environmental exposure and cardiopulmonary disease, but additional research is needed to further define this relationship.

Clementi EA, Talusan A, Vaidyanathan S, et al. 2019. Metabolic syndrome and air pollution: A narrative review of their cardiopulmonary effects. Toxics. 7 (1)

HTTPS://DOI.ORG/10.3390/TOXICS7010006

BACKGROUND: Particulate matter (PM) exposure and metabolic syndrome (MetSyn) are both significant global health burdens. PM exposure has been implicated in the pathogenesis of MetSyn and cardiopulmonary diseases. Individuals with pre-existing MetSyn may be more susceptible to the detrimental effects of PM exposure. Our aim was to provide a narrative review of MetSyn/PM-induced systemic inflammation in cardiopulmonary disease, with a focus on prior studies of the World Trade Center (WTC)-exposed Fire Department of New York (FDNY). We included studies (1) published within the last 16-years; (2) described the epidemiology of MetSyn, obstructive airway disease (OAD), and vascular disease in PM-exposed individuals; (3) detailed the known mechanisms of PM-induced inflammation, MetSyn and cardiopulmonary disease; and (4) focused on the effects of PM exposure in WTC-exposed FDNY firefighters. Several investigations support that inhalation of PM elicits pulmonary and systemic inflammation resulting in MetSyn and cardiopulmonary disease. Furthermore, individuals with these preexisting conditions are more sensitive to PM exposure-related inflammation, which can exacerbate their conditions and increase their risk for hospitalization and chronic disease. Mechanistic research is required to elucidate biologically plausible therapeutic targets of MetSyn- and PM-induced cardiopulmonary disease.

Cleven KL, Ye K, Zeig-Owens R, et al. 2019. Genetic variants associated with FDNY WTC-related sarcoidosis. International journal of environmental research and public health. 16 (10)

HTTPS://DOI.ORG/10.3390/IJERPH16101830

BACKGROUND: Sarcoidosis is a systemic granulomatous disease of unknown etiology. It may develop in response to an exposure or inflammatory trigger in the background of a genetically primed abnormal immune response. Thus, genetic studies are potentially important to our understanding of the pathogenesis of sarcoidosis. We developed a case-control study which explored the genetic variations between firefighters in the Fire Department of the City of New York (FDNY) with World Trade Center (WTC)-related sarcoidosis and those with WTC exposure, but without sarcoidosis. The loci of fifty-one candidate genes related to granuloma formation, inflammation, immune response, and/or sarcoidosis were sequenced at high density in enhancer/promoter, exonic, and 5' untranslated regions. Seventeen allele variants of human leukocyte antigen (HLA) and non-HLA genes were found to be associated with sarcoidosis, and all were within chromosomes 1 and 6. Our results also suggest an association between extrathoracic involvement and allele variants of HLA and non-HLA genes found not only on chromosomes 1 and 6, but also on chromosomes 16 and 17. We found similarities between genetic variants with WTC-related sarcoidosis and those reported previously in sporadic sarcoidosis cases within the general population. In addition, we identified several allele variants never previously reported in association with sarcoidosis. If confirmed in larger studies with known environmental exposures, these novel findings may provide insight into the gene-environment interactions key to the development of sarcoidosis.

Clouston SAP, Edelman NH, Abraham A, et al. 2019. Shortened leukocyte telomere length is associated with reduced pulmonary function and greater subsequent decline in function in a sample of World Trade Center responders. Scientific Reports (Nature Publisher Group). 9 (1):8148.

HTTPS://DOI.ORG/10.1038/S41598-019-44625-1

THE OBJECTIVE OF THIS STUDY: was to examine whether shorter leukocyte telomere length (LTL) is associated with more rapid pulmonary function decline in a longitudinal study of World Trade Center (WTC) responders. WTC responders (N = 284) participating in a monitoring study underwent blood sampling and were followed prospectively for spirometric outcomes.

METHOD: A single blood sample was taken to measure LTL using southern blotting. Outcomes included percent-predicted one-second forced expiratory volume (FEV1%), forced vital capacity (FVC%), and the FEV1/FVC ratio. In a subset, percent-predicted diffusing capacity (DLCO%) was also measured. Longitudinal modeling examined prospectively collected information over five years since blood was banked was used to examine the rate of change in pulmonary functioning over time. Severity of WTC exposure was assessed. Shorter LTL was associated with lower FEV1% and FVC% at baseline. For example, 29.9% of those with LTL <6.5 kbps had FEV1% <80% whereas only 12.4% of those with LTL ≥6.5 had FEV1% <80% (RR = 2.53, 95%CI = [1.70–3.76]). Lower DLCO% was also significantly associated with shorter

LTL. Longitudinal models identified a prospective association between shorter LTL and greater yearly rates of decline in FEV1% (0.46%/year, 95%CI = [0.05–0.87]) and in the FEV1/FVC ratio (0.19%/year, 95%CI = [0.03–0.36]).

RESULTS:here were no associations between severity of exposure and either LTL or pulmonary function. Longitudinal analyses revealed that shorter LTL, but not severity of WTC exposures, was associated with poorer pulmonary functioning and with greater subsequent decline in pulmonary functioning over time. These findings are consistent with the idea that shortened LTL may act as a biomarker for enhanced pulmonary vulnerability in the face of acute severe toxic inhalation exposures.

Crowley G, Kwon S, Ostrofsky DF, et al. 2019. Assessing the protective metabolome using machine learning in World Trade Center particulate exposed firefighters at risk for lung injury. Sci Rep. 9 (1):11939.

HTTPS://DOI.ORG/10.1038/S41598-019-48458-W

BACKGROUND: The metabolome of World Trade Center (WTC) particulate matter (PM) exposure has yet to be fully defined and may yield information that will further define bioactive pathways relevant to lung injury. A subset of Fire Department of New York firefighters demonstrated resistance to subsequent loss of lung function. We intend to characterize the metabolome of never smoking WTC-exposed firefighters, stratified by resistance to WTC-Lung Injury (WTC-LI) to determine metabolite pathways significant in subjects resistant to the loss of lung function. The global serum metabolome was determined in those resistant to WTC-LI and controls (n = 15 in each). Metabolites most important to class separation (top 5% by Random Forest (RF) of 594 qualified metabolites) included elevated amino acid and long-chain fatty acid metabolites, and reduced hexose monophosphate shunt metabolites in the resistant cohort. RF using the refined metabolic profile was able to classify cases and controls with an estimated success rate of 93.3%, and performed similarly upon cross-validation. Agglomerative hierarchical clustering identified potential influential pathways of resistance to the development of WTC-LI. These pathways represent potential therapeutic targets and warrant further research.

de la Hoz RE, Jeon Y, Reeves AP, et al. 2019. Increased pulmonary artery diameter is associated with reduced FEV1 in former World Trade Center workers. Clin Respir J. 13 (10):614–623.

HTTPS://DOI.ORG/10.1111/CRJ.13067

RATIONALE: Occupational exposures at the WTC site after September 11, 2001 have been associated with several presumably inflammatory lower airway diseases. Pulmonary arterial enlargement, as suggested by an increased ratio of the diameter of the pulmonary artery to the diameter of the aorta (PAAr) has been reported as a computed tomographic (CT) scan marker of adverse respiratory health outcomes, including WTC-related disease. In this study, we sought to utilize a novel quantitative CT (QCT) measurement of PAAr to test the hypothesis that an increased ratio is associated with FEV1 below each subject's statistically determined lower limit of normal (FEV1 <LLN).

METHODS: In a group of 1,180 WTC workers and volunteers, we examined whether FEV1 <LLN was associated with an increased QCT-measured PAAr, adjusting for previously identified important covariates.

RESULTS: Unadjusted analyses showed a statistically significant association of FEV1 <LLN with PAAr (35.3% vs. 24.7%, p=0.0001), as well as with height, body mass index, early arrival at the WTC disaster site, shorter WTC exposure duration, posttraumatic stress disorder checklist (PCL) score, wall area percent, and evidence of bronchodilator response. The multivariate logistic regression model confirmed the association of FEV1 <LLN with PAAr (OR 1.63, 95% CI 1.21, 2.20, p=0.0015) and all the unadjusted associations, except for PCL score.

CONCLUSIONS: In WTC workers, FEV1 <LLN is associated with elevated PAAr which, although likely multifactorial, may be related to distal vasculopathy, as has been hypothesized for chronic obstructive pulmonary disease.

de la Hoz RE, Liu X, Celedón JC, et al. 2019. Association of obesity with quantitative chest ct measured airway wall thickness in WTC workers with lower airway disease. Lung. 197 (4):517–522.

HTTPS://DOI.ORG/10.1007/S00408-019-00246-Z

BACKGROUND: We previously reported that wall area percent (WAP), a quantitative CT (QCT) indicator of airway wall thickness and, presumably, inflammation, is associated with adverse longitudinal expiratory flow trajectories in WTC workers, but that obesity and weight gain also seemed to be independently predictive of the latter. Previous studies have reported no association between WAP and obesity, so we investigated that association in nonsmoking WTC-exposed individuals and healthy unexposed controls.

METHODS:We assessed WAP using the Chest Imaging Platform QCT system in a segmental bronchus in 118 former WTC workers, and 89 COPDGene® WTC-unexposed and asymptomatic subjects. We used multiple regression to model WAP vs. body mass index (BMI) in the two groups, adjusting for important subject and CT image characteristics.ResultsUnadjusted analyses revealed significant differences between the two groups with regards to WAP, age, gender, scan pixel spacing and slice interval, but not BMI or total lung capacity. In adjusted analysis, there was a significant interaction between BMI and WTC exposure on WAP. BMI was significantly and positively associated with WAP in the WTC group, but not in the COPDGene® group, but stratified analyses revealed that the effect was significant in WTC subjects with clinical evidence of lower airway disease (LAD).

DISCUSSION: Unlike non-diseased subjects, BMI was significantly associated with WAP in WTC workers and, in stratified analyses, the association was significant only among those with LAD. Our findings suggest that this adverse effect of obesity on airway structure and inflammation may be confined to already diseased individuals.

de la Hoz RE, Weber J, Xu D, et al. 2019. Chest ct scan findings in World Trade Center workers. Arch Environ Occup Health. 74 (5):263–270.

HTTPS://DOI.ORG/10.1080/19338244.2018.1452712

BACKGROUND: We examined the chest CT scans of 1,453 WTC responders using the International Classification of High-resolution CT for Occupational and Environmental Respiratory Diseases. Univariate and bivariate analyses of potential work-related pleural abnormalities were performed with pre-WTC and WTC-related occupational exposure data, spirometry, demographics and quantitative CT measurements. Logistic regression was used to evaluate occupational predictors of those abnormalities. Chest CT scans were performed first at a median of 6.8 years after 9/11/2001. Pleural abnormalities were the most frequent (21.1%) across all occupational groups In multivariable analyses, significant pre-WTC occupational asbestos exposure, and work as laborer/cleaner were predictive of pleural abnormalities, with prevalence being highest for the Polish subgroup (n = 237) of our population. Continued occupational lung disease surveillance is warranted in this cohort.

Dietch JR, Ruggero CJ, Schuler K, et al. 2019. Posttraumatic stress disorder symptoms and sleep in the daily lives of World Trade Center responders. J Occup Health Psychol. 24 (6):689–702.

HTTPS://DOI.ORG/10.1037/OCP0000158

BACKGROUND: Sleep disturbances are common in posttraumatic stress disorder (PTSD) and can have major impacts on workplace performance and functioning. Although effects between PTSD and sleep broadly have been documented, little work has tested their day-to-day temporal relationship particularly in those exposed to occupational trauma. The present study examined daily, bidirectional associations between PTSD symptoms and self-reported sleep duration and quality in World Trade Center (WTC) responders oversampled for PTSD. WTC responders (N = 202; 19.3% with current PTSD diagnosis) were recruited from the Long Island site of the WTC health program.

PARTICIPANTS: were administered the Structured Clinical Interview for Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition (DSM-IV; SCID; First, Spitzer, Gibbon, & Williams, 1997) and completed daily assessments of PTSD symptoms, sleep duration and sleep quality for 7 days. PTSD symptoms on a given day were prospectively associated with shorter sleep duration (beta = -.13) and worse sleep quality (beta = -.18) later that night. Reverse effects were also significant but smaller, with reduced sleep duration (not quality) predicting increased PTSD the next day (beta = -.04). Effects of PTSD on sleep duration and quality were driven by numbing symptoms, whereas effects of sleep duration on PTSD were largely based on intrusion symptoms. PTSD symptoms and sleep have bidirectional associations that occur on a daily basis, representing potential targets to disrupt maintenance of each. Improving PTSD numbing symptoms may improve sleep, and increasing sleep duration may improve intrusion symptoms in individuals with exposure to work-related traumatic events.

Gaylord A, Berger KI, Naidu M, et al. 2019. Serum perfluoroalkyl substances and lung function in adolescents exposed to the World Trade Center disaster. Environmental Research. 172:266–272.

HTTPS://DOI.ORG/10.1016/J.ENVRES.2019.02.024

BACKGROUND: The effects of childhood exposure to perfluoroalkyl substances (PFASs) on lung function remain mostly unknown. Previous research indicates that children living or going to school near the World Trade Center (WTC) disaster were exposed to high levels of PFASs, among other toxic chemicals. To explore the effects of PFAS exposure on lung function, we measured serum PFASs in a cohort of children from the WTC Health Registry and a matched control group. Perfluorooctanesulfonate had the highest median concentrations in both groups (WTCHR = 3.72 ng/mL, Comparison = 2.75 ng/mL), while the lowest median concentrations were seen for perfluoroundecanoic acid (WTCHR = 0.12 ng/mL, Comparison = 0.01 ng/mL). Lung function outcomes were measured by spirometry, plethysmography, and oscillometry. Asthma diagnosis and serum eosinophil count were also recorded. We examined the relationships of each PFAS with lung function parameters and eosinophil count using linear regressions. Odds ratios for asthma were obtained for each PFAS using logistic regression. The effect of total PFASs on these outcomes was also assessed. All regression models were adjusted for sex, race/ethnicity, age, body mass index (BMI) and tobacco smoke exposure. We found that serum PFASs were not statistically associated with the measured lung function parameters, asthma diagnosis, or eosinophil count in this cohort ($p < 0.05$). These findings highlight the need for more longitudinal studies to explore the long-term effects of childhood PFAS exposure on lung function past adolescence and early adulthood.

Geronazzo-Alman L, Fan B, Duarte CS, et al. 2019. The distinctiveness of grief, depression, and posttraumatic stress: Lessons from children after 9/11. J Am Acad Child Adolesc Psychiatry. 58 (10):971–982.

HTTPS://DOI.ORG/10.1016/J.JAAC.2018.12.012

OBJECTIVE: The clinical and nosological significance of grief reactions in youth exposed to a shared trauma (9/11) was tested by examining whether the (1) predictors (i.e., non-loss related trauma vs. traumatic bereavement), (2) clinical correlates, (3) factorial structure, and (4) phenomenology of grief reactions are distinct from those of major depressive disorder (MDD) and 9/11-related posttraumatic stress disorder (PTSD).

METHOD: In a representative sample of New York City schoolchildren (N=8,236; grades 4-12; n=1,696 bereaved), assessed six months post-9/11, multivariate regressions examined (1) predictors of grief, PTSD, and MDD, and (2) the incremental validity of grief in predicting health problems and functional impairment; factor analysis and latent class analysis determined, respectively, (3) the factorial and (4) syndromic distinctiveness of grief, PTSD, and MDD.

RESULTS: Four types of evidence supporting the distinctiveness of grief emerged. (1) Bereavement was associated with grief independently of PTSD and MDD, but not with PTSD and MDD after adjusting for grief; conversely, non-loss related trauma was associated primarily with PTSD. (2) Grief contributed uniquely to functional impairment. (3) Grief reactions loaded on a separate factor. (4) Youth with elevated grief reactions fell

into two classes characterized by only moderate and negligible probability of co-occurring PTSD and MDD symptoms, respectively.

CONCLUSION: A multi-faceted approach provided convergent evidence that grief reactions are independent of other common types of post-disaster child and adolescent psychopathology, and capture a unique aspect of bereavement-related distress. These findings suggest that grief reactions in traumatically bereaved youth merit separate clinical attention, informing tailored interventions.

Gong Y, Wang L, Yu H, et al. 2019. Prostate cancer in World Trade Center responders demonstrates evidence of an inflammatory cascade. Molecular Cancer Research. 17 (8):1605–1612.

HTTPS://DOI.ORG/10.1158/1541-7786.MCR-19-0115

BACKGROUND: An excess incidence of prostate cancer has been identified among World Trade Center (WTC) responders. In this study, we hypothesized that WTC dust, which contained carcinogens and tumor-promoting agents, could facilitate prostate cancer development by inducing DNA damage, promoting cell proliferation, and causing chronic inflammation. We compared expression of immunologic and inflammatory genes using a NanoString assay on archived prostate tumors from WTC Health Program (WTCHP) patients and non-WTC patients with prostate cancer. Furthermore, to assess immediate and delayed responses of prostate tissue to acute WTC dust exposure via intratracheal inhalation, we performed RNA-seq on the prostate of normal rats that were exposed to moderate to high doses of WTC dust. WTC prostate cancer cases showed significant upregulation of genes involved in DNA damage and G2–M arrest. Cell-type enrichment analysis showed that Th17 cells, a subset of proinflammatory Th cells, were specifically upregulated in WTC patients. In rats exposed to WTC dust, we observed upregulation of gene transcripts of cell types involved in both adaptive immune response (dendritic cells and B cells) and inflammatory response (Th17 cells) in the prostate. Unexpectedly, genes in the cholesterol biosynthesis pathway were also significantly upregulated 30 days after acute dust exposure.

RESULTS: Our results suggest that respiratory exposure to WTC dust can induce inflammatory and immune responses in prostate tissue.Implications: WTC-related prostate cancer displayed a distinct gene expression pattern that could be the result of exposure to specific carcinogens. Our data warrant further epidemiologic and cellular mechanistic studies to better understand the consequences of WTC dust exposure.

Graber JM, Harris G, Black K, et al. 2019. Excess hpv-related head and neck cancer in the World Trade Center Health Program general responder cohort. Int J Cancer. 145 (6):1504–1509.

HTTPS://DOI.ORG/10.1002/IJC.32070

BACKGROUND: The World Trade Center (WTC) attacks exposed rescue and recovery workers to a complex mix of toxicants, including carcinogens. our study compared site-specific cancer in-

cidence of head and neck cancers (HNC) from 2003 through 2012 among 33,809 consented WTC General Responder Cohort (GRC) members to the New Jersey State Cancer Registry, using standardized incidence ratios (SIRs). HNC grouped using SEER ICD-O-3 codes into HPV-related (oropharyngeal) and non-related (other oral-nasal; laryngeal) tumors based on anatomical site. For the 73 GRC members identified with HNC, proportional hazard regression assessed the relationship between WTC exposure and other socio-demographic characteristics. An overall excess of HNC was not observed (SIR = 1.00, 95% CI: 0.78, 1.25) but excess cancer was seen in the latest observation period (2009-2012: SIR = 1.4; 95% CI: 1.01, 1.89). A similar temporal pattern was seen for HPV-related oropharyngeal cancer and laryngeal cancer, but not for non-HPV-related sites (oral-nasal cancer). HNC was significantly associated with increasing age (8% per year, 95% CI: 5%, 12%), non-Hispanic white ethnic group-ethnicity (hazard ratio (HR) = 3.51, 95 CI: 1.49, 8.27); there was a borderline association with the 9/11 occupation of military/protective services vs. others (HR = 1.83 95% CI: 0.99, 3.38; p = 0.0504).

CONCLUSION: Caution is needed in interpreting these results given the small number of cases, potential for surveillance bias, and long latency for most cancers. Our findings highlight the need to examine the potentially carcinogenic effects of WTC exposure in the context of other strong risk factors, and the need for continued medical monitoring of WTC responders.

Haider SH, Oskuei A, Crowley G, et al. 2019. Receptor for advanced glycation end-products and environmental exposure related obstructive airways disease: A systematic review. Eur Respir Rev. 28 (151)

HTTPS://DOI.ORG/10.1183/16000617.0096-2018

BACKGROUND: Our group has identified the receptor for advanced glycation end-products (RAGE) as a predictor of World Trade Center particulate matter associated lung injury. The aim of this systematic review is to assess the relationship between RAGE and obstructive airways disease secondary to environmental exposure.

METHODS: A comprehensive search using PubMed and Embase was performed on January 5, 2018 utilising keywords focusing on environmental exposure, obstructive airways disease and RAGE and was registered with PROSPERO (CRD42018093834). We included original human research studies in English, focusing on pulmonary end-points associated with RAGE and environmental exposure.

RESULTS: A total of 213 studies were identified by the initial search. After removing the duplicates and applying inclusion and exclusion criteria, we screened the titles and abstracts of 61 studies. Finally, 19 full-text articles were included. The exposures discussed in these articles include particulate matter (n=2) and cigarette smoke (n=17).

CONCLUSION: RAGE is a mediator of inflammation associated end-organ dysfunction such as obstructive airways disease. Soluble RAGE, a decoy receptor, may have a protective effect in some pulmonary processes. Overall, RAGE is biologically relevant in environmental exposure associated lung disease. Future investigations should focus on further

understanding the role and therapeutic potential of RAGE in particulate matter exposure associated lung disease.

Kuan PF, Mi Z, Georgopoulos P, et al. 2019. Enhanced exposure assessment and genome-wide DNA methylation in World Trade Center disaster responders. Eur J Cancer Prev. 28 (3):225–233.

HTTPS://DOI.ORG/10.1097/CEJ.0000000000000460

BACKGROUND: DNA methylation has emerged as a promising target linking environmental exposures and cancer. The World Trade Center (WTC) responders sustained exposures to potential carcinogens, resulting in an increased risk of cancer. Previous studies of cancer risk in WTC-exposed responders were limited by the deficiency in quantitative and individual information on exposure to carcinogens.

RESULTS:The current study introduces a new exposure-ranking index (ERI) for estimating cancer-related acute and chronic exposures, which aimed to improve the ability of future analyses to estimate cancer risk. An epigenome-wide association study based on DNA methylation and a weighted gene co-expression network analysis were carried out to identify cytosine-phosphate-guanosine (CpG) sites, modules of correlated CpG sites, and biological pathways associated with the new ERI. Methylation was profiled on blood samples using Illumina 450K Beadchip. No significant epigenome-wide association was found for ERI at a false discovery rate of 0.05. Several cancer-related pathways emerged in pathway analyses for the top ranking genes from epigenome-wide association study as well as enriched module from the weighted gene co-expression network analysis. The current study was the first DNA methylation study that aimed to identify methylation signature for cancer-related exposure in the WTC population. No CpG sites survived multiple testings adjustment. However, enriched gene sets involved in cancer, were identified in both acute and chronic ERIs, supporting the view that multiple genes play a role in this complex exposure.

Kuan PF, Yang X, Clouston S, et al. 2019. Cell type-specific gene expression patterns associated with posttraumatic stress disorder in World Trade Center responders. Transl Psychiatry. 9 (1):1.

HTTPS://DOI.ORG/10.1038/S41398-018-0355-8

Posttraumatic stress disorder (PTSD), a chronic disorder resulting from severe trauma, has been linked to immunologic dysregulation. Gene expression profiling has emerged as a promising tool for understanding the pathophysiology of PTSD. However, to date, all but one gene expression study was based on whole blood or unsorted peripheral blood mononuclear cell (PBMC), a complex tissue consisting of several populations of cells.

THE OBJECTIVE OF THIS STUDY: was to utilize RNA sequencing to simultaneously profile the gene expression of four immune cell subpopulations (CD4T, CD8T, B cells, and monocytes) in 39 World Trade Center responders (20 with and 19 without PTSD) to determine which immune subsets play a role in the transcriptomic changes found in whole blood. Transcriptome-wide analyses identified cell-spe-

cific and shared differentially expressed genes across the four cell types. FKBP5 and PI4KAP1 genes were consistently upregulated across all cell types. Notably, REST and SEPT4, genes linked to neurodegeneration, were among the top differentially expressed genes in monocytes. Pathway analyses identified differentially expressed gene sets involved in mast cell activation and regulation in CD4T, interferon-beta production in CD8T, and neutrophil-related gene sets in monocytes. These findings suggest that gene expression indicative of immune dysregulation is common across several immune cell populations in PTSD. Furthermore, given notable differences between cell subpopulations in gene expression associated with PTSD, the results also indicate that it may be valuable to analyze different cell populations separately. Monocytes may constitute a key cell type to target in research on gene expression profile of PTSD.

Kung WW, Goldmann E, Liu X, et al. 2019. Mental health service use among asian americans five to six years after exposure to the World Trade Center attack. Social Service Review. 93 (1):96–128.

HTTPS://DOI.ORG/10.1086/702767

ABSTRACT: This study uses World Trade Center Health Registry data, based on Andersen's health-care model, to investigate 2,557 Asians mental health service use and associated factors 5-6 years after the World Trade Center attack, compared against 32,111 non-Hispanic white participants. We find that Asians had a lower proportion of service use (15.76 vs. 26.60 percent) than white people. A previous mental health diagnosis and perceived and evaluated mental health needs strongly predicted Asians? mental health service use, as did having routine medical checkups, being female, and being married or cohabiting. These factors, in addition to other socioeconomic predictors that were nonsignificant among Asians, were significant among white people, as well. Our findings suggest that service providers need to provide clear diagnoses to service users, explore mental health needs during medical checkups, and provide postdisaster mental health education and free treatment.

Kung WW, Wang X, Liu X, et al. 2019. Unmet mental health care needs among asian americans 10(-)11 years after exposure to the World Trade Center attack. Int J Environ Res Public Health. 16 (7)

HTTPS://DOI.ORG/10.3390/IJERPH16071302

THE OBJECTIVE OF THIS STUDY: This study investigated the prevalence of unmet mental health care needs (UMHCN) and their associated factors among 2344 Asian Americans directly exposed to the World Trade Center (WTC) attack 10-11 years afterwards. Given the pervasive underutilization of mental health services among Asians, their subjective evaluation of unmet needs could provide more nuanced information on disparities of service. We used the WTC Health Registry data and found that 12% of Asian Americans indicated UMHCN: 69% attributing it to attitudinal barriers, 36% to cost barriers, and 29% to access barriers. Among all the factors significantly related to UMHCN in the logistic model, disruption of health insurance in the past year had

the largest odds ratio (OR = 2.37, 95% confidence interval: 1.61-3.48), though similar to functional impairment due to mental disorders. Post-9/11 mental health diagnosis, probable mental disorder and >/=14 poor mental health days in the past month were also associated with greater odds of UMHCN, while greater social support was associated with lower odds. Results suggest that continued outreach efforts to provide mental health education to Asian communities to increase knowledge about mental illness and treatment options, reduce stigmatization of mental illness, and offer free mental health services are crucial to address UMHCN.

Kwon S, Crowley G, Caraher EJ, et al. 2019. Validation of predictive metabolic syndrome biomarkers of World Trade Center lung injury: A 16-year longitudinal study. Chest. 156 (3):486–496.

HTTPS://DOI.ORG/10.1016/J.CHEST.2019.02.019

BACKGROUND: Metabolic Syndrome (MetSyn) predicted future development of World Trade Center lung injury(WTC-LI) in a subgroup of never smoking, male firefighters. An intra-cohort validation of MetSyn as predictors of WTC-LI is examined in the WTC-exposed cohort that has been longitudinally followed for 16 years.

METHODS: PFTs(N=98,221) of WTC-exposed workers(N=9,566) were evaluated. A baseline cohort of firefighters with normal FEV1 prior to 9/11 and had serum drawn prior to site closure on July 24, 2002(N=7,487) was investigated. Cases of WTC-LI(N=1,208) were identified if they had at least two measured FEV1<LLN. Cox-proportional hazards modeled early MetSyn biomarker ability to predict development of FEV1<LLN.

RESULTS: Cases were more likely to smoke, be highly exposed, and have MetSyn. There was a significant exposure dose response; the most highly-exposed individuals had 30.1%-increased risk of developing WTC-LI; having MetSyn increased risk of WTC-LI by 55.7%; smoking increased risk by 15.2%. There was significant interaction between smoking and exposure.

CONCLUSIONS: We validated the utility of MetSyn to predict future WTC-LI in a larger population of exposed individuals. MetSyn defined by dyslipidemia, insulin resistance, and cardiovascular disease suggests that systemic inflammation can contribute to future lung function loss.

Kwon S, Crowley G, Mikhail M, et al. 2019. Metabolic syndrome biomarkers of World Trade Center airway hyperreactivity: A 16-year prospective cohort study. International journal of environmental research and public health. 16 (9)

HTTPS://DOI.ORG/10.3390/IJERPH16091486

BACKGROUND: Airway hyperreactivity (AHR) related to environmental exposure is a significant public health risk worldwide. Similarly, metabolic syndrome (MetSyn), a risk factor for obstructive airway disease (OAD) and systemic inflammation, is a significant contributor to global adverse health. This prospective cohort study followed N = 7486 World Trade Center (WTC)-exposed male firefighters from 11 September 2001 (9/11) until 1

August 2017 and investigated N = 539 with newly developed AHR for clinical biomarkers of MetSyn and compared them to the non-AHR group. Male firefighters with normal lung function and no AHR pre-9/11 who had blood drawn from 9 September 2001-24 July 2002 were assessed. World Trade Center-Airway Hyperreactivity (WTC-AHR) was defined as either a positive bronchodilator response (BDR) or methacholine challenge test (MCT). The electronic medical record (EMR) was queried for their MetSyn characteristics (lipid profile, body mass index (BMI), glucose), and routine clinical biomarkers (such as complete blood counts). We modeled the association of MetSyn characteristics at the first post-9/11 exam with AHR. Those with AHR were significantly more likely to be older, have higher BMIs, have high intensity exposure, and have MetSyn. Smoking history was not associated with WTC-AHR. Those present on the morning of 9/11 had 224% increased risk of developing AHR, and those who arrived in the afternoon of 9/11 had a 75.9% increased risk. Having ≥3 MetSyn parameters increased the risk of WTC-AHR by 65.4%. Co-existing MetSyn and high WTC exposure are predictive of future AHR and suggest that systemic inflammation may be a contributor.

Lieberman-Cribbin W, Tuminello S, Gillezeau C, et al. 2019. Complementary biobank of rodent tissue samples to study the effect of World Trade Center exposure on cancer development. J Transl Med. 17 (1):342.

HTTPS://DOI.ORG/10.1186/S12967-019-2089-7

BACKGROUND: World Trade Center (WTC) responders were exposed to mixture of dust, smoke, chemicals and carcinogens. New York University (NYU) and Mount Sinai have recreated WTC exposure in rodents to observe the resulting systemic and local biological responses. These experiments aid in the interpretation of epidemiological observations and are useful for understanding the carcinogenesis process in the exposed human WTC cohort. Here we describe the implementation of a tissue bank system for the rodents experimentally exposed to WTC dust. NYU samples were experimentally exposed to WTC dust via intratracheal inhalation that mimicked conditions in the immediate aftermath of the disaster. Tissue from Mount Sinai was derived from genetically modified mice exposed to WTC dust via nasal instillation. All processed tissues include annotations of the experimental design, WTC dust concentration/dose, exposure route and duration, genetic background of the rodent, and method of tissue isolation/storage. A biobank of tissue from rodents exposed to WTC dust has been compiled representing an important resource for the scientific community. The biobank remains available as a scientific resource for future research through established mechanisms for samples request and utilization. Studies using the WTC tissue bank would benefit from confirming their findings in corresponding tissues from organs of animals experimentally exposed to WTC dust. Studies on rodent tissues will advance the understanding of the biology of the tumors developed by WTC responders and ultimately impact the modalities of treatment, and

the probability of success and survival of WTC cancer patients.

Liu C, Putman B, Singh A, et al. 2019. Abnormalities on chest computed tomography and lung function following an intense dust exposure: A 17-year longitudinal study. International Journal of Environmental Research and Public Health. 16 (9)

HTTPS://DOI.ORG/10.3390/IJERPH16091655

BACKGROUND: Fire Department of the City of New York (FDNY) firefighters experienced intense dust exposure working at the World Trade Center (WTC) site on and after 11/9/2001 (9/11). We hypothesized that high-intensity WTC exposure caused abnormalities found on chest computed tomography (CT). Between 11/9/2001–10/9/2018, 4277 firefighters underwent a clinically-indicated chest CT. Spirometric measurements and symptoms were recorded during routine medical examinations. High-intensity exposure, defined as initial arrival at the WTC on the morning of 9/11, increased the risk of bronchial wall thickening, emphysema, and air trapping. Early post-9/11 symptoms of wheeze and shortness of breath were associated with bronchial wall thickening, emphysema, and air trapping. The risk of accelerated forced expiratory volume at one second (FEV1) decline (>64 mL/year decline) increased with bronchial wall thickening and emphysema, but decreased with air trapping. The risk of airflow obstruction also increased with bronchial wall thickening and emphysema but decreased with air trapping. In a previously healthy occupational cohort, high-intensity WTC exposure increased the risk for CT abnormalities. Bronchial wall thickening and emphysema were associated with respiratory symptoms, accelerated FEV1 decline, and airflow obstruction. Air trapping was associated with respiratory symptoms, although lung function was preserved. Physiologic differences between CT abnormalities suggest that distinct types of airway injury may result from a common exposure.

Morales-Raveendran E, Goodman E, West E, et al. 2019. Associations between asthma trigger reports, mental health conditions, and asthma morbidity among World Trade Center rescue and recovery workers. J Asthma. 56 (8):833–840.

HTTPS://DOI.ORG/10.1080/02770903.2018.1502300

AIM: There is limited information regarding asthma triggers in World Trade Center (WTC) rescue and recovery workers (RRW) or how mental health conditions affect the perception of triggers.

METHODS: We included 372 WTC workers with asthma. The Asthma Trigger Inventory (ATI) assessed triggers along five domains: psychological, allergens, physical activity, infection, and pollution. We administered the Structured Clinical Interview to diagnose post-traumatic stress disorder (PTSD), major depression and panic disorder (PD). The Asthma Control Questionnaire (ACQ) and Mini Asthma Quality of Life Questionnaire (AQLQ) measured asthma control and quality of life, respectively. Linear regression models were fitted to examine the association of ATI total and subdomain scores with mental health conditions as well as the percent of ACQ and AQLQ variance explained by ATI subscales.

RESULTS: The most common triggers were air pollution (75%) and general allergens (68%). PTSD was significantly associated with psychological triggers (partial r(2)=0.05, p < 0.01), physical activity (partial r(2)=0.03, p < 0.01) and air pollution (partial r(2)=0.02, p = 0.04) subscales while PD was significantly associated with air pollution (partial r(2)=0.03, p = 0.03) and general allergens (partial r(2)=0.02, p = 0.03). ATI subscales explained a large percentage of variance in asthma control (r(2)=0.37, p < 0.01) and quality of life scores (r(2)=0.40, p < 0.01). Psychological subscale scores explained the largest portion of the total variability in ACQ (partial r(2)= 0.11, p = 0.72) and AQLQ (partial r(2)=0.14, p = 0.64) scores.

CONCLUSION: RRW with mental health conditions reported more asthma triggers and these triggers were associated with asthma morbidity. These data can help support interventions in RRW with asthma.

Pradhan D, Xu N, Reibman J, et al. 2019. Bronchodilator response predicts longitudinal improvement in small airway function in World Trade Center dust exposed community members. Int J Environ Res Public Health. 16 (8)

HTTPS://DOI.ORG/10.3390/IJERPH16081421

BACKGROUND: The evolution of lung function, including assessment of small airways, was assessed in individuals enrolled in the World Trade Center Environmental Health Center (WTC-EHC). We hypothesized that a bronchodilator response at initial evaluation shown by spirometry or in small airways, as measured by forced oscillation technique (FOT), would be associated with improvement in large and small airway function over time. Standardized longitudinal assessment included pre and post bronchodilator (BD) spirometry (forced vital capacity, FVC; forced expiratory volume in 1 second, FEV1) and FOT (resistance at 5 Hz, R5; resistance at 5 minus 20 Hz, R5-20). Longitudinal changes were assessed using linear mixed-effects modelling with adjustment for potential confounders (median follow-up 2.86 years; 95% measurements within 4.9 years). Data demonstrated: (1) parallel improvement in airflow and volume measured by spirometry and small airway function (R5 and R5-20) measured by FOT; (2) the magnitude of longitudinal improvement was tightly linked to the initial BD response; and (3) longitudinal values for small airway function on FOT were similar to residual abnormality observed post BD at initial visit. These findings suggest presence of reversible and irreversible components of small airway injury that are identifiable at initial presentation. These results have implications for treatment of isolated small airway abnormalities that can be identified by non-invasive effort independent FOT particularly in symptomatic individuals with normal spirometry indices. This study underscores the need to study small airway function to understand physiologic changes over time following environmental and occupational lung injury.

Putman B, Lahousse L, Zeig-Owens R, et al. 2019. Low serum iga and airway injury in World Trade Center-exposed firefighters: A 17-year longitudinal

study. Thorax. 74 (12):1182–1184.

HTTPS://DOI.ORG/10.1136/THORAXJNL-2019-213715

BACKGROUND: Serum IgA ≤70 mg/dL (low IgA) is associated with exacerbations of chronic obstructive pulmonary disease. The association of low IgA with longitudinal lung function is poorly defined. This study included 917 World Trade Center (WTC)-exposed firefighters with longitudinal spirometry measured between September 2001 and September 2018 and IgA measured between October 2001 and March 2002. Low IgA, compared with IgA >70 mg/dL, was associated with lower forced expiratory volume in 1 s (FEV1) % predicted in the year following 11 September 2001 (94.1% vs 98.6%, p<0.001), increased risk of FEV1/FVC <0.70 (HR 3.8, 95% CI 1.6 to 8.8) and increased antibiotic treatment (22.5/100 vs 11.6/100 person-years, p=0.002). Following WTC exposure, early IgA ≤70 mg/dL was associated with worse lung function and increased antibiotic treatment.

Rojano B, West E, Ferdermann E, et al. 2019. Allergen sensitization and asthma outcomes among World Trade Center rescue and recovery workers. Int J Environ Res Public Health. 16 (5):737.

HTTPS://DOI.ORG/10.3390/IJERPH16050737

BACKGROUND: A large number of World Trade Center (WTC) rescue and recovery workers are affected by asthma. While physical and mental health comorbidities have been associated with poor asthma control in this population, the potential role of allergen sensitization is unknown. This study examined the association of indoor sensitization and exposure as a risk factor for increased asthma morbidity in WTC workers. We used data from a prospective cohort of 331 WTC workers with asthma. Sensitization to indoor allergens was assessed by measurement of antigen-specific serum immunoglobulin E (IgE) levels. We used validated tools to evaluate the exposure to indoor allergens. Asthma morbidity outcomes included level of control (Asthma Control Questionnaire, ACQ), quality of life (Asthma Quality of Life Questionnaire, AQLQ) and acute resource utilization. The prevalence of sensitization to cat, dog, mouse, dust mite, cockroach, and mold allergens were 33%, 21%, 17%, 40%, 17%, and 17%, respectively. Unadjusted and regression analyses showed no significant relationship between sensitization and increased asthma morbidity (p > 0.05 for all comparisons), except for sensitization to Aspergillus Fumigatus, cat and mouse epithelium, which were associated with decreased morbidity.

Rojano B, West E, Goodman E, et al. 2019. Self-management behaviors in World Trade Center rescue and recovery workers with asthma. J Asthma. 56 (4):411–421.

HTTPS://DOI.ORG/10.1080/02770903.2018.1462377

BACKGROUND: Asthma is a major source of morbidity among World Trade Center (WTC) rescue and recovery workers. While physical and mental health comorbidities have been associated with poor asthma control, the potential role and determinants of adherence to self-management behaviors (SMB) among WTC rescue and recovery work-

ers is unknown. OBJECTIVES: To identify modifiable determinants of adherence to asthma self-management behaviors in WTC rescue and recovery worker that could be potential targets for future interventions.

METHODS: We enrolled a cohort of 381 WTC rescue and recovery workers with asthma. Sociodemographic data and asthma history were collected during in-person interviews. Based on the framework of the Model of Self-regulation, we measured beliefs about asthma and controller medications. Outcomes included medication adherence, inhaler technique, use of action plans, and trigger avoidance.

RESULTS: Medication adherence, adequate inhaler technique, use of action plans, and trigger avoidance were reported by 44%, 78%, 83%, and 47% of participants, respectively. Adjusted analyses showed that WTC rescue and recovery workers who believe that they had asthma all the time (odds ratio [OR]: 2.37; 95% confidence interval [CI]: 1.38-4.08), that WTC-related asthma is more severe (OR: 1.73; 95% CI: 1.02-2.93), that medications are important (OR: 12.76; 95% CI: 5.51-29.53), and that present health depends on medications (OR: 2.39; 95% CI: 1.39-4.13) were more likely to be adherent to their asthma medications. Illness beliefs were also associated with higher adherence to other SMB.

CONCLUSIONS: Low adherence to SMB likely contributes to uncontrolled asthma in WTC rescue and recovery workers. Specific modifiable beliefs about asthma chronicity, the importance of controller medications, and the severity of WTC-related asthma are independent predictors of SMB in this population. Cognitive behavioral interventions targeting these beliefs may improve asthma self-management and outcomes in WTC rescue and recovery workers. Key message: This study identified modifiable beliefs associated with low adherence to self-management behaviors among World Trade Center rescue and recovery rescue and recovery workers with asthma which could be the target for future interventions.

CAPSULE SUMMARY: Improving World Trade Center-related asthma outcomes will require multifactorial approaches such as supporting adherence to controller medications and other self-management behaviors. This study identified several modifiable beliefs that may be the target of future efforts to support self-management in this patient population.

Spratlen MJ, Perera FP, Lederman SA, et al. 2019. Cord blood perfluoroalkyl substances in mothers exposed to the World Trade Center disaster during pregnancy. Environ Pollut. 246:482–490.

HTTPS://DOI.ORG/10.1016/J.ENVPOL.2018.12.018

BACKGROUND: Perfluoroalkyl substances (PFAS) may have been released during the collapse of the World Trade Center (WTC) on 9/11. Evidence suggests PFAS can cross the placental barrier in humans and cause harm to the developing fetus; however, no studies have measured PFAS in mothers exposed to the WTC disaster during pregnancy. We measured PFAS in maternal plasma (n=48) or cord blood

(n=231) from pregnant women in the Columbia University WTC birth cohort, enrolled between December 13, 2001 and June 26, 2002at one of three hospitals located near the WTC site. In order to maximize sample size, we used a linear regression to transform the 48 maternal plasma samples to cord blood equivalents in our study; cord blood and transformed maternal plasma-to-cord blood samples were then analyzed together. We evaluated the association between WTC exposure and PFAS concentrations using three exposure variables: 1) living/working within two miles of WTC; 2) living within two miles of WTC regardless of work location; and 3) working but not living within two miles of WTC. Exposure was compared with those not living/working within two miles of WTC (reference group). Living/working within two miles of WTC was associated with 13% higher perfluorooctanoic acid (PFOA) concentrations compared with the reference group [GMR (95% CI): 1.13 (1.01, 1.27)]. The association was stronger when comparing only those who lived within two miles of WTC to the reference group [GMR (95% CI): 1.17 (1.03, 1.33)], regardless of work location. Our results provide evidence that exposure to the WTC disaster during pregnancy resulted in increases in PFAS concentrations, specifically PFOA. This work identifies a potentially vulnerable and overlooked population, children exposed to the WTC disaster in utero, and highlights the importance of future longitudinal studies in this cohort to investigate later life effects resulting from these early life exposures.

Sunderram J, Weintraub M, Black K, et al. 2019. Chronic rhinosinusitis is an independent risk factor for osa in World Trade Center responders. Chest. 155 (2):375–383.

HTTPS://DOI.ORG/10.1016/J.CHEST.2018.10.015

BACKGROUND: Many respiratory conditions have been attributed to toxic dust and fume exposure in World Trade Center (WTC) rescue and recovery workers, who frequently report symptoms of OSA. We examined the prevalence of new-onset OSA and tested if the prevalence and severity of OSA are related to the presence of chronic rhinosinusitis (CRS).

METHODS: A total of 601 subjects (83% men; age, 33-87 years; BMI, 29.9 +/- 5.5 kg/m(2)) enrolled in the WTC Health Program, excluding those with significant pre-September 11, 2001, snoring or prior CRS, underwent two nights of home sleep testing. OSA was defined as Apnea Hypopnea Index 4% >/= 5 events/h or respiratory disturbance index of >/= 15 events/h. CRS was assessed using nasal symptom questionnaires.

RESULTS: The prevalence of OSA was 75% (25% no OSA, 46% mild OSA, 19% moderate OSA, and 10% severe OSA), and the prevalence of CRS was 43.5%. Compared with no CRS, new and worsening CRS was a significant risk factor for OSA with an OR of 1.80 (95% CI, 1.18-2.73; P = .006) unadjusted and 1.76 (95% CI, 1.08-2.88; P = .02) after adjustment for age, BMI, sex, gastroesophageal reflux disorder, and alcohol use.

CONCLUSIONS: The high prevalence of OSA in WTC responders was not explained

fully by obesity and sex. Possible mechanisms for the elevated risk of OSA in subjects with CRS include increased upper airway inflammation and/or elevated nasal/upper airway resistance, but these need confirmation.

Thawani S, Wang B, Shao Y, et al. 2019. Time to onset of paresthesia among community members exposed to the World Trade Center disaster. Int J Environ Res Public Health. 16 (8)

HTTPS://DOI.ORG/10.3390/IJERPH16081429

BACKGROUND: We examined whether time to onset of paresthesia was associated with indicators of severity of World Trade Center (WTC) exposure. We analyzed data from 3411 patients from the Bellevue Hospital-WTC Environmental Health Center. Paresthesia was defined as present if the symptom occurred in the lower extremities with frequency "often" or "almost continuous." We plotted hazard functions and used the log-rank test to compare time to onset of paresthesia between different exposure groups. We also used Cox regression analysis to examine risk factors for time-to-paresthesia after 9/11/2001 and calculate hazard ratios adjusted for potential confounders. We found significantly elevated hazard ratios for paresthesia for (a) working in a job that required cleaning of WTC dust in the workplace; and (b) being heavily exposed to WTC dust on September 11, 2001, after adjusting for age, race/ethnicity, depression, anxiety, post-traumatic stress disorder, and body mass index. These observational data are consistent with the hypothesis that exposure to WTC dust or some other aspect of cleaning WTC dust in the workplace, is associated with neuropathy and paresthesia. Further neurological evaluations of this and other WTC-exposed populations is warranted.

Tuminello S, van Gerwen MAG, Genden E, et al. 2019. Increased incidence of thyroid cancer among World Trade Center first responders: A descriptive epidemiological assessment. International journal of environmental research and public health. 16 (7):1258.

HTTPS://DOI.ORG/10.3390/IJERPH16071258

BACKGROUND: An increased incidence of thyroid cancer among 9/11 rescue workers has been reported, the etiology of which remains unclear but which may, at least partly, be the result of the increased medical surveillance this group undergoes. This study aimed to investigate thyroid cancer in World Trade Center (WTC) responders by looking at the demographic data and questionnaire responses of thyroid cancer cases from the Mount Sinai WTC Health Program (WTCHP). WTCHP thyroid cancer tumors were of a similar size ($p = 0.4$), and were diagnosed at a similar age ($p = 0.2$) compared to a subset of thyroid cancer cases treated at Mount Sinai without WTC exposure. These results do not support the surveillance bias hypothesis, under which smaller tumors are expected to be diagnosed at earlier ages. WTCHP thyroid cancer cases also reported a past history of radiation exposure and a family history of thyroid conditions at lower rates than expected, with higher than expected rates of previous cancer diagnoses, family histories of other can-

cers, and high Body Mass Indexes (BMIs). Further research is needed to better understand the underlying risk factors that may play a role in the development of thyroid cancer in this group.

van Gerwen MAG, Tuminello S, Riggins GJ, et al. 2019. Molecular study of thyroid cancer in World Trade Center responders. International journal of environmental research and public health. 16 (9)

HTTPS://DOI.ORG/10.3390/IJERPH16091600

BACKGROUND: Thyroid cancer incidence is higher in World Trade Center (WTC) responders compared with the general population. It is unclear whether this excess in thyroid cancer is associated with WTC-related exposures or if instead there is an over-diagnosis of malignant thyroid cancer among WTC first responders due to enhanced surveillance and physician bias. To maximize diagnostic yield and determine the false positive rate for malignancy, the histological diagnoses of thyroid cancer tumors from WTC responders and age, gender, and histology matched non-WTC thyroid cancer cases were evaluated using biomarkers of malignancy. Using a highly accurate panel of four biomarkers that are able to distinguish benign from malignant thyroid cancer, our results suggest that over-diagnosis by virtue of misdiagnosis of a benign tumor as malignant does not explain the increased incidence of thyroid cancer observed in WTC responders. Therefore, rather than over-diagnosis due to physician bias, the yearly screening visits by the World Trade Center Health Program are identifying true cases of thyroid cancer. Continuing regular screening of this cohort is thus warranted.

Vandromme M, Jun T, Perumalswami P, et al. 2019. Automated phenotyping of patients with non-alcoholic fatty liver disease reveals clinically relevant disease subtypes. Biocomputing 2020. 0:91–102.

HTTPS://DOI.ORG/10.1142/9789811215636_0009

BACKGROUND: Non-alcoholic fatty liver disease (NAFLD) is a complex heterogeneous disease which affects more than 20% of the population worldwide. Some subtypes of NAFLD have been clinically identified using hypothesis-driven methods. In this study, we used data mining techniques to search for subtypes in an unbiased fashion. Using electronic signatures of the disease, we identified a cohort of 13,290 patients with NAFLD from a hospital database. We gathered clinical data from multiple sources and applied unsupervised clustering to identify five subtypes among this cohort. Descriptive statistics and survival analysis showed that the subtypes were clinically distinct and were associated with different rates of death, cirrhosis, hepatocellular carcinoma, chronic kidney disease, cardiovascular disease, and myocardial infarction. Novel disease subtypes identified in this manner could be used to risk-stratify patients and guide management.

Waszczuk MA, Ruggero C, Li K, et al. 2019. The role of modifiable health-related behaviors in the association between PTSD and respiratory illness. Behav Res Ther. 115:64–72.

HTTPS://DOI.ORG/10.1016/J.BRAT.2018.10.018

BACKGROUND: Posttraumatic stress disorder (PTSD) increases risk of future respiratory illness. However, mechanisms that underpin the association between these common and debilitating conditions remain unknown. The aim of this study was to identify modifiable, health-related behaviors they may explain the link between PTSD and respiratory problems.

METHODS: World Trade Center responders (N=452, 89% male, mean age=55 years) completed baseline PTSD and sleep questionnaires, followed by 2-weeks of daily diaries, actigraphy and ambulatory spirometry to monitor lower respiratory symptoms, pulmonary function, activity levels, stressors, and sleep. Lipid levels were obtained from electronic medical records.

RESULTS: Cross-sectional mediation analyses revealed that the association between PTSD and self-reported respiratory symptoms was explained by poor sleep, low activity, and daily stressors. The association between PTSD symptoms and pulmonary function was explained by insomnia and low activity.

CONCLUSIONS: A range of health-related daily behaviors and experiences, especially sleep disturbances and inactivity, may explain excess respiratory illness morbidity in PTSD. The findings were generally consistent across daily self-report and spirometry measures of respiratory problems. Targeting these behaviors might enhance prevention of and intervention in respiratory problems in traumatized populations.

Wu BG, Sulaiman I, Wang J, et al. 2019. Severe obstructive sleep apnea is associated with alterations in the nasal microbiome and increase in inflammation. Am J Respir Crit Care Med. 199 (1):99–109.

HTTPS://DOI.ORG/10.1164/RCCM.201801-01190C

RATIONALE: Obstructive Sleep Apnea (OSA) is associated with recurrent obstruction, sub-epithelial edema, and airway inflammation. The resultant inflammation may influence or be influenced by the nasal microbiome.

OBJECTIVES: To evaluate whether the composition of the nasal microbiota is associated with obstructive sleep apnea and inflammatory biomarkers.

METHODS: Two large cohorts were utilized: 1) a discovery cohort of 472 subjects from the WTCSNORE cohort; and 2) a validation cohort of 93 subjects from the Zaragoza Sleep cohort. Sleep apnea was diagnosed using home sleep tests. Nasal lavages were obtained from cohort subjects to measure: 1) microbiome composition (based on 16S rRNA gene sequencing); 2) biomarkers for inflammation (inflammatory cells, IL-8, and IL-6). Longitudinal 3 months samples were obtained in the validation cohort including post-CPAP treatment when indicated.

RESULTS: In both cohorts, we identified that: 1) severity of OSA correlated with differences in microbiome diversity and composition; 2) the nasal microbiome of subjects with severe OSA were enriched with Streptococcus, Prevotella, and Veillonella; 3) the nasal microbiome differences were associated with inflammatory biomarkers. Network analysis identified clusters of co-occurring microbes that defined communities. Several common

oral commensals (e.g., Streptococcus, Rothia, Veillonella, and Fusobacterium) correlated with apnea-hypopnea index. Three months of treatment with CPAP did not change the composition of the nasal microbiota.

CONCLUSIONS: We demonstrate that the presence of an altered microbiome in severe OSA is associated with inflammatory markers. Further experimental approaches to explore causal links are needed.

Year Published 2020 (24)

Bover Manderski MT, Black K, Udasin IG, et al. 2020. Retrospective assessment of risk factors for head and neck cancer among World Trade Center general responders. Front Public Health. 8:488057.

HTTPS://DOI.ORG/10.3389/FPUBH.2020.488057

OBJECTIVE: To assess the reliability of a questionnaire designed to reconstruct risk factors for head and neck cancer relative to the 9/11 World Trade Center (WTC) response and over the lifetime.

METHODS: As part of a nested case-control study, 200 WTC Health Program (WTCHP) General Responder Cohort (GRC) members completed a newly-developed study questionnaire via telephone (with a trained interviewer) or online (self-administered). We assessed agreement between measures of tobacco and alcohol use in our questionnaire results and data collected previously during WTCHP-GRC monitoring visits using Cohens Kappa (κ) and intraclass correlation coefficient (ICC) for categorical and continuous measures, respectively. We compared agreement by disease status, survey mode, and year of WTCHP enrollment.

RESULTS: We observed high agreement between measures of lifetime, pre-WTC, and post-WTC smoking prevalence (all κ > 0.85) and smoking duration (all ICC > 0.84). There was moderate agreement between measures of smoking frequency (ICC: 0.61-0.73). Agreement between measures of smoking frequency, but not duration, differed by disease status, and agreement between smoking measures was higher for participants who completed our survey by phone than by web. Among cases, there were no differences based on enrollment in the WTCHP before or after diagnosis.

CONCLUSION: Agreement between measures was generally high, although potential reporting bias and a mode effect that should be considered when interpreting analyses of self-reported data in this population; however differential misclassification appears to be minimal. Our questionnaire may be useful for future studies examining similar behavioral risk factors among disaster-exposed populations.

Chen C, Salim R, Rodriguez J, et al. 2020. The burden of subthreshold posttraumatic stress disorder in World Trade Center responders in the second decade after 9/11. J Clin Psychiatry. 81 (1)

HTTPS://DOI.ORG/10.4088/JCP.19M12881

OBJECTIVE: To characterize the prevalence, risk and protective correlates, and clinical characteristics associated with

probable subthreshold posttraumatic stress disorder (PTSD) in police and nontraditional (eg, construction workers) World Trade Center (WTC) responders a median of 12.2 years after September 11, 2001.

METHODS: A total of 4,196 WTC responders, monitored via the WTC Health Program, completed a web-based survey between 2012 and 2014 assessing a range of variables, including demographics, WTC exposures, medical and psychiatric comorbidities, and mental health services use. The sample included 2,029 police responders and 2,167 nontraditional responders. Current (past-month) probable WTC-related PTSD level (none, subthreshold, or full PTSD) was assessed based on DSM-IV criteria using the PTSD Checklist-Specific Stressor version (PCL-S).

RESULTS: The prevalence of current probable full and subthreshold WTC-related PTSD in police responders was 9.3% and 17.5%, respectively, and in nontraditional responders was 21.9% and 24.1%, respectively. Risk and protective correlates for subthreshold PTSD included post-9/11 medical comorbidities and traumatic events (odds ratios [ORs] = 1.1-1.2). Clinical characteristics included elevated rates of comorbid depression (OR = 3.2 and 3.9 for subthreshold PTSD and 17.2 and 30.3 for full PTSD for nontraditional and police responders, respectively). Among responders with subthreshold PTSD, police were more likely to have accessed mental health services and utilized a greater variety of treatments than nontraditional responders.

CONCLUSIONS: Overall, 26.8% of police and 46.0% of nontraditional responders met criteria for probable WTC-related full or subthreshold PTSD an average of 12 years after 9/11. Probable subthreshold PTSD, which is not typically assessed in clinical settings, was more prevalent than probable full PTSD and was associated with significantly elevated rates of psychiatric comorbidities, functional impairment, and reduced quality of life. These findings underscore the importance of assessing, monitoring, and possibly treating subthreshold PTSD in WTC and other disaster responders.

Chen X, Ma T, Yip R, et al. 2020. Elevated prevalence of moderate-to-severe hepatic steatosis in World Trade Center general responder cohort in a program of ct lung screening. Clin Imaging. 60 (2):237–243.

HTTPS://DOI.ORG/10.1016/J.CLINIMAG.2019.12.009

BACKGROUND AND AIMS: To determine the prevalence of moderate-to-severe hepatic steatosis (HS) and associated risk factors in members of the World Trade Center (WTC) General Responder Cohort (GRC) who qualify for low-dose non-contrast computed tomography for lung cancer screening and compare them to non-WTC participants in the same screening program.

METHODS: All participants gave written informed consent before participating in this IRB-approved study. Clinical variables and laboratory values were recorded. Hepatic attenuation measurement (Hounsfield unit; HU) was measured on low-dose computed tomography (LDCT) and a threshold attenuation value <40HU

indicated moderate-to-severe HS. Bivariate and multivariable linear and logistic regression analyses were performed. Propensity scores (PS) were calculated and inverse probability weighting (IPW) was used to adjust for potential confounders when comparing the WTC with non-WTC participants.

RESULTS: The prevalence of moderate-to-severe HS was 16.2% among 154 WTC participants compared to 5.3% among 170 non-WTC participants. In WTC members, moderate-to-severe HS was associated with higher BMI, higher laboratory liver function tests, and former smoking status. Using PS analysis and IPW to account for potential confounders, the odds ratio for moderate-to-severe HS was 3.4-fold higher (95% confidence interval: 1.7-6.7) in the WTC participants compared with non-WTC participants. Moderate-to-severe HS was also associated with higher BMI and former smoker status.

CONCLUSION: Prevalence of moderate-to-severe HS was >3-fold higher in the WTC-GRC group than in other participants.

Clouston SAP, Deri Y, Horton M, et al. 2020. Reduced cortical thickness in World Trade Center responders with cognitive impairment. Alzheimers Dement (Amst). 12 (1):e12059.

HTTPS://DOI.ORG/10.1002/DAD2.12059

INTRODUCTION: This study examined cortical thickness (CTX) in World Trade Center (WTC) responders with cognitive impairment (CI).

METHODS: WTC responders (N = 99) with/without CI, recruited from an epidemiologic study, completed a T1-MPRAGE protocol. CTX was automatically computed in 34 regions of interest. Region-based and surface-based morphometry examined CTX in CI versus unimpaired responders. CTX was automatically computed in 34 regions of interest. Region-based measures were also compared to published norms.

RESULTS: Participants were 55.8 (SD = 0.52) years old; 48 had CI. Compared to unimpaired responders, global mean CTX was reduced in CI and across 21/34 cortical subregions. Surface-based analyses revealed reduced CTX across frontal, temporal, and parietal lobes when adjusting for multiple comparisons. Both CI and unimpaired WTC groups had reduced CTX in the entorhinal and temporal cortices compared to published normative data.

DISCUSSION: Results from the first structural magnetic resonance imaging study in WTC responders identified reduced CTX consistent with a neurodegenerative disease of unknown etiology.

Cohen MD, Chen L-C, and Lippmann M. 2020. World Trade Center (WTC) dust. Journal. (0):973–997.

HTTPS://DOI.ORG/10.1002/9781119438922.CH26

SUMMARY: This chapter deals with the dust exposures resulting from the collapse of the two World Trade Center (WTC) towers in New York due to terrorist attacks on September 11, 2001. It discusses the

post-collapse human inhalation exposures to the WTC dusts, the potential dosimetry of the dusts, the link between the dusts and adverse health effects on humans, and the biological responses to the dusts. The chapter also details the roles of minor and major components as causal factors for the observed health effects. As a result of the collapse of the towers, the settled dusts differed in important ways from conventional settled dusts in regard to particle size distributions, chemical composition, and ease of redispersion into the ambient air. The adverse health effects include chronic diseases/pathologies, such as respiratory and gastroesophageal illness, as well as cardiovascular abnormalities, at levels greater than seen in comparison populations away from the towers.

Cohen MD, Prophete C, Horton L, et al. 2020. Impact on rats from acute intratracheal inhalation exposures to WTC dusts. Inhal Toxicol. 32 (5):218–230.

HTTPS://DOI.ORG/10.1080/08958378.2020.1768322

BACKGROUND: Studies have revealed the increased incidence of health disorders in First Responders (FR) who were at Ground Zero over the initial 72 hr after the World Trade Center (WTC) collapses. Previous studies in rats exposed to WTC dusts using exposure scenarios that mimicked FR mouthbreathing showed exposure led to altered expression of genes whose products could be involved in lung ailments. Nevertheless, it was uncertain if repeated exposures (as occurred in earliest days post-disaster) might have given rise to long-term changes in the lungs/other organs, in white blood cell (WBC) profiles, and/or systemic expression of select (mostly immune-related) proteins.Methods: To examine this, rats were exposed on 2 consecutive days (2 hr/d, intratracheal inhalation) to WTC dusts and then examined over a 1-yr period thereafter. At select times post-exposure, organ (lung, heart, liver, kidney, spleen) weights, WBC profiles, and blood levels of a variety of proteins were evaluated.

RESULTS: The study showed that over the 1-yr period, there were nominal effects on organ weights (absolute, index) as a result of the dust exposures. There were significant changes (relative to in naive rats) in WBC profiles, with exposed rats having increased monocyte-macrophage and decreased lymphocyte percentages. The study also found that dust exposure led to significant systemic increases in many proteins, including MCP-1, RANTES, MMP-9, RAGE, and Galectin-3.

CONCLUSIONS: These results provide further support for our longstanding hypothesis that the WTC dusts could potentially have acted as direct inducers of many of the health effects that have been seen in the exposed FR.

Colbeth HL, Genere N, Hall CB, et al. 2020. Evaluation of medical surveillance and incidence of post-September 11, 2001, thyroid cancer in World Trade Center-exposed firefighters and emergency medical service workers. JAMA Intern Med. 180 (6):888–895.

HTTPS://DOI.ORG/10.1001/JAMAINTERNMED.2020.0950

IMPORTANCE: Elevated incidence rates of thyroid cancer among World Trade Center (WTC)-exposed individuals may

be associated with the identification of asymptomatic cancers during medical surveillance.

OBJECTIVE: To examine the association between WTC exposure and thyroid cancer among Fire Department of the City of New York (hereafter, Fire Department) rescue/recovery workers as well as the association with medical surveillance.

DESIGN, SETTING, AND PARTICIPANTS: This closed-cohort study classified the method of detection (asymptomatic and symptomatic) of thyroid cancers in 14987 men monitored through the Fire Department-WTC Health Program diagnosed from September 12, 2001, to December 31, 2018. Age-, sex-, and histologic-specific Fire Department incidence rates were calculated and compared with demographically similar men in Olmsted County, Minnesota, from the Rochester Epidemiology using age-standardized rates, relative rates (RRs), and 95% CIs. The secondary analysis was restricted to papillary carcinomas.

EXPOSURES: World Trade Center exposure was defined as rescue/recovery work at the WTC site from September 11, 2001, to July 25, 2002.

MAIN OUTCOMES AND MEASURES: The outcomes evaluated comprised (1) number of incident thyroid cancers and their detection method categorizations in the Fire Department and Rochester Epidemiology cohorts; (2) Fire Department, Rochester Epidemiology Project, and Surveillance, Epidemiology, and End Results-21 age-standardized incidence rates of thyroid cancer; and (3) RRs comparing Fire Department and Rochester Epidemiology overall and by detection method categorization.

RESULTS: Seventy-two post-9/11 Fire Department cases of thyroid cancer were identified. Among the 65 cases (90.3%) with a categorized detection method, 53 cases (81.5%) were asymptomatic and 12 cases (18.5%) were symptomatic. Median (interquartile range) age at diagnosis was 50.2 (44.0-58.6) vs 46.6 (43.9-52.9) years for asymptomatic vs symptomatic cases. Associated primarily with asymptomatic cancers, the overall age-standardized incidence of Fire Department thyroid cancers (24.7; 95% CI, 17.4-52.3) was significantly higher than the Rochester Epidemiology (10.4; 95% CI, 8.5-12.7) and Surveillance, Epidemiology, and End Results-21 (9.1; 95% CI, 9.0-9.1) per 100000 person-years. Furthermore, the RR of thyroid cancer among symptomatic men in Fire Department cases was not significantly different from that of men in the Rochester Epidemiology (0.8; 95% CI, 0.4-1.5); however, the rate of asymptomatic cancers was more than 3-fold that of the Rochester Epidemiology rate (RR, 3.1; 95% CI, 2.1-4.7).

CONCLUSIONS AND RELEVANCE: Excess asymptomatic thyroid cancer in Fire Department WTC-exposed rescue/recovery workers is apparently attributable to the identification of occult lesions during medical surveillance. Among WTC-exposed cohorts and the general population, these findings appear to have important implications for how thyroid cancer incidence rates are interpreted and how diagnoses should be managed.

de la Hoz RE, Shapiro M, Nolan A, et al. 2020. Association of low fvc spirometric pattern with WTC occupational exposures. Respiratory Medicine. 170:106058.

HTTPS://DOI.ORG/10.1016/J.RMED.2020.106058

BACKGROUND: A reduced forced vital capacity without obstruction (low FVC) is the predominant spirometric abnormality reported in workers and volunteers exposed to dust, gases, and fumes at the World Trade Center (WTC) disaster site in 2001-2002. While low FVC has been associated with obesity and metabolic syndrome, its association with WTC occupational exposures has not been demonstrated. We estimated the prevalence of this abnormality and examined its association with WTC exposure level.

METHODS: Longitudinal study of the relation between arrival at the WTC site within 48 h and FVC below the lower limit of normal (FVC < LLN, with normal FEV1/FVC ratio) at any time in 10,284 workers with at least two spirometries between 2002 and 2018. Logistic regression and linear mixed models were used for the multivariable analyses.

RESULTS: The prevalence of low FVC increased from 17.0% (95% CI 15.4%, 18.5%) in June 2003, to 26.4% (95% CI 24.8%, 28.1%) in June 2018, and exceeded at both times that of obstruction. The rate of FVC decline was -43.7 ml/year during the study period. In a multivariable analysis adjusting for obesity, metabolic syndrome indicators, and other factors, early arrival at the WTC disaster site was significantly associated with low FVC, but only among men (ORadj = 1.29, 95% CI 1.17, 1.43). Longitudinal FVC rate of decline did not differ by WTC site arrival time.

CONCLUSIONS: Among WTC workers, the prevalence of low FVC increased over a 16-year period. Early arrival to the WTC disaster site was significantly associated with low FVC in males.

Diab O, DePierro J, Cancelmo L, et al. 2020. Mental healthcare needs in World Trade Center responders: Results from a large, population-based health monitoring cohort. Administration and Policy in Mental Health and Mental Health Services Research. 47 (3):427–434.

HTTPS://DOI.ORG/10.1007/S10488-019-00998-Z

BACKGROUND: Nearly two decades after the 9/11 attacks on the World Trade Center (WTC), the prevalence of mental disorders remains elevated among traditional (e.g., police) and non-traditional (e.g., construction workers) responders who were involved in the WTC rescue, recovery, and clean-up efforts. To date, however, scarce research has examined factors associated with perceived need for mental health care, which is critical to promoting engagement in mental health treatment in this population. Data were analyzed from 16,170 WTC responders, including 8881 police responders and 7289 non-traditional responders, who completed their first annual health monitoring visit with the WTC Health Program an average of 6.5 years after September 11, 2001. Predisposing, enabling, and need-based factors associated with perceived need

for mental health care were examined using multivariable logistic regression analyses. Nearly half (48.7%) of non-traditional responders and a fifth (20.6%) of police responders reported a need for mental health care. The most common perceived needs were for psychotropic medication, individual psychotherapy, and stress management counseling. Predisposing (e.g., female gender) and need-based factors (e.g., WTC-related posttraumatic stress disorder) predicted perceived need for mental health care in both groups. Among non-traditional responders, Hispanic ethnicity and current suicidal ideation were additionally associated with this outcome. Non-traditional WTC responders are substantially more likely than police WTC responders to perceive a need for mental health treatment. Characterization of factors associated with perceived need for treatment can help inform population-based outreach and monitoring efforts designed to promote engagement in mental health treatment in WTC responders.

Dornbach-Bender A, Ruggero CJ, Schuler K, et al. 2020. Positive and negative affect in the daily life of World Trade Center responders with PTSD: An ecological momentary assessment study. Psychol Trauma. 12 (1):75–83.

HTTPS://DOI.ORG/10.1037/TRA0000429

OBJECTIVE: The ability to experience positive affect (PA) has clinical and quality of life implications, particularly in vulnerable populations such as trauma-exposed disaster responders. Low PA is included in the diagnostic criteria for posttraumatic stress disorder (PTSD), however evidence for PA reduction in PTSD has been mixed. In contrast, negative affect (NA) has consistently been found to be elevated among individuals with PTSD. to date.

METHOD: World Trade Center (WTC) responders (N = 202) oversampled for the presence of PTSD were recruited from the WTC Health Program. Participants were administrated the Structured Clinical Interview for DSM-IV and the PTSD Checklist for DSM-5 at baseline, then completed EMA surveys of affect four times a day over seven consecutive days.

RESULTS: Participants with current PTSD (19.3% of the sample) showed significantly higher levels of daily NA compared with those without PTSD. However, there was no group difference in daily PA, nor was PA associated with a dimensional measure of PTSD.

CONCLUSION: Results suggest that for chronic PTSD among disaster responders, positive emotions are not inhibited across daily living. Such findings add to evidence suggesting that PA reduction may not be diagnostically relevant to PTSD, whereas NA remains an important target for therapeutic interventions. Moreover, results show that WTC responders can experience and benefit from positive emotion, even if they continue to have PTSD symptoms.

Haider SH, Veerappan A, Crowley G, et al. 2020. Multiomics of WTC-particulate induced persistent airway hyperreactivity: Role of receptor for advanced glycation end products. Am J Respir Cell Mol Biol. 63 (2):219–233.

HTTPS://DOI.ORG/10.1165/RCMB.2019-0064OC

BACKGROUND: Pulmonary disease after World Trade Center particulate matter(WTC-PM) exposure is associated with dyslipidemia and the receptor for advanced glycation end products (RAGE); however, the mechanisms are not well understood. We utilized a murine model and a multiOMIC assessment to understand the role of RAGE in the pulmonary long-term effects of a single high intensity exposure to WTC-PM. After 1-month(1-M), WTC-PM exposed wild-type(WT) mice had airway hyperreactivity(AHR) while RAGE-deficient(Ager-/-) were protected. PM-exposed WT mice also had histologic evidence of airspace disease while Ager-/- remained unchanged. Inflammatory mediators such as G-CSF, IP-10, and KC were differentially expressed after WTC-PM exposure. WTC-PM induced alpha-SMA, DIAPH1, RAGE and significant lung collagen deposition in WT compared to Ager-/-. Compared to WT with PM exposure, relative expression of phosphorylated to total CREB and JNK were significantly increased in the lung of PM-exposed Ager-/-, whereas Akt was decreased. Random forests of the refined lung metabolomic profile classified subjects with 92% accuracy; principal components analysis captured 86.7% of the variance in 3 components and demonstrated prominent sub-pathway involvement including known mediators of lung disease such as vitamin B6 metabolites, sphingolipids, fatty acids, and phosphatidylcholines. Treatment with a partial RAGE antagonist, pioglitazone, yielded similar fold-change expression of metabolites(N6-carboxymethyllysine, 1-methylnicotinamide, (N(1)+N(8))-acetylspermidine and Succinylcarnitine(C4-DC)) between WT and Ager-/- exposed to WTC-PM. RAGE can mediate WTC-PM-induced AHR, and warrants further investigation.

Hernandez M, Harrington A, Ma Y, et al. 2020. World Trade Center dust induces airway inflammation while promoting aortic endothelial dysfunction. Toxicol Appl Pharmacol. 400:115041.

HTTPS://DOI.ORG/10.1016/J.TAAP.2020.115041

BACKGROUND: Respiratory ailments have plagued occupational and public health communities exposed to World Trade Center (WTC) dust since the September 11, 2001 attack on the Twin Towers in Lower Manhattan. We proposed that these ailments were proposed to be induced by inhalation exposure to WTC particulate matter (WTCPM), that was released during the collapse of the buildings and its subsequent resuspension during cleanup. We investigated this hypothesis using both an in vitro and an in vivo mouse intranasal (IN) exposure models to identify the inflammatory potential of WTCPM with specific emphasis on respiratory and endothelial tissue responses. The in vitro exposure studies found WTCPM exposure to be positively correlated with cytotoxicity and increased NO2(-) production in both BEAS-2B pulmonary epithelial cells and THP-1 macrophage cells. The in vivo C57BL/6 mouse studies found significant increases in inflammatory markers including increases in polymorphonuclear neutrophil (PMN) influx into nasal and bronchoalveolar lavage fluids (NLF and BALF), as well as increased levels of total protein and cytokine/

chemokines levels. Concurrently, NLF, BALF, and serum NO2(-) levels exhibited significant homeostatic temporal deviations as well as temporal myograohic aortic dysfunction in myography studies. Respiratory exposure to- and evidence -based retention of- WTCPM may have contributed to chronic systemic effects in exposed mice that r resembled to observed effects in WTCPM-exposed human populations. Collectively, these findings are reflective of WTCPM exposure and its effect(s) on respiratory and aortic tissues, highlighting potential dysfunctional pathways that may precipitate inflammatory events, while simultaneously altering homeostatic balances. The tight interplay between these balances, when chronically altered, may contribute to- or result in- chronically diseased pathological states.

Huang D, Wang X, and Kung W. 2020. The impact of job loss on posttraumatic stress disorder among asian americans: 11–12 years after the World Trade Center attack. Traumatology (Tallahass Fla). 26 (1):117–126.

HTTPS://DOI.ORG/10.1037/TRM0000216

BACKGROUND: Adversities following disasters are associated with the delayed onset and persistence of post-traumatic stress disorder (PTSD). In the wake of the World Trade Center attack, a sizeable group of Asian Americans being directly exposed to the disaster had endured job loss during the decade afterwards. Yet, no studies to date have examined the relationship between job loss and long-term PTSD in this group. This study examined the 10-11-year prevalence of probable PTSD (>/= PCL score of 44) among Asian (n=1,712) and Caucasian American (n=25,011) participants of the World Trade Center Health Registry who had completed three waves of survey studies (2003-04, 2006-08, 2011-12). Logistic regression was used to model the relationship between job loss since the disaster and probable PTSD for the two racial groups separately while controlling for sociodemographics, disaster exposure, post-disaster traumatic/stressful events exposure, lower respiratory symptoms, PTSD history since 911, and mental health service use. The long-term prevalence of probable PTSD was 15.1% for Asian Americans and 14.4% for Caucasian Americans, with no significant difference. For both groups, having job loss since 911 was a significant risk factor for probable PTSD (Asian Americans: AOR=1.80; 95% CI=1.19, 2.71; Caucasian Americans: AOR=1.73; 95% CI=1.56, 1.93). While job loss was an important risk factor, employment opportunities were more restricted for Asian Americans given the cultural and language limitations. Current findings highlight the importance of improving employment as part of post-disaster assistance.

Kuan P-F, Clouston S, Yang X, et al. 2020. Molecular linkage between post-traumatic stress disorder and cognitive impairment: A targeted proteomics study of World Trade Center responders. Translational Psychiatry. 10 (1):269.

HTTPS://DOI.ORG/10.1038/S41398-020-00958-4

BACKGROUND: Existing work on proteomics has found common biomarkers that are altered in individuals with post-traumatic stress disorder (PTSD) and mild cognitive

impairment (MCI). The current study expands our understanding of these biomarkers by profiling 276 plasma proteins with known involvement in neurobiological processes using the Olink Proseek Multiplex Platform in individuals with both PTSD and MCI compared to either disorder alone and with unaffected controls. Participants were World Trade Center (WTC) responders recruited through the Stony Brook WTC Health Program. PTSD and MCI were measured with the PTSD Checklist (PCL) and the Montreal Cognitive Assessment, respectively. Compared with unaffected controls, we identified 16 proteins associated with comorbid PTSD–MCI at $P < 0.05$ (six at FDR < 0.1), 20 proteins associated with PTSD only (two at FDR < 0.1), and 24 proteins associated with MCI only (one at FDR < 0.1), for a total of 50 proteins. The multiprotein composite score achieved AUCs of 0.84, 0.77, and 0.83 for PTSD–MCI, PTSD only, and MCI only versus unaffected controls, respectively. To our knowledge, the current study is the largest to profile a large set of proteins involved in neurobiological processes. The significant associations across the three case-group analyses suggest that shared biological mechanisms may be involved in the two disorders. If findings from the multiprotein composite score are replicated in independent samples, it has the potential to add a new tool to help classify both PTSD and MCI.

Kwon S, Riggs J, Crowley G, et al. 2020. Food intake restriction for health outcome support and education (firehouse) protocol: A randomized clinical trial. Int J Environ Res Public Health. 17 (18):6569.

HTTPS://DOI.ORG/10.3390/IJERPH17186569

BACKGROUND: Fire Department of New York (FDNY) rescue and recovery workers exposed to World Trade Center (WTC) particulates suffered loss of forced expiratory volume in 1 s (FEV1). Metabolic Syndrome increased the risk of developing WTC-lung injury (WTC-LI). We aim to attenuate the deleterious effects of WTC exposure through a dietary intervention targeting these clinically relevant disease modifiers. We hypothesize that a calorie-restricted Mediterranean dietary intervention will improve metabolic risk, subclinical indicators of cardiopulmonary disease, quality of life, and lung function in firefighters with WTC-LI. To assess our hypothesis, we developed the Food Intake REstriction for Health OUtcome Support and Education (FIREHOUSE), a randomized controlled clinical trial (RCT). Male firefighters with WTC-LI and a BMI > 27 kg/m2 will be included. We will randomize subjects (1:1) to either: (1) Low Calorie Mediterranean (LoCalMed)-an integrative multifactorial, technology-supported approach focused on behavioral modification, nutritional education that will include a self-monitored diet with feedback, physical activity recommendations, and social cognitive theory-based group counseling sessions; or (2) Usual Care. Outcomes include reduction in body mass index (BMI) (primary), improvement in FEV1, fractional exhaled nitric oxide, pulse wave velocity, lipid profiles, targeted metabolic/clinical biomarkers, and quality of life measures (secondary). By implementing a technology-supported LoCalMed diet our FIREHOUSE RCT may help further the treatment of WTC associated pulmonary disease.

Lam R, Haider SH, Crowley G, et al. 2020. Synergistic effect of WTC-particulate matter and lysophosphatidic acid exposure and the role of rage: In-vitro and translational assessment. International Journal of Environmental Research and Public Health. 17 (12):4318.

HTTPS://DOI.ORG/10.3390/IJERPH17124318

BACKGROUND: World Trade Center particulate matter (WTC-PM)-exposed firefighters with metabolic syndrome (MetSyn) have a higher risk of WTC lung injury (WTC-LI). Since macrophages are crucial innate pulmonary mediators, we investigated WTC-PM/lysophosphatidic acid (LPA) co-exposure in macrophages. LPA, a low-density lipoprotein metabolite, is a ligand of the advanced glycation end-products receptor (AGER or RAGE). LPA and RAGE are biomarkers of WTC-LI. Human and murine macrophages were exposed to WTC-PM, and/or LPA, and compared to controls. Supernatants were assessed for cytokines/chemokines; cell lysate immunoblots were assessed for signaling intermediates after 24 h. To explore the translatability of our in-vitro findings, we assessed serum cytokines/chemokines and metabolites of symptomatic, never-smoking WTC-exposed firefighters. Agglomerative hierarchical clustering identified phenotypes of WTC-PM-induced inflammation. WTC-PM induced GM-CSF, IL-8, IL-10, and MCP-1 in THP-1-derived macrophages and induced IL-1alpha, IL-10, TNF-alpha, and NF-kappaB in RAW264.7 murine macrophage-like cells. Co-exposure induced synergistic elaboration of IL-10 and MCP-1 in THP-1-derived macrophages. Similarly, co-exposure synergistically induced IL-10 in murine macrophages. Synergistic effects were seen in the context of a downregulation of NF-kappaB, p-Akt, -STAT3, and -STAT5b. RAGE expression after co-exposure increased in murine macrophages compared to controls. In our integrated analysis, the human cytokine/chemokine biomarker profile of WTC-LI was associated with discriminatory metabolites (fatty acids, sphingolipids, and amino acids). LPA synergistically elaborated WTC-PM's inflammatory effects in vitro and was partly RAGE-mediated. Further research will focus on the intersection of MetSyn/PM exposure.

Marmor M, Thawani S, Cotrina ML, et al. 2020. Case-control study of paresthesia among World Trade Center-exposed community members. J Occup Environ Med. 62 (4):307–316.

HTTPS://DOI.ORG/10.1097/JOM.0000000000001828

OBJECTIVE: To investigate whether paresthesia of the lower extremities following exposure to the World Trade Center (WTC) disaster was associated with signs of neuropathy, metabolic abnormalities, or neurotoxin exposures.

METHODS: Case-control study comparing WTC-exposed paresthesia cases with "clinic controls" (WTC-exposed subjects without paresthesias), and "community controls" (WTC-unexposed persons).

RESULTS: Neurological histories and examination findings were significantly worse in cases than controls. Intraepidermal nerve fiber densities were below normal in 47% of cases and sural to

radial sensory nerve amplitude ratios were less than 0.4 in 29.4%. Neurologic abnormalities were uncommon among WTC-unexposed community controls. Metabolic conditions and neurotoxin exposures did not differ among groups.

CONCLUSIONS: Paresthesias among WTC-exposed individuals were associated with signs of neuropathy, small and large fiber disease. The data support WTC-related exposures as risk factors for neuropathy, and do not support non-WTC etiologies.

Putman B, Lahousse L, Goldfarb DG, et al. 2020. Factors predicting treatment of World Trade Center-related lung injury: A longitudinal cohort study. Int J Environ Res Public Health. 17 (23):9056.

HTTPS://DOI.ORG/10.3390/IJERPH17239056

BACKGROUND: The factors that predict treatment of lung injury in occupational cohorts are poorly defined. We aimed to identify patient characteristics associated with initiation of treatment with inhaled corticosteroid/long-acting beta-agonist (ICS/LABA) >2 years among World Trade Center (WTC)-exposed firefighters. The study population included 8530 WTC-exposed firefighters. Multivariable logistic regression assessed the association of patient characteristics with ICS/LABA treatment for >2 years over two-year intervals from 11 September 2001-10 September 2017. Cox proportional hazards models measured the association of high probability of ICS/LABA initiation with actual ICS/LABA initiation in subsequent intervals. Between 11 September 2001-1 July 2018, 1629/8530 (19.1%) firefighters initiated ICS/LABA treatment for >2 years. Forced Expiratory Volume in 1 s (FEV1), wheeze, and dyspnea were consistently and independently associated with ICS/LABA treatment. High-intensity WTC exposure was associated with ICS/LABA between 11 September 2001-10 September 2003. The 10th percentile of risk for ICS/LABA between 11 September 2005-10 Septmeber 2007 was associated with a 3.32-fold increased hazard of actual ICS/LABA initiation in the subsequent 4 years. In firefighters with WTC exposure, FEV1, wheeze, and dyspnea were independently associated with prolonged ICS/LABA treatment. A high risk for treatment was identifiable from routine monitoring exam results years before treatment initiation.

Reibman J, Caplan-Shaw C, Wu Y, et al. 2020. Characterization of persistent uncontrolled asthma symptoms in community members exposed to World Trade Center dust and fumes. Int. J. Environ. Res. Public Health. 17 (18):6645.

HTTPS://DOI.ORG/10.3390/IJERPH17186645

BACKGROUND: The destruction of the World Trade Center (WTC) towers on the 11th of September, 2001 released a vast amount of aerosolized dust and smoke resulting in acute and chronic exposures to community members as well as responders. The WTC Environmental Health Center (WTC EHC) is a surveillance and treatment program for a diverse population of community members, including local residents and local workers with WTC dust exposure. Many of these patients have reported persistent lower respiratory symptoms (LRS) despite treatment for presumed asthma. Our goal was to identify conditions associated with persistent un-

controlled LRS despite standard asthma management. We recruited 60 patients who were uncontrolled at enrollment and, after a three-month run-in period on high-dose inhaled corticosteroid and long acting bronchodilator, reassessed their status as Uncontrolled or Controlled based on a score from the Asthma Control Test (ACT). Despite this treatment, only 11 participants (18%) gained Controlled status as defined by the ACT. We compared conditions associated with Uncontrolled and Controlled status. Those with Uncontrolled symptoms had higher rates of upper airway symptoms. Many patients had persistent bronchial hyper-reactivity (BHR) and upper airway hyper-reactivity as measured by paradoxical vocal fold movement (PVFM). We found a significant increasing trend in the percentage of Controlled with respect to the presence of BHR and PVFM. We were unable to identify significant differences in lung function or inflammatory markers in this small group. Our findings suggest persistent upper and lower airway hyper-reactivity that may respond to standard asthma treatment, whereas others with persistent LRS necessitate additional diagnostic evaluation, including a focus on the upper airway.

Spratlen MJ, Perera FP, Lederman SA, et al. 2020. The association between prenatal exposure to perfluoroalkyl substances and childhood neurodevelopment. Environ Pollut. 263 (0):114444.

HTTPS://DOI.ORG/10.1016/J.ENVPOL.2020.114444

BACKGROUND: Perfluoroalkyl substances (PFAS) were among various persistent organic pollutants suspected to have been released during the collapse of the World Trade Center (WTC) on 9/11. Evidence on the association between prenatal PFAS exposure and child neurodevelopment is limited and inconsistent. This study evaluated the association between prenatal PFAS exposure and child cognitive outcomes measured at 5 different time points in a population prenatally exposed to the WTC disaster. The study population included 302 pregnant women in the Columbia University WTC birth cohort enrolled between December 13, 2001 and June 26, 2002 at three hospitals located near the WTC site: Beth Israel, St. Vincent's, and New York University Downtown. We evaluated the association between prenatal exposure to four PFAS (perfluorooctane sulfonate (PFOS), perfluorooctanoic acid (PFOA), perfluorohexanesulfonic acid (PFHxS), perfluorononanoic acid (PFNA)) and child neurodevelopment measured using the Bayley Scales of Infant Development (BSID-II) at approximately 1, 2 and 3 years of age and using The Wechsler Preschool and Primary Scale of Intelligence (WPPSI) at approximately 4 and 6 years of age. Geometric mean (range) concentrations of PFAS were 6.03 (1.05, 33.7), 2.31 (0.18, 8.14), 0.43 (<LOQ, 10.3) and 0.67 (<LOQ, 15.8) ng/mL for PFOS, PFOA, PFNA and PFHxS, respectively. Several PFAS were associated with increases in cognitive outcomes in females and overall (males and females combined). Child sex modified the association between PFOS and the mental development index measured using BSID-II, with the observed relationship being positive for females and negative for males. Through principal

component analyses, we observed a negative relationship between PFNA and the psychomotor development index measured using BSID-II and the verbal IQ measured using WPPSI.

OUR RESULTS: suggest a sex- and compound-specific relationship between prenatal PFAS exposures and childhood neurodevelopment.

Spratlen MJ, Perera FP, Lederman SA, et al. 2020. The association between perfluoroalkyl substances and lipids in cord blood. The Journal of clinical endocrinology and metabolism. 105 (1)

HTTPS://DOI.ORG/10.1210/CLINEM/DGZ024

INTRODUCTION: Perfluoroalkyl substances (PFAS) were among various persistent organic pollutants suspected to have been released during the collapse of the World Trade Center (WTC) on 9/11/2001. Evidence suggests that PFAS may have cardiometabolic effects, including alterations in lipid profiles. This study evaluated the association between cord blood PFAS and lipids in a population prenatally exposed to the WTC disaster. STUDY POPULATION: 222 pregnant women in the Columbia University WTC birth cohort enrolled between December 13, 2001 and June 26, 2002 at hospitals located near the WTC site: Beth Israel, St. Vincent's, and New York University Downtown.

METHODS: We evaluated the association between 5 cord blood PFAS-perfluorooctane sulfonate (PFOS), perfluorooctanoic acid (PFOA), perfluorohexanesulfonic acid (PFHxS), perfluorononanoic acid (PFNA), perfluorodecane sulfonate (PFDS)-and cord blood lipids (total lipids, total cholesterol, triglycerides).

RESULTS: Median (interquartile range [IQR]) concentrations of PFAS were 6.32 (4.58-8.57), 2.46 (1.77-3.24), 0.38 (0.25-0.74), 0.66 (0.48-0.95) and 0.11 (0.09-0.16) ng/mL for PFOS, PFOA, PFNA, PFHxS, and PFDS, respectively. Median (IQR) for lipids were 59.0 (51.5-68.5) mg/dL for total cholesterol, 196.5 (170.5-221.2) mg/dL for total lipids and 33.1 (24.2-43.9) mg/dL for triglycerides. In fully adjusted models, several PFAS were associated with higher lipid levels, including evidence of a strong linear trend between triglycerides and both PFOA and PFHxS.

CONCLUSIONS: Findings support previous evidence of an association between PFAS exposure and altered lipid profiles and add novel information on this relationship in cord blood, as well as for an understudied PFAS, PFDS.

Veerappan A, Oskuei A, Crowley G, et al. 2020. World Trade Center-cardiorespiratory and vascular dysfunction: Assessing the phenotype and metabolome of a murine particulate matter exposure model. Scientific reports. 10 (1):3130–3130.

HTTPS://DOI.ORG/10.1038/S41598-020-58717-W

BACKGROUND: Vascular changes occur early in the development of obstructive airways disease. However, the vascular remodeling and dysfunction due to World Trade Center-Particulate Matter (WTC-PM) exposure are not well described and are therefore the focus of this investigation. C57Bl/6 female mice oropharyngeally aspirated 200 µg of WTC-PM(53) or phosphate-buffered saline (PBS) (controls). 24-hours (24-hrs) and 1-Month (1-M) after exposure, echo-

cardiography, micro-positron emission tomography(μ-PET), collagen quantification, lung metabolomics, assessment of antioxidant potential and soluble-receptor for advanced glycation end products (sRAGE) in bronchoalveolar lavage(BAL) and plasma were performed. 24-hrs post-exposure, there was a significant reduction in (1) Pulmonary artery(PA) flow-velocity and pulmonary ejection time(PET) (2) Pulmonary acceleration time(PAT) and PAT/PET, while (3) Aortic ejection time(AET) and velocity time integral(VTI) were increased, and (4) Aortic acceleration time (AAT)/AET, cardiac output and stroke volume were decreased compared to controls. 1-M post-exposure, there was also significant reduction of right ventricular diameter as right ventricle free wall thickness was increased and an increase in tricuspid E, A peaks and an elevated E/A. The pulmonary and cardiac standard uptake value and volume 1-M post-exposure was significantly elevated after PM-exposure. Similarly, α-smooth muscle actin(α-SMA) expression, aortic collagen deposition was elevated 1-M after PM exposure. In assessment of the metabolome, prominent subpathways included advanced glycation end products (AGEs), phosphatidylcholines, sphingolipids, saturated/unsaturated fatty acids, eicosanoids, and phospholipids. BAL superoxide dismutase(SOD), plasma total-antioxidant capacity activity, and sRAGE (BAL and plasma) were elevated after 24-hrs. PM exposure and associated vascular disease are a global health burden. Our Vascular changes occur early in the development of obstructive airways disease. However, the vascular remodeling and dysfunction due to World Trade Center-Particulate Matter (WTC-PM) exposure are not well described and are therefore the focus of this investigation.

Waszczuk MA, Docherty AR, Shabalin AA, et al. 2020. Polygenic prediction of PTSD trajectories in 9/11 responders. Psychol Med. :1–9.

HTTPS://DOI.ORG/10.1017/S0033291720003839

BACKGROUND: Genetics hold promise of predicting long-term post-traumatic stress disorder (PTSD) outcomes following trauma. The aim of the current study was to test whether six hypothesized polygenic risk scores (PRSs) developed to capture genetic vulnerability to psychiatric conditions prospectively predict PTSD onset, severity, and 18-year course after trauma exposure.

METHODS: Participants were 1490 responders to the World Trade Center (WTC) disaster (mean age at 9/11 = 38.81 years, s.d. = 8.20; 93.5% male; 23.8% lifetime WTC-related PTSD diagnosis). Prospective longitudinal data on WTC-related PTSD symptoms were obtained from electronic medical records and modelled as PTSD trajectories using growth mixture model analysis. Independent regression models tested whether six hypothesized psychiatric PRSs (PTSD-PRS, Re-experiencing-PRS, Generalized Anxiety-PRS, Schizophrenia-PRS, Depression-PRS, and Neuroticism-PRS) are predictive of WTC-PTSD outcomes: lifetime diagnoses, average symptom severity, and 18-year symptom trajectory. All analyses were adjusted for population stratification, 9/11 exposure severity,

and multiple testing. RESULTS: Depression-PRS predicted PTSD diagnostic status (OR 1.37, CI 1.17-1.61, adjusted p = 0.001). All PRSs, except PTSD-PRS, significantly predicted average PTSD symptoms (beta = 0.06-0.10, adjusted p < 0.05). Re-experiencing-PRS, Generalized Anxiety-PRS and Schizophrenia-PRS predicted the high severity PTSD trajectory class (ORs 1.21-1.28, adjusted p < 0.05). Finally, PRSs prediction was independent of 9/11 exposure severity and jointly accounted for 3.7 times more variance in PTSD symptoms than the exposure severity.

CONCLUSIONS: Psychiatric PRSs prospectively predicted WTC-related PTSD lifetime diagnosis, average symptom severity, and 18-year trajectory in responders to 9/11 disaster. Jointly, PRSs were more predictive of subsequent PTSD than the exposure severity. In the future, PRSs may help identify at-risk responders who might benefit from targeted prevention approaches.

Weber J, Reeves AP, Doucette JT, et al. 2020. Quantitative ct evidence of airway inflammation in WTC workers and volunteers with low fvc spirometric pattern. Lung. 198 (3):555–563.

HTTPS://DOI.ORG/10.1007/S00408-020-00350-5

BACKGROUND: The most common abnormal spirometric pattern reported in WTC worker and volunteer cohorts has consistently been that of a nonobstructive reduced forced vital capacity (low FVC). Low FVC is associated with obesity, which is highly prevalent in these cohorts. We used quantitative CT (QCT) to investigate proximal and distal airway inflammation and emphysema in participants with stable low FVC pattern. Methods We selected study participants with at least two available longitudinal surveillance spirometries, and a chest CT with QCT measurements of proximal airway inflammation (wall area percent, WAP), end-expiratory air trapping, suggestive of distal airway obstruction (expiratory to inspiratory mean lung attenuation ratio, MLAEI), and emphysema (percentage of lung volume with attenuation below – 950 HU, LAV%). The comparison groups in multinomial logistic regression models were participants with consistently normal spirometries, and participants with stable fixed obstruction (COPD).

RESULTS: Compared to normal spirometry participants, and after adjusting for age, sex, race/ethnicity, BMI, smoking, and early arrival at the WTC disaster site, low FVC participants had higher WAP (ORadj 1.24, 95% CI 1.06, 1.45, per 5% unit), suggestive of proximal airway inflammation, but did not differ in MLAEI, or LAV%. COPD participants did not differ in WAP with the low FVC ones and were more likely to have higher MLAEI or LAV% than the other two subgroups. Discussion WTC workers with spirometric low FVC have higher QCT-measured WAP compared to those with normal spirometries, but did not differ in distal airway and emphysema measurements, independently of obesity, smoking, and other covariates.

Year Published 2021 (35)

Bello GA, Ornstein KA, Lucchini RG, et al. 2021. Development and validation of a clinical frailty index for the World Trade Center general responder cohort. Journal of Aging and Health. 33 (44750):531–544.

HTTPS://DOI.ORG/10.1177/0898264321997675

OBJECTIVES: To develop and validate a clinical frailty index to characterize aging among responders to the 9/11 World Trade Center (WTC) attacks.

METHODS: This study was conducted on health monitoring data on a sample of 6197 responders. A clinical frailty index, WTC FI-Clinical, was developed according to the cumulative deficit model of frailty. The validity of the resulting index was assessed using all-cause mortality as an endpoint. Its association with various cohort characteristics was evaluated.

RESULTS: The sample's median age was 51 years. Thirty items were selected for inclusion in the index. It showed a strong correlation with age, as well as significant adjusted associations with mortality, 9/11 exposure severity, sex, race, pre-9/11 occupation, education, and smoking status.

DISCUSSION: The WTC FI-Clinical highlights effects of certain risk factors on aging within the 9/11 responder cohort. It will serve as a useful instrument for monitoring and tracking frailty within this cohort.Brackbill RM, Kahn AR, Li J, et al. 2021. Combining three cohorts of World Trade Center rescue/recovery workers for assessing cancer incidence and mortality. International Journal of Environmental Research and Public Health. 18 (4):1386.

HTTPS://DOI.ORG/10.3390/IJERPH18041386

Three cohorts including the Fire Department of the City of New York (FDNY), the World Trade Center Health Registry (WTCHR), and the General Responder Cohort (GRC), each funded by the World Trade Center Health Program have reported associations between WTC-exposures and cancer. Results have generally been consistent with effect estimates for excess incidence for all cancers ranging from 6 to 14% above background rates. Pooling would increase sample size and de-duplicate cases between the cohorts. However, pooling required time consuming steps: obtaining Institutional Review Board (IRB) approvals and legal agreements from entities involved; establishing an honest broker for managing the data; de-duplicating the pooled cohort files; applying to State Cancer Registries (SCRs) for matched cancer cases; and finalizing analysis data files. Obtaining SCR data use agreements ranged from 6.5 to 114.5 weeks with six states requiring >20 weeks. Records from FDNY (n = 16,221), WTCHR (n = 29,372), and GRC (n = 33,427) were combined de-duplicated resulting in 69,102 unique individuals. Overall, 7894 cancer tumors were matched to the pooled cohort, increasing the number cancers by as much as 58% compared to previous analyses. Pooling resulted in a coherent resource for future research for studies on rare cancers and mortality, with more representative of occupations and WTC- exposure. Note--This paper

describes the processes involved with combining data across the three WTC-exposed cohorts and linking the pooled data with state cancer registries; and the strategies for overcoming administrative challenges. To our knowledge, studies that use pooled data do not typically provide a detailed description of their combining process. The transparency of this approach is important for a fuller understanding of the findings derived from analyses of WTC-exposure and health in our case, as well as, other endeavors that also use information combined from multiple sources.

Chen APF, Clouston SAP, Kritikos M, et al. 2021. A deep learning approach for monitoring parietal-dominant alzheimer's disease in World Trade Center responders at midlife. Brain Commun. 3 (3):fcab145.

HTTPS://DOI.ORG/10.1093/BRAINCOMMS/FCAB145

Little is known about the characteristics and causes of early-onset cognitive impairment. Responders to the 2001 New York World Trade Center disaster represent an ageing population that was recently shown to have an excess prevalence of cognitive impairment. Neuroimaging and molecular data demonstrate that a subgroup of affected responders may have a unique form of parietal-dominant Alzheimer's Disease. Recent neuropsychological testing and artificial intelligence approaches have emerged as methods that can be used to identify and monitor subtypes of cognitive impairment. We utilized data from World Trade Center responders participating in a health monitoring program and applied a deep learning approach to evaluate neuropsychological and neuroimaging data to generate a cortical atrophy risk score. We examined risk factors associated with the prevalence and incidence of high risk for brain atrophy in responders who are now at midlife. Training was conducted in a randomly selected two-thirds sample (N = 99) enrolled using of the results of a structural neuroimaging study. Testing accuracy was estimated for each training cycle in the remaining third subsample. After training was completed, the scoring methodology that was generated was applied to longitudinal data from 1441 World Trade Center responders. The artificial neural network provided accurate classifications of these responders in both the testing (Area Under the Receiver Operating Curve, 0.91) and validation samples (Area Under the Receiver Operating Curve, 0.87). At baseline and follow-up, responders identified as having a high risk of atrophy (n = 378) showed poorer cognitive functioning, most notably in domains that included memory, throughput, and variability as compared to their counterparts at low risk for atrophy (n = 1063). Factors associated with atrophy risk included older age [adjusted hazard ratio, 1.045 (95% confidence interval = 1.027-1.065)], increased duration of exposure at the WTC site [adjusted hazard ratio, 2.815 (1.781-4.449)], and a higher prevalence of post-traumatic stress disorder [aHR, 2.072 (1.408-3.050)]. High atrophy risk was associated with an increased risk of all-cause mortality [adjusted risk ratio, 3.19 (1.13-9.00)]. In sum, the high atrophy risk group displayed higher levels of previously identified risk factors and characteristics of cognitive impairment, including advanced age, symptoms of post-traumatic stress disorder, and prolonged duration of exposure to particu-

late matter. Thus, this study suggests that a high risk of brain atrophy may be accurately monitored using cognitive data.

Ciro D, Pietrzak RH, Lee RJ, et al. 2021. Acculturation, coping, and PTSD in hispanic 9/11 rescue and recovery workers. Psychol Trauma. 13 (1):84–93.

HTTPS://DOI.ORG/10.1037/TRA0000624

OBJECTIVE: Research examining the responders of the World Trade Center terrorist attacks of 9/11 has found that Hispanic responders are at greater risk for posttraumatic stress disorder (PTSD) than non-Hispanic White responders. However, no studies have examined how acculturation may influence the relationship between coping and PTSD in Hispanic 9/11 responders. This novel study is the first to examine differences in coping and PTSD among Hispanic responders by level of acculturation.

METHODS: The sample is composed of 845 Hispanic 9/11 responders who were seen at the World Trade Center Health Program and participated in a web-based survey. Using logistic and multiple linear regression, we examined how acculturation is related to their coping strategies and risk for PTSD. We also tested for interaction to examine whether level of acculturation moderated the relationship between coping and PTSD symptom severity.

RESULTS: Key findings revealed that higher acculturation is associated with the use of substances, venting, and humor to cope, while lower acculturation is associated with the use of active coping and self-distraction in this sample. We also found that less acculturated responders were more likely to experience more severe PTSD. Lastly, our findings revealed that Hispanics who are more acculturated and used substances to cope had more severe PTSD than less acculturated responders.

CONCLUSION: These findings highlight the need to consider the role of acculturation in Hispanic responders' coping and PTSD.

Cleven KL, Rosenzvit C, Nolan A, et al. 2021. Twenty-year reflection on the impact of World Trade Center exposure on pulmonary outcomes in fire department of the city of New York (FDNY) rescue and recovery workers. Lung. 199 (6):569–578.

HTTPS://DOI.ORG/10.1007/S00408-021-00493-Z

After the terrorist attacks on September 11, 2001 (9/11), many rescue/recovery workers developed respiratory symptoms and pulmonary diseases due to their extensive World Trade Center (WTC) dust cloud exposure. Nearly all Fire Department of the City of New York (FDNY) workers were present within 48 h of 9/11 and for the next several months. Since the FDNY had a well-established occupational health service for its firefighters and Emergency Medical Services workers prior to 9/11, the FDNY was able to immediately start a rigorous monitoring and treatment program for its WTC-exposed workers. As a result, respiratory symptoms and diseases were identified soon after 9/11. This focused review summarizes the WTC-related respiratory diseases that developed in the FDNY cohort after 9/11, including WTC cough syndrome, obstructive airways disease, accelerated lung function decline, airway hyperreactivity, sarcoidosis, and obstructive sleep

apnea. Additionally, an extensive array of biomarkers has been identified as associated with WTC-related respiratory disease. Future research efforts will not only focus on further phenotyping/treating WTC-related respiratory disease but also on additional diseases associated with WTC exposure, especially those that take decades to develop, such as cardiovascular disease, cancer, and interstitial lung disease.

Cleven KL, Vaeth B, Zeig-Owens R, et al. 2021. Performance of risk factor-based guidelines and model-based chest ct lung cancer screening in World Trade Center-exposed fire department rescue/recovery workers. Chest. 159 (5):2060–2071.

HTTPS://DOI.ORG/10.1016/J.CHEST.2020.11.028

BACKGROUND: Lung cancer is a leading cause of cancer incidence and death in the United States. Risk factor-based guidelines and risk model-based strategies are used to identify patients who could benefit from low-dose chest CT (LDCT) screening. Few studies compare guidelines or models within the same cohort. We evaluate lung cancer screening performance of two risk factor-based guidelines (US Preventive Services Task Force 2014 recommendations [USPSTF-2014] and National Comprehensive Cancer Network Group 2 [NCCN-2]) and two risk model-based strategies, Prostate Lung Colorectal and Ovarian Cancer Screening (PLCOm2012) and the Bach model) in the same occupational cohort.

RESEARCH QUESTION: Which risk factor-based guideline or model-based strategy is most accurate in detecting lung cancers in a highly exposed occupational cohort? .

STUDY DESIGN AND METHODS: Fire Department of City of New York (FDNY) rescue/recovery workers exposed to the September 11, 2001 attacks underwent LDCT lung cancer screening based on smoking history and age. The USPSTF-2014, NCCN-2, PLCOm2012 model, and Bach model were retrospectively applied to determine how many lung cancers were diagnosed using each approach.

RESULTS: Among the study population (N = 3,953), 930 underwent a baseline scan that met at least one risk factor or model-based LDCT screening strategy; 73% received annual follow-up scans. Among the 3,953, 63 lung cancers were diagnosed, of which 50 were detected by at least one LDCT screening strategy. The NCCN-2 guideline was the most sensitive (79.4%; 50/63). When compared with NCCN-2, stricter age and smoking criteria reduced sensitivity of the other guidelines/models (USPSTF-2014 [44%], PLCOm2012 [51%], and Bach[46%]). The 13 missed lung cancers were mainly attributable to smoking less and quitting longer than guideline/model eligibility criteria. False-positive rates were similar across all four guidelines/models.

INTERPRETATION: In this cohort, our findings support expanding eligibility for LDCT lung cancer screening by lowering smoking history from >/=30 to >/=20 pack-years and age from 55 years to 50 years old. Additional studies are needed to determine its generalizability to other occupational/environmental exposed cohorts.Crowley G, Kim J, Kwon S, et al. 2021. PEDF, a pleiotropic WTC-LI biomarker:

Machine learning biomarker identification and validation. PLoS Comput Biol. 17 (7):e1009144.

HTTPS://DOI.ORG/10.1371/JOURNAL.PCBI.1009144

BACKGROUND: Biomarkers predict World Trade Center-Lung Injury (WTC-LI); however, there remains unaddressed multicollinearity in our serum cytokines, chemokines, and high-throughput platform datasets used to phenotype WTC-disease. To address this concern, we used automated, machine-learning, high-dimensional data pruning, and validated identified biomarkers. The parent cohort consisted of male, never-smoking firefighters with WTC-LI (FEV1, %Pred< lower limit of normal (LLN); n = 100) and controls (n = 127) and had their biomarkers assessed. Cases and controls (n = 15/group) underwent untargeted metabolomics, then feature selection performed on metabolites, cytokines, chemokines, and clinical data. Cytokines, chemokines, and clinical biomarkers were validated in the non-overlapping parent-cohort via binary logistic regression with 5-fold cross validation. Random forests of metabolites (n = 580), clinical biomarkers (n = 5), and previously assayed cytokines, chemokines (n = 106) identified that the top 5% of biomarkers important to class separation included pigment epithelium-derived factor (PEDF), macrophage derived chemokine (MDC), systolic blood pressure, macrophage inflammatory protein-4 (MIP-4), growth-regulated oncogene protein (GRO), monocyte chemoattractant protein-1 (MCP-1), apolipoprotein-AII (Apo-AII), cell membrane metabolites (sphingolipids, phospholipids), and branched-chain amino acids. Validated models via confounder-adjusted (age on 9/11, BMI, exposure, and pre-9/11 FEV1, %Pred) binary logistic regression had AUCROC [0.90(0.84-0.96)]. Decreased PEDF and MIP-4, and increased Apo-AII were associated with increased odds of WTC-LI. Increased GRO, MCP-1, and simultaneously decreased MDC were associated with decreased odds of WTC-LI. In conclusion, automated data pruning identified novel WTC-LI biomarkers; performance was validated in an independent cohort. One biomarker-PEDF, an antiangiogenic agent-is a novel, predictive biomarker of particulate-matter-related lung disease. Other biomarkers-GRO, MCP-1, MDC, MIP-4-reveal immune cell involvement in WTC-LI pathogenesis. Findings of our automated biomarker identification warrant further investigation into these potential pharmacotherapy targets.

Deri Y, Clouston SAP, DeLorenzo C, et al. 2021. Selective hippocampal subfield volume reductions in World Trade Center responders with cognitive impairment. Alzheimer's & Dementia: Diagnosis, Assessment & Disease Monitoring. 13 (1):e12165.

HTTPS://DOI.ORG/10.1002/DAD2.12165Introduction: The objective of this study was to investigate associations between dementia in World Trade Center (WTC) responders and in vivo volumetric measures of hippocampal subfield volumes in WTC responders at midlife.

METHODS: A sample of 99 WTC responders was divided into dementia and unimpaired groups. Participants underwent structural T1-weighted magnetic resonance imaging.

Volumetric measures included the overall hippocampus and eight subfields. Regression models examined volumetric measure of interest adjusting for confounders including intracranial volume.

RESULTS: Dementia was associated with smaller hippocampal volume and with reductions across hippocampal subfields. Smaller hippocampal subfield volumes were associated with longer cumulative time worked at the WTC. Domain-specific cognitive performance was associated with lower volumetric measures across hippocampal subregions.

CONCLUSIONS: This is the first study to investigate hippocampal subfield volumes in a sample of WTC responders at midlife. Selective hippocampal subfield volume reductions suggested abnormal cognition that were associated with WTC exposure duration.

Goldfarb DG, Colbeth HL, Skerker M, et al. 2021. Impact of healthcare services on thyroid cancer incidence among World Trade Center-exposed rescue and recovery workers. American Journal of Industrial Medicine. 64 (10):861–872.

HTTPS://DOI.ORG/10.1002/AJIM.23277

BACKGROUND: A recent study of World Trade Center (WTC)-exposed firefighters and emergency medical service workers demonstrated that elevated thyroid cancer incidence may be attributable to frequent medical testing, resulting in the identification of asymptomatic tumors. We expand on that study by comparing the incidence of thyroid cancer among three groups: WTC-exposed rescue/recovery workers enrolled in a New York State (NYS) WTC-medical monitoring and treatment program (MMTP); WTC-exposed rescue/recovery workers not enrolled in an MMTP (non-MMTP); and the NYS population.

METHODS: Person-time began on 9/12/2001 or at enrollment in a WTC cohort and ended at death or on 12/31/2015. Cancer data were obtained through linkages with 13 state cancer registries. We used Poisson regression to estimate rate ratios (RRs) and 95% confidence intervals (CIs) for MMTP and non-MMTP participants. NYS rates were used as the reference. To estimate potential changes over time in WTC-associated risk, change points in RRs were estimated using profile likelihood.

RESULTS: The thyroid cancer incidence rate among MMTP participants was more than twice that of NYS population rates (RR = 2.31; 95% CI = 2.00–2.68). Non-MMTP participants had a risk similar to NYS (RR = 0.96; 95% CI = 0.72–1.28). We observed no change points in the follow-up period.

CONCLUSION: Our findings support the hypothesis that no-cost screening (a benefit provided by WTC-MMTPs) is associated with elevated identification of thyroid cancer. Given the high survival rate for thyroid cancer, it is important to weigh the costs and benefits of treatment, as many of these cancers were asymptomatic and may have been detected incidentally.

Goldfarb DG, Putman B, Lahousse L, et al. 2021. Lung function decline before and after treatment of World Trade Center associated obstructive airways

disease with inhaled corticosteroids and long-acting beta agonists. Am J Ind Med. 64 (10):853–860.

HTTPS://DOI.ORG/10.1002/AJIM.23272

BACKGROUND: Greater than average loss of one-second forced expiratory volume (FEV(1)) is a risk factor for asthma, chronic obstructive pulmonary disease (COPD), and asthma/COPD overlap syndrome in World Trade Center (WTC)-exposed firefighters. Inhaled corticosteroids and long-acting beta agonists (ICS/LABA) are used to treat obstructive airways disease but their impact on FEV(1) -trajectory in this population is unknown.

METHODS: The study population included WTC-exposed male firefighters who were treated with ICS/LABA for 2 years or longer (with initiation before 2015), had at least two FEV(1) measurements before ICS/LABA initiation and two FEV(1) measurements posttreatment between September 11, 2001 and September 10, 2019. Linear mixed-effects models were used to estimate FEV(1) -slope pre- and post-treatment.

RESULTS: During follow-up, 1023 WTC-exposed firefighters were treated with ICS/LABA for 2 years or longer. When comparing intervals 6 years before and 6 years after treatment, participants had an 18.7 ml/year (95% confidence interval [CI]: 11.3-26.1) improvement in FEV(1) -slope after adjustment for baseline FEV(1) , race, height, WTC exposure, weight change, blood eosinophil concentration, and smoking status. After stratification by median date of ICS/LABA initiation (January 14, 2010), earlier ICS/LABA-initiators had a 32.5 ml/year (95% CI: 19.5-45.5) improvement in slope but later ICS/LABA-initiators had a nonsignificant FEV(1) -slope improvement (7.9 ml/year, 95% CI: -0.5 to 17.2).

CONCLUSIONS: WTC-exposed firefighters treated with ICS/LABA had improved FEV(1) slope after initiation, particularly among those who started earlier. Treatment was, however, not associated with FEV(1) -slope improvement if started after the median initiation date (1/14/2010), likely because onset of disease began before treatment initiation. Research on alternative treatments is needed for patients with greater than average FEV(1) -decline who have not responded to ICS/LABA.

Goldfarb DG, Zeig-Owens R, Kristjansson D, et al. 2021. Cancer survival among World Trade Center rescue and recovery workers: A collaborative cohort study. Am J Ind Med. 64 (10):815–826.

HTTPS://DOI.ORG/10.1002/AJIM.23278

BACKGROUND: World Trade Center (WTC)-exposed responders may be eligible to receive no-cost medical monitoring and treatment for certified conditions, including cancer. The survival of responders with cancer has not previously been investigated.

METHODS: This study compared the estimated relative survival of WTC-exposed responders who developed cancer while enrolled in two WTC medical monitoring and treatment programs in New York City (WTC-MMTP responders) and WTC-exposed responders not enrolled (WTC-non-MMTP responders) to non-responders from New York State (NYS-non-responders), all restricted to the 11-southernmost

NYS counties, where most responders resided. Parametric survival models estimated cancer-specific and all-cause mortality. Follow-up ended at death or on December 31, 2016.

RESULTS: From January 1, 2005 to December 31, 2016, there were 2,037 cancer cases and 303 deaths (248 cancer-related deaths) among WTC-MMTP responders, 564 cancer cases, and 143 deaths (106 cancer-related deaths) among WTC-non-MMTP responders, and 574,075 cancer cases and 224,040 deaths (158,645 cancer-related deaths) among the NYS-non-responder population. Comparing WTC-MMTP responders with NYS-non-responders, the cancer-specific mortality hazard ratio (HR) was 0.72 (95% confidence interval [CI] = 0.64-0.82), and all-cause mortality HR was 0.64 (95% CI = 0.58-0.72). The cancer-specific HR was 0.94 (95% CI = 0.78-1.14), and all-cause mortality HR was 0.93 (95% CI = 0.79-1.10) comparing WTC-non-MMTP responders to the NYS-non-responder population.

CONCLUSIONS: WTC-MMTP responders had lower mortality compared with NYS-non-responders, after controlling for demographic factors and temporal trends. There may be survival benefits from no-out-of-pocket-cost medical care which could have important implications for healthcare policy, however, other occupational and socioeconomic factors could have contributed to some of the observed survival advantage.

Goldfarb DG, Zeig-Owens R, Kristjansson D, et al. 2021. Temporal association of prostate cancer incidence with World Trade Center rescue/recovery work. Occup Environ Med. 78 (10):699–706.

HTTPS://DOI.ORG/10.1136/OEMED-2021-107405

BACKGROUND: The World Trade Center (WTC) attacks on 11 September 2001 created a hazardous environment with known and suspected carcinogens. Previous studies have identified an increased risk of prostate cancer in responder cohorts compared with the general male population.

OBJECTIVES: To estimate the length of time to prostate cancer among WTC rescue/recovery workers by determining specific time periods during which the risk was significantly elevated.

METHODS: Person-time accruals began 6 months after enrolment into a WTC cohort and ended at death or 12/31/2015. Cancer data were obtained through linkages with 13 state cancer registries. New York State was the comparison population. We used Poisson regression to estimate hazard ratios and 95% CIs; change points in rate ratios were estimated using profile likelihood.

RESULTS: The analytic cohort included 54 394 male rescue/recovery workers. We observed 1120 incident prostate cancer cases. During 2002-2006, no association with WTC exposure was detected. Beginning in 2007, a 24% increased risk (HR: 1.24, 95% CI 1.16 to 1.32) was observed among WTC rescue/recovery workers when compared with New York State. Comparing those who arrived earliest at the disaster site on the morning of 11 September 2001 or any time on 12 September 2001 to those who first arrived later, we observed a positive, monotonic, dose-response

association in the early (2002-2006) and late (2007-2015) periods.

CONCLUSIONS: Risk of prostate cancer was significantly elevated beginning in 2007 in the WTC combined rescue/recovery cohort. While unique exposures at the disaster site might have contributed to the observed effect, screening practices including routine prostate specific antigen screening cannot be discounted.

Goodwin RD, Cheslack-Postava K, Musa GJ, et al. 2021. Exposure to mass disaster and probable panic disorder among children in New York City. Journal of Psychiatric Research. 138:349–353.

HTTPS://DOI.ORG/10.1016/J.JPSYCHIRES.2021.04.001

While both direct and indirect exposure to mass trauma are increasing in the United States, relatively little is known about the potential link between mass trauma and risk of panic disorder early in life. It is also unclear whether history of prior individual trauma increases risk of panic disorder even further among those with exposure to mass trauma. The current study investigated the association between exposure to a mass trauma event (the World Trade Center (WTC) attack) and risk of panic disorder among children, how panic disorder varies by exposure severity and sociodemographic characteristics, and whether there is an interaction between individual and mass trauma exposure in the risk of panic disorder. Data were from an epidemiologic study of probable mental disorders among New York City schoolchildren exposed to the WTC terrorist attack. Severe (adjusted odds ratio [AOR] = 2.0 (1.1, 3.7)) exposure to the WTC disaster was associated with increased odds of probable panic disorder, relative to mild exposure. The prevalence of panic disorder increased with higher level of WTC exposure among all sociodemographic strata. Prior individual trauma exposure was associated with increased odds of panic disorder (AOR = 2.4 (1.6, 3.5)), but there was no evidence of interaction between prior individual trauma exposure and exposure to the WTC disaster. Preventive measures to address the widespread nature of mass disaster exposure at increasingly earlier ages and via media could mitigate the potential impact on mental health.

Jirapatnakul A, Yip R, Branch AD, et al. 2021. Dose-response relationship between World Trade Center dust exposure and hepatic steatosis. Am J Ind Med. 64 (10):837–844.

HTTPS://DOI.ORG/10.1002/AJIM.23269

BACKGROUND: The World Trade Center (WTC) attack exposed thousands of workers to toxic chemicals that have been linked to liver diseases and cancers. This study examined the relationship between the intensity of WTC dust exposure and the risk of hepatic steatosis in the WTC General Responders Cohort (GRC).

METHODS: All low-dose computed tomography (CT) scans of the chest performed on the WTC GRC between September 11, 2001 and December 31, 2018, collected as part of the World Trade Center Health Program, were reviewed. WTC dust exposure was categorized into five groups based on WTC arrival time. CT liver density was estimated using an automated algorithm, statistics-based

liver density estimation from imaging. The relationship between the intensity of WTC dust exposure and the risk of hepatic steatosis was examined using univariate and multivariable regression analyses.

RESULTS: Of the 1788 WTC responders, 258 (14.4%) had liver attenuation less than 40 Hounsfield units (HU < 40) on their earliest CT. Median time after September 11, 2001 and the earliest available CT was 11.3 years (interquartile range: 8.0-14.9 years). Prevalence of liver attenuation less than 40 HU was 17.0% for arrivals on September 11, 2001, 16.0% for arrivals on (September 12, 2001 or September 13, 2001), 10.9% for arrivals on September 14-30, 2001, and 9.0% for arrivals on January 10, 2001 or later ($p = 0.0015$). A statistically significant trend of increasing liver steatosis was observed with earlier arrival times ($p < 0.0001$). WTC arrival time remained a significant independent factor for decreased liver attenuation after controlling for other covariates.

CONCLUSIONS: Early arrival at the WTC site was significantly associated with increasing hepatic steatosis.

Kritikos M, Clouston SAP, Huang C, et al. 2021. Cortical complexity in world trade center responders with chronic posttraumatic stress disorder. Translational Psychiatry. 11 (1):597.

HTTPS://DOI.ORG/10.1038/S41398-021-01719-7

BACKGROUND: Approximately 23% of World Trade Center (WTC) responders are experiencing chronic posttraumatic stress disorder (PTSD) associated with their exposures at the WTC following the terrorist attacks of 9/11/2001, which has been demonstrated to be a risk factor for cognitive impairment raising concerns regarding their brain health. Cortical complexity, as measured by analyzing Fractal Dimension (FD) from T1 MRI brain images, has been reported to be reduced in a variety of psychiatric and neurological conditions. In this report, we hypothesized that FD would be also reduced in a case-control sample of 99 WTC responders as a result of WTC-related PTSD. The results of our surface-based morphometry cluster analysis found alterations in vertex clusters of complexity in WTC responders with PTSD, with marked reductions in regions within the frontal, parietal, and temporal cortices, in addition to whole-brain absolute bilateral and unilateral complexity. Furthermore, region of interest analysis identified that the magnitude of changes in regional FD severity was associated with increased PTSD symptoms (reexperiencing, avoidance, hyperarousal, negative affect) severity.

CONCLUSIONS: This study confirms prior findings on FD and psychiatric disorders and extends our understanding of FD associations with posttraumatic symptom severity. The complex and traumatic experiences that led to WTC-related PTSD were associated with reductions in cortical complexity. Future work is needed to determine whether reduced cortical complexity arose prior to, or concurrently with, onset of PTSD.

Kuan PF, Clouston S, Yang X, et al. 2021. Single-cell transcriptomics analysis of mild cognitive impairment in World Trade Center disaster responders. Alzheimer's & Dementia: Diagnosis, Assessment & Disease Monitoring. 13 (1):e12154.

HTTPS://DOI.ORG/10.1002/DAD2.12154

INTRODUCTION: Recent research has found that World Trade Center (WTC) responders in their mid-50s have an elevated prevalence of mild cognitive impairment (MCI) that is associated with neural degeneration and subcortical thinning. This article extends our understanding of the molecular complexity of MCI through gene expression profiling of blood.

METHODS: The transcriptomics of 40 male WTC responders were profiled across two cohorts (discovery: nine MCI and nine controls; replication: 11 MCI and 11 controls) using CITE-Seq at single-cell resolution in blood.

RESULTS: Comparing the transcriptomic signatures across seven major cell subpopulations, the largest differences were observed in monocytes in which 226 genes were differentially expressed. Pathway analysis on the genes unique to monocytes identified processes associated with cerebral immune response.

DISCUSSION: Our findings suggested monocytes may constitute a key cell type to target in blood-based biomarker studies for early detection of risk of MCI and development of new interventions.

Kuan PF, Ren X, Clouston S, et al. 2021. PTSD is associated with accelerated transcriptional aging in World Trade Center responders. Transl Psychiatry. 11 (1):311.

HTTPS://DOI.ORG/10.1038/S41398-021-01437-0

BACKGROUND: Posttraumatic stress disorder (PTSD) is associated with shortened lifespan and healthspan, which suggests accelerated aging. Emerging evidence suggests that methylation age may be accelerated in PTSD. It is important to examine whether transcriptional age is also accelerated because transcriptome is highly dynamic, associated with age-related outcomes, and may offer greater insight into the premature aging in PTSD. This study is the first reported investigation of the relationship between transcriptional age and PTSD. Using RNA-Seq data from our previous study on 324 World Trade Center responders (201 never had PTSD, 81 with current PTSD, and 42 with past PTSD), as well as a transcriptional age calculator (RNAAgeCalc) recently developed by our group, we found that responders with current PTSD, compared with responders without a PTSD diagnosis, showed accelerated transcriptional aging ($p = 0.0077$) after adjustment for chronological age and race.

RESULTS: We compared our results to the epigenetic aging results computed from several epigenetic clock calculators on matching DNA methylation data. GrimAge methylation age acceleration was also associated with PTSD diagnosis ($p = 0.0097$), and the results remained significant after adjustment for the proportions of immune cell types. PhenoAge, Hannum, and Horvath methylation age acceleration were not reliably related to PTSD. Both epigenetic and transcriptional aging may provide biological insights into the mechanisms underpinning aging in PTSD.

Kuan PF, Yang X, Ren X, et al. 2021. Mapping the transcriptomics landscape of post-traumatic stress disorder symptom dimensions in World Trade Center responders. Transl Psychiatry. 11 (1):310.

HTTPS://DOI.ORG/10.1038/S41398-021-01431-6

BACKGROUND: Gene expression has provided promising insights into the pathophysiology of post-traumatic stress disorder (PTSD); however, specific regulatory transcriptomic mechanisms remain unknown. The present study addressed this limitation by performing transcriptome-wide RNA-Seq of whole-blood samples from 226 World Trade Center responders. The investigation focused on differential expression (DE) at the gene, isoform, and for the first time, alternative splicing (AS) levels associated with the symptoms of PTSD: total burden, re-experiencing, avoidance, numbing, and hyperarousal subdimensions. These symptoms were associated with 76, 1, 48, 15, and 49 DE genes, respectively (FDR < 0.05). Moreover, they were associated with 103, 11, 0, 43, and 32 AS events. Avoidance differed the most from other dimensions with respect to DE genes and AS events. Gene set enrichment analysis (GSEA) identified pathways involved in inflammatory and metabolic processes, which may have implications in the treatment of PTSD. Overall, the findings shed a novel light on the wide range of transcriptomic alterations associated with PTSD at the gene and AS levels. The results of DE analysis associated with PTSD subdimensions highlights the importance of studying PTSD symptom heterogeneity.

Kwon S, Lee M, Crowley G, et al. 2021. Dynamic metabolic risk profiling of World Trade Center-lung disease: A longitudinal cohort study. Am J Respir Crit Care Med. 204 (9):1035–1047.

HTTPS://DOI.ORG/10.1164/RCCM.202006-2617OC

RATIONALE: Metabolic Syndrome (MetSyn) increases the risk of World Trade Center-Lung Injury (WTC-LI). However, the temporal relationship of MetSyn, exposure intensity, and lung dysfunction is not well understood. We modeled the association of longitudinal MetSyn characteristics with WTC-lung disease to define modifiable risk.

METHODS: Consented firefighters (N=5,738) were active-duty on 9/11/01 (9/11). WTC-LI (N=1,475; FEV1%predicted<LLN) and non-WTC-LI (N=4,263; FEV1%predicted≥LLN at all exams) was the primary-outcome, FVC%,predicted<LLN and FEV1/FVC<0.70 were secondary-outcomes. We assessed: I. effect of concurrent MetSyn on longitudinal lung function by linear mixed models; II. temporal effect of MetSyn and exposure by Weibull-proportional hazards (PH); III. effects of MetSyn's rate of change by two-stage models; IV. nonlinear joint effect of longitudinal MetSyn components by partially linear single index models (PLSI).

RESULTS: WTC-LI cases were more often ever-smokers, arrived the morning (9/11), and had MetSyn. BMI≥30kg/m2 and HDL<40mg/dL were most contributory to concurrent loss of FEV1%,predicted and FVC%,predicted while conserving FEV1/FVC. BMI≥30kg/m2 and dyslipidemia significantly predicted WTC-LI,

FVC%,predicted<LLN in a Weibull-PH model. Dynamic risk assessment of WTC-LI based on MetSyn and exposure showed how reduction of MetSyn-factors further reduce WTC-LI likelihood in susceptible populations. PLSI demonstrates that MetSyn has a nonlinear relationship on WTC-lung disease, and increases in cumulative MetSyn risk factors exponentially increase WTC-LI risk. Interactive metabolic-risk modeling application developed to simplify PLSI interpretation.

CONCLUSION:. MetSyn and WTC-exposure contribute to the development of lung disease. Dynamic risk assessment may be utilized to encourage treatment of MetSyn in susceptible populations. Future studies will focus on dietary intervention as a disease-modifier.

Lam R, Kwon S, Riggs J, et al. 2021. Dietary phenotype and advanced glycation end-products predict WTC-obstructive airways disease: A longitudinal observational study. Respiratory Research. 22 (1):19.

HTTPS://DOI.ORG/10.1186/S12931-020-01596-6

BACKGROUND: Diet is a modifier of metabolic syndrome which in turn is associated with World Trade Center obstructive airways disease (WTC-OAD). We have designed this study to (1) assess the dietary phenotype (food types, physical activity, and dietary habits) of the Fire Department of New York (FDNY) WTC-Health Program (WTC-HP) cohort and (2) quantify the association of dietary quality and its advanced glycation end product (AGE) content with the development of WTC-OAD.

METHODS: WTC-OAD, defined as developing WTC-Lung Injury (WTC-LI; FEV1 < LLN) and/or airway hyperreactivity (AHR; positive methacholine and/or positive bronchodilator response). Rapid Eating and Activity Assessment for Participants-Short Version (REAP-S) deployed on 3/1/2018 in the WTC-HP annual monitoring assessment. Clinical and REAP-S data of consented subjects was extracted (7/17/2019). Diet quality [low-(15–19), moderate-(20–29), and high(30–39)] and AGE content per REAP-S questionnaire were assessed for association with WTC-OAD. Regression models adjusted for smoking, hyperglycemia, hypertension, age on 9/11, WTC-exposure, BMI, and job description.

RESULTS: N = 9508 completed the annual questionnaire, while N = 4015 completed REAP-S and had spirometry. WTCOAD developed in N = 921, while N = 3094 never developed WTC-OAD. Low- and moderate-dietary quality, eating more (processed meats, fried foods, sugary drinks), fewer (vegetables, whole-grains),and having a diet abundant in AGEs were significantly associated with WTC-OAD. Smoking was not a significant risk factor of WTC-OAD.

CONCLUSIONS: REAP-S was successfully implemented in the FDNY WTC-HP monitoring questionnaire and produced valuable dietary phenotyping. Our observational study has identified low dietary quality and AGE abundant dietary habits as risk factors for pulmonary disease in the context of WTC-exposure. Dietary phenotyping, not only focuses our metabolomic/biomarker profiling but also

further informs future dietary interventions that may positively impact particulate matter associated lung disease.

Liu X, Reeves AP, Antoniak K, et al. 2021. Association of quantitative ct lung density measurements and lung function decline in World Trade Center workers. Clinical Respiratory Journal. 15 (6):613–621.

HTTPS://DOI.ORG/10.1111/CRJ.13313

BACKGROUND: Occupational exposures at the WTC site after 11 September 2001 have been associated with presumably inflammatory chronic lower airway diseases. Aims: In this study, we describe the trajectories of expiratory air flow decline, identify subgroups with adverse progression, and investigate the association of those trajectories with quantitative computed tomography (QCT) imaging measurement of increased and decreased lung density.

METHODS: We examined the trajectories of expiratory air flow decline in a group of 1,321 former WTC workers and volunteers with at least three periodic spirometries, and using QCT-measured low (LAV%, –950 HU) and high (HAV%, from –600 to –250 HU) attenuation volume percent. We calculated the individual regression line slopes for first-second forced expiratory volume (FEV1slope), identified subjects with rapidly declining ("accelerated decliners") and increasing ("improved"), and compared them to subjects with "intermediate" (0 to –66.5 mL/year) FEV1slope. We then used multinomial logistic regression to model those three trajectories, and the two lung attenuation metrics.

RESULTS: The mean longitudinal FEV1 slopes for the entire study population, and its intermediate, decliner, and improved subgroups were, respectively, –40.4, –34.3, –106.5, and 37.6 mL/year. In unadjusted and adjusted analyses, LAV% and HAV% were both associated with "accelerated decliner" status (OR-adj, 95% CI 2.37, 1.41–3.97, and 1.77, 1.08–2.89, respectively), compared to the intermediate decline.

CONCLUSIONS: Longitudinal FEV1 decline in this cohort, known to be associated with QCT proximal airway inflammation metric, is also associated with QCT indicators of increased and decreased lung density. The improved FEV1 trajectory did not seem to be associated with lung density metrics.

Mueller AK, Singh A, Webber MP, et al. 2021. PTSD symptoms, depressive symptoms, and subjective cognitive concerns in WTC-exposed and non-WTC-exposed firefighters. American Journal of Industrial Medicine. 0 (0):803–814.

HTTPS://DOI.ORG/10.1002/AJIM.23285

ABSTRACT BACKGROUND: Firefighting has been associated with posttraumatic stress disorder (PTSD) and other mental health conditions. We previously found that among Fire Department of the City of New York (FDNY) responders to the World Trade Center (WTC) disaster, higher-intensity WTC-exposure predicted PTSD symptoms, depressive symptoms, and subjective cognitive concerns. The present study aims to compare these symptoms in the FDNY WTC-exposed cohort versus a comparison cohort of non-FDNY, non-WTC-exposed firefighters.

METHODS: The study population included WTC-exposed male firefighters from FDNY (N= 8466) and non-WTC-exposed male firefighters from Chicago (N =1195), Philadelphia (N =770), and San Francisco (N = 650) fire departments who were employed on 9/11/2001 and completed a health questionnaire between 3/1/2018 and 12/31/2020. Current PTSD symptoms, depressive symptoms, and subjective cognitive concerns were assessed via validated screening instruments. Multivariable linear regression analyses stratified by fire department estimated the impact of covariates on each outcome.

RESULTS: Adjusted mean PTSD symptom scores ranged from 23.5 ± 0.6 in Chicago firefighters to 25.8 ± 0.2 in FDNY, and adjusted mean depressive symptom scores ranged from 7.3 ± 0.5 in Chicago to 9.4 ± 0.6 in Philadelphia. WTC-exposure was associated with fewer subjective cognitive concerns (β =0.69±0.05, p<.001) after controlling for covariates. Across cohorts, older age was associated with more cognitive concerns, but fewer PTSD and depressive symptoms.

CONCLUSIONS: WTC-exposed firefighters had fewer cognitive concerns compared with non-WTC-exposed firefighters. We were unable to estimate associations between WTC exposure and PTSD symptoms or depressive symptoms due to variability between non-WTC-exposed cohorts. Longitudinal follow-up is needed to assess PTSD, depressive, and cognitive symptom trajectories in firefighter populations as they age.

Musa GJ, Geronazzo-Alman L, Fan B, et al. 2021. Neighborhood characteristics and psychiatric disorders in the aftermath of mass trauma: A representative study of New York City public school 4th–12th graders after 9/11. J Psychiatr Res. 138:584–590.

HTTPS://DOI.ORG/10.1016/J.JPSYCHIRES.2021.05.002

BACKGROUND: Studies of the relationship between neighborhood characteristics and childhood/adolescent psychopathology in large samples examined one outcome only, and/or general (e.g., 'psychological distress') or aggregate (e.g., 'any anxiety disorder') measures of psychopathology. Thus, in the only representative sample of New York City public school 4th-12th graders (N = 8202) surveyed after the attacks of 9/11/2001, this study examined whether (1) indices of neighborhood Socioeconomic Status, Quality, and Safety and (2) neighborhood disadvantage (defined as multidimensional combinations of SES, Quality and Safety indicators) are associated with eight psychiatric disorders: posttraumatic stress disorder, separation anxiety disorder (SAD), agoraphobia, generalized anxiety disorder (GAD), panic disorder, major depression, conduct disorder, and alcohol use disorder (AUD). (1) The odds ratios (OR) of psychiatric disorders were between 0.55 (AUD) and 1.55 (agoraphobia), in low and intermediate-low SES neighborhoods, respectively, between 0.50 (AUD) and 2.54 (agoraphobia) in low Quality neighborhoods, and between 0.52 (agoraphobia) and 0.65 (SAD) in low Safety neighborhoods. (2) In neighborhoods characterized by high disadvantage, the OR were between 0.42 (AUD) and 1.36

(SAD). This study suggests that neighborhood factors are important social determinants of childhood/adolescent psychopathology, even in the aftermath of mass trauma. At the community level, interventions on modifiable neighborhood characteristics and targeted resources allocation to high-risk contexts could have a cost-effective broad impact on children's mental health. At the individual-level, increased knowledge of the living environment during psychiatric assessment and treatment could improve mental health outcomes; for example, specific questions about neighborhood factors could be incorporated in DSM-5's Cultural Formulation Interview.

Oltmanns JR, Schwartz HA, Ruggero C, et al. 2021. Artificial intelligence language predictors of two-year trauma-related outcomes. Journal of Psychiatric Research. 143:239–245.

HTTPS://DOI.ORG/10.1016/J.JPSYCHIRES.2021.09.015

BACKGROUND: Recent research on artificial intelligence has demonstrated that natural language can be used to provide valid indicators of psychopathology. The present study examined artificial intelligence-based language predictors (ALPs) of seven trauma-related mental and physical health outcomes in responders to the World Trade Center disaster. Methods The responders (N = 174, Mage = 55.4 years) provided daily voicemail updates over 14 days. Algorithms developed using machine learning in large social media discovery samples were applied to the voicemail transcriptions to derive ALP scores for several risk factors (depressivity, anxiousness, anger proneness, stress, and personality). Responders also completed self-report assessments of these risk factors at baseline and trauma-related mental and physical health outcomes at two-year follow-up (including symptoms of depression, posttraumatic stress disorder, sleep disturbance, respiratory problems, and GERD).

RESULTS: Voicemail ALPs were significantly associated with a majority of the trauma-related outcomes at two-year follow-up, over and above corresponding baseline self-reports. ALPs showed significant convergence with corresponding self-report scales, but also considerable uniqueness from each other and from self-report scales. Limitations The study has a relatively short follow-up period relative to trauma occurrence and a limited sample size.

CONCLUSIONS: This study shows evidence that ALPs may provide a novel, objective, and clinically useful approach to forecasting, and may in the future help to identify individuals at risk for negative health outcomes.

Parekh A, Castillo B, Kim DH, et al. 2021. 401 clinical phenotypes of obstructive sleep apnea in World Trade Center responders. Sleep. 44 (0):A159-A160.

HTTPS://DOI.ORG/10.1093/SLEEP/ZSAB072.400

INTRODUCTION: The heterogeneity of symptoms in obstructive sleep apnea (OSA) patients has been recently formalized into 3 distinct clusters: Sleepy, Disturbed Sleep, and Minimally Symptomatic. Our previous data showed that OSA is highly prevalent (>75%) in World Trade

Center (WTC) responders, and positive airway pressure (PAP) treatment adherence is very poor (<20%). To better understand the heterogeneity of OSA in the WTC cohort, here we sought to examine the distribution of these distinct clinical phenotypes.

METHODS: 643 subjects with no history of OSA or reported loud and frequent snoring before 9/11/2001 from the WTC health program clinical centers at Rutgers RWJMS, New Jersey, NYU School of Medicine, and Icahn School Medicine at Mount Sinai, New York underwent 2 nights of home sleep testing using the ARES unicorder (SleepMed, Inc., West Palm Beach, FL, USA). Epworth Sleepiness Scale (ESS), sleep onset insomnia, and sleep maintenance insomnia were assessed with questionnaires. OSA was defined as (AHI4%>=5 or RDI>=15/hr). The three clusters were defined as 1) Sleepy (ESS>10 and/or sleep onset/maintenance insomnia); 2) Disturbed Sleep (not sleepy (ESS<=10) and sleep onset/maintenance insomnia); and 3) Minimally Symptomatic (not sleepy (ESS<=10) and no sleep onset/maintenance insomnia). Distribution of clusters in the WTC cohort was compared to published data from the Sleep Apnea Global Interdisciplinary Consortium (SAGIC) and the Hispanic Community Health Study/Study of Latinos (HCHS/SOL).

RESULTS: Among the subjects diagnosed with OSA (N 440; AHI4%=13(15); RDI =28(19); median(iqr); 81% men; age, 33–87 years; BMI, 27.4±3.7 kg/m2), the distribution of clinical phenotypes was 31.4% sleepy, 48.9% disturbed sleep, and 19.7% minimally symptomatic, and did not differ between OSA severity groups. In comparison to SAGIC and HCHS/SOL, the WTC cohort exhibited significantly increased prevalence of the disturbed sleep phenotype (WTC vs SAGIC: 48.9% vs. 19.8%,X2=54.9; p<0.001; WTC vs. HCHS/SOL: 48.9% vs. 38.1%, X2=26.1, p<0.001).

CONCLUSION: The predominant clinical phenotype of OSA in the WTC cohort is disturbed sleep (insomnia) and its prevalence is significantly greater than what has been observed in other large OSA cohorts. These findings may help explain the poor adherence to PAP treatment observed in the WTC cohort. Support (if any) NIOSH U01OH01415; AASM Foundation 233-BS-20.

Parekh A, Castillo B, Kim DH, et al. 2021. Obstructive sleep apnea pathophysiology in World Trade Center (WTC) responders. Journal. (0)

HTTPS://DOI.ORG/10.1164/AJRCCM-CONFERENCE.2021.203.1_MEETINGABSTRACTS.A3075

TP062 TERRORISM AND INHALATIONAL DISASTERS: WORLD TRADE CENTER AND BEYOND / Thematic Poster Session;Obstructive Sleep Apnea Pathophysiology in World Trade Center (WTC) Responders

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RATIONALE: Obstructive sleep apnea (OSA) is highly prevalent in World Trade Center (WTC) responders and treatment adherence very poor, with our previous data suggesting a greater than 75% prev-

alence, and <20% adherence, respectively. It is being increasingly recognized that the mechanisms that lead to OSA are multifactorial and dependent on arousal threshold, respiratory control gain, upper airway muscle responsiveness and altered anatomy. While the presentation of OSA in the WTC cohort is similar to those in referred to a sleep clinic, whether the physiologic endotypes causing OSA are different in the WTC cohort is not well known.

METHODS: Using a previously published method by Sands et. al. that estimates OSA causing physiological endotypes of loop gain, arousal threshold and pharyngeal muscle responsiveness, we compared the endotypes between WTC responders (N = 14) and non-WTC responders (N = 12) that were referred to a sleep clinic (Mount Sinai Hospital, NY and Rutgers Health at RWJMS, New Brunswick, NJ). Vpassive (ventilatory equivalent of critical collapsing pressure) and muscle compensation (change in ventilation accompanying an increase in ventilatory drive) were calculated using diagnostic polysomnograms.

RESULTS: The two unmatched groups had similar characteristics (see Table 1). Sleep architecture was not significantly different across the two groups. Significantly higher loop gain was observed among the WTC responders as compared to the non-WTC responders while endotypes of arousal threshold (Mann-Whitney U Z value = -2.3, p=0.02), Vpassive and muscle compensation were not significantly different across the two groups (see Table 1).

CONCLUSION: We observe that WTC responders appear to have significantly higher loop gain;as compared to non-WTC responders, with similar muscle responsiveness and arousal mechanisms. Corroboration of our observations with a larger sample size would lead to better understanding of the underlying mechanisms of OSA in WTC responders and possibly improve adherence to treatment of OSA in WTC responders by improved treatment targeting.

Ruggero CJ, Schuler K, Waszczuk MA, et al. 2021. Posttraumatic stress disorder in daily life among World Trade Center responders: Temporal symptom cascades. Journal of Psychiatric Research. 138:240–245.

HTTPS://DOI.ORG/10.1016/J.JPSYCHIRES.2021.04.002

BACKGROUND: Posttraumatic stress disorder (PTSD) symptoms are common in the immediate aftermath of a trauma, but it is their persistence over time that leads to a diagnosis. This pattern highlights the critical role of symptom maintenance to understanding and treating the disorder. Relatively few studies have explored whether PTSD symptoms may be interacting or triggering one another to worsen and maintain the disorder, a dynamic we refer to as "symptom cascades." Additionally, no work has tested how other maintenance factors, such as stress, contribute to such events in daily life. Methods The present study in a group (N = 202) of World Trade Center (WTC) responders oversampled for PTSD tested day-to-day temporal associations among PTSD symptom dimensions (i.e., intrusions, avoidance, numbing, and hyperarousal) and stress across one week.

RESULTS: Longitudinal models found hyperarousal on a given day predicted increased PTSD symptoms the next day, with the effect sizes almost double compared to other symptom dimensions or daily stress. Intrusions, in contrast, showed little prospective predictive effects, but instead were most susceptible to the effects from other symptoms the day before. Avoidance and numbing showed weaker bidirectional effects.

LIMITATIONS FINDINGS: are from a unique population and based on naturalistic observation. Conclusions Results are consistent with the idea of symptom cascades, they underscore hyperarousal's strong role in forecasting short-term increases in PTSD (even more than stress per se) and they raise the prospect of highly specific ecological momentary interventions to potentially disrupt PTSD maintenance in daily life.Schuler K, Ruggero CJ, Mahaffey B, et al. 2021. When hindsight is not 20/20: Ecological momentary assessment of PTSD symptoms versus retrospective report. Assessment. 28 (1):238–247.

HTTPS://DOI.ORG/10.1177/1073191119869826

Assessment of posttraumatic stress disorder (PTSD) has relied almost exclusively on retrospective memory of symptoms, sometimes over long intervals. This approach creates potential for recall bias and obscures the extent to which symptoms fluctuate. The aim of the present study was to examine the discrepancy between retrospective self-reporting of PTSD symptoms and ecological momentary assessment (EMA), which captures symptoms closer to when they occur. The study also sought to estimate the degree to which PTSD symptoms vary or are stable in the short-term. World Trade Center responders (N = 202) oversampled for current PTSD (19.3% met criteria in past month) were assessed three times a day for 7 consecutive days. Retrospective assessment of past week symptoms at the end of the reporting period were compared with daily EMA reports. There was correspondence between two approaches, but retrospective reports most closely reflected symptom severity on the worst day of the reporting period rather than average severity across the week. Symptoms varied significantly, even within the span of hours. Findings support intervention research efforts focused on exploiting significant, short-term variability of PTSD symptoms, and suggest that traditional assessments most reflect the worst day of symptoms over a given period of recall.Stein CR, Cooney ML, Frank B, et al. 2021. Mental health mediators of subjective cognitive concerns among World Trade Center responders. J Psychiatr Res. 140:187–196.

HTTPS://DOI.ORG/10.1016/J.JPSYCHIRES.2021.05.081

Decline in cognitive functioning among rescue and recovery workers who responded in the aftermath of the September 11, 2001, World Trade Center (WTC) attacks is of emerging interest. Responders are vulnerable to cognitive decline from exposure to airborne toxins present at the WTC site, as well as from WTC-related mental and physical health conditions. To better understand the relationship between occupational WTC exposure, mental health, physical health and subjective cognitive functioning, we examined the mediating role of health status in the association between exposure and subjective cognitive concerns in a multi-site, longitudinal investigation of the WTC

General Responder cohort (n = 16,380 responders; n = 58,575 visits) for the period 2002-2015. Through latent class analyses, we identified a four-level marker of cognitive concerns based on information from a Self-Administered Mental Health Questionnaire. Using generalized linear mixed models with random intercepts, we observed that a higher intensity WTC exposure composite was associated with greater cognitive concerns, and that this association was operating almost entirely through mental health comorbidities, not physical health comorbidities. In fully adjusted models, the inclusion of probable depression, anxiety, PTSD and use of psychotropic medications attenuated the association between highest WTC exposure and greatest cognitive concerns. Physical health did not appear to be on the pathway between WTC exposure and cognitive concerns. Understanding the underlying sources of cognitive concerns may help identify vulnerable members of the General Responder cohort and potentially aid clinical decision-making, such as treatment choice and enhanced screening options. Earlier diagnosis and symptom treatment may help preserve functional independence.

Sunderram J, Ayappa I, Lu S-E, et al. 2021. Pap adherence and nasal resistance: A randomized control trial of cpapflex vs cpap. Annals of the American Thoracic Society. 18 (4):668–677.

HTTPS://DOI.ORG/10.1513/ANNALSATS.202009-1161OC

RATIONALE: Continuous Positive Airway Pressure (CPAP) adherence is often poor in obstructive sleep apnea (OSA) and may be influenced by nasal resistance. CPAP with reduction of expiratory pressure (CPAPFlex) may reduce discomfort in those with high nasal resistance and improve adherence in this subgroup. Objectives: To evaluate the association of PAP adherence to nasal resistance and examine if CPAPFlex improves adherence over CPAP in subjects with high nasal resistance.

METHODS: A randomized double-blind control cross-over trial of 4 weeks each of CPAPFlex versus CPAP in World Trade Center dust-exposed subjects with OSA stratified by nasal resistance measured by 4-Phase Rhinomanometry.

RESULTS: 317 subjects with OSA (mean AHI4%=17±14/hr) were randomized. Overall, PAP adherence was poor, but adherence to CPAP (n=239, mean hours per night (95% CI)) = 1.97h (1.68, 2.26) was greater than to CPAPFlex (n=249, 1.65h (1.39, 1.91); difference 0.31h (0.03, 0.6); p<0.05). Contrary to our hypothesis there was no correlation between nasal resistance and adherence to CPAP (r=0.098, p=NS) or CPAPFlex(r=0.056, p=NS). There was no difference in adherence between CPAP and CPAPFlex (mean Δ hours (95% CI)) in subjects with low resistance (0.33h (-0.10, 0.76)) or high nasal resistance (0.26h (-0.14, 0.66)). No significant differences were observed in any of the secondary outcomes between PAP modes.

CONCLUSIONS: Contrary to expectations, our data do not show better adherence to CPAPFlex than to CPAP in subjects with high or low nasal resistance, and, show clinically insignificant better adherence overall with CPAP. Clinical Trial registered with ***CLINICALTRIALS.GOV*** (NCT01753999)

Page 3 of 43 ANNALSATS Articles in Press. Published November 17, 2020 as 10.1513/AnnalsATS.202009-1161OC

van Gerwen M, Cerutti JM, Rapp J, et al. 2021. Post–9/11 excess risk of thyroid cancer: Surveillance or exposure?. Am J Ind Med. 64 (10):881–884.

HTTPS://DOI.ORG/10.1002/AJIM.23268

An excess risk of thyroid cancer has been reported in different World Trade Center (WTC)-dust exposed cohorts. Increased surveillance of these cohorts has been suggested as a potential explanation of this reported excess thyroid cancer risk leading to an increased diagnosis of earlier-stage thyroid cancers. However, the uncertainty to what extent surveillance or physician bias may be contributing to the reported incidence of thyroid cancer in WTC-dust exposed populations remains, highlighting the need to investigate a potential causal link between WTC dust exposure and thyroid cancer. Future studies are therefore indicated to investigate potential consequences of WTC dust exposure on the thyroid gland. Studies of the heavily exposed populations offer the possibility to better understand the mechanisms behind the exposure to a variety of environmental contaminants, and may provide useful insights into exposures harmful to the thyroid. These can be used in risk stratification when implementing screening in high-risk populations and may inform shared decision-making regarding the extent of thyroid cancer treatment.

Webber MP, Singh A, Zeig-Owens R, et al. 2021. Cancer incidence in World Trade Center-exposed and non-exposed male firefighters, as compared with the us adult male population: 2001–2016. Occupational and environmental medicine. 78 (10):707–714.

HTTPS://DOI.ORG/10.1136/OEMED-2021-107570

OBJECTIVE: To compare cancer incidence in Fire Department of the City of New York (FDNY) firefighters who worked at the World Trade Center (WTC) site to incidence in a population of non-WTC-exposed firefighters, the Career Firefighter Health Study (CFHS) cohort, and to compare rates from each firefighter cohort to rates in demographically similar US males.

METHODS: FDNY (N=10 786) and CFHS (N=8813) cohorts included male firefighters who were active on 11 September 2001 (9/11) and were followed until death or 31 December 2016. Cases were identified from 15 state cancer registries. Poisson regression models assessed cancers in each group (FDNY and CFHS) versus US males, and associations between group and cancer rates; these models estimated standardised incidence ratios (SIRs) and adjusted relative rates (RRs), respectively. Secondary analyses assessed surveillance bias and smoking history.

RESULTS: We identified 915 cancer cases in 841 FDNY firefighters and 1002 cases in 909 CFHS firefighters. FDNY had: higher rates for all cancers (RR=1.13; 95% CI 1.02 to 1.25), prostate (RR=1.39; 95% CI 1.19 to 1.63) and thyroid cancer (RR=2.53; 95% CI 1.37 to 4.70); younger median ages at diagnosis (55.6 vs 59.4; p<0.001, all cancers); and more cases with localised disease when compared with CFHS. Compared with US males, both firefighter cohorts had elevated

SIRs for prostate cancer and melanoma. Control for surveillance bias in FDNY reduced most differences.

CONCLUSIONS: Excess cancers occurred in WTC-exposed firefighters relative to each comparison group, which may partially be explained by heightened surveillance. Two decades post-9/11, clearer understanding of WTC-related risk requires extended follow-up and modelling studies (laboratory or animal based) to identify workplace exposures in all firefighters.

Weiden MD, Singh A, Goldfarb DG, et al. 2021. Serum TH-2 cytokines and FEV 1 decline in WTC-exposed firefighters: A 19-year longitudinal study. American Journal of Industrial Medicine. 64 (10):845–852.

HTTPS://DOI.ORG/10.1002/AJIM.23276

BACKGROUND: Accelerated-FEV1 -decline, defined as rate of decline in FEV1 > 64 ml/year, is a risk factor for asthma and chronic obstructive pulmonary disease in World Trade Center (WTC)-exposed firefighters. Accelerated-FEV1 -decline in this cohort is associated with elevated blood eosinophil concentrations, a mediator of Th-2 response. We hypothesized that an association exists between Th-2 biomarkers and FEV1 decline rate in those with accelerated-FEV1 -decline.

METHODS: Serum was drawn from Fire Department of the City of New York (FDNY) firefighters 1-6 months (early) (N = 816) and 12-13 years (late) (N = 983) after 9/11/2001. Th-2 biomarkers IL-4, IL-13, and IL-5 were assayed by multiplex Luminex. Individual FEV1 decline rates were calculated using spirometric measurements taken: (1) between 9/11/2001 and 9/10/2020 for the early biomarker group and (2) between late measurement date and 9/10/2020 for the late biomarker group. Associations of early and late Th-2 biomarkers with subsequent FEV1 decline rates were analyzed using multivariable linear regression controlling for demographics, smoking status, and other potential confounders.

RESULTS: In WTC-exposed firefighters with accelerated-FEV1 -decline, IL-4, IL-13, and IL-5 measured 1-6 months post-9/11/2001 were associated with greater FEV1 decline ml/year between 9/11/2001 and 9/10/2020 (-2.9 +/- 1.4 ml/year per IL-4 doubling; -8.4 +/- 1.2 ml/year per IL-13 doubling; -7.9 +/- 1.3 ml/year per IL-5 doubling). Among late measured Th-2 biomarkers, only IL-4 was associated with subsequent FEV1 decline rate (-4.0 +/- 1.6 ml/year per IL-4 doubling).

CONCLUSIONS: In WTC-exposed firefighters with accelerated-FEV1 -decline, elevated serum IL-4 measured both 1-6 months and 12-13 years after 9/11 is associated with greater FEV1 decline/year. Drugs targeting the IL-4 pathway may improve lung function in this high-risk subgroup.

Wisnivesky J, Markowitz SB, James S, et al. 2021. Comorbid post-traumatic stress disorder and major depression disorder associated with asthma morbidity among WTC workers. Annals of Allergy, Asthma & Immunology. 126 (3):278–283.

HTTPS://DOI.ORG/10.1016/J.ANAI.2020.10.007

BACKGROUND: World Trade Center (WTC) rescue and recovery workers suffer a high

burden of asthma, comorbid post-traumatic stress disorder (PTSD) ,and depression. PTSD is associated with worse asthma outcomes. Objective In this study, we evaluated whether the relationship between PTSD and asthma morbidity is modified by depression.

METHODS: We used data from a cohort of WTC workers with asthma. Asthma control (ACQ), resource utilization, and quality of life (AQLQ) were evaluated. We used regression analyses to evaluate the adjusted association of PTSD and depression with asthma control, resource utilization and quality of life.

RESULTS: Of the study cohort of 293 WTC workers with asthma, 19% had PTSD alone, 2% had MDD alone and 12% had PTSD and MDD. Adjusted mean differences (95% CI) in ACQ scores were 1.32 (0.85 to 1.80) for WTC workers with PTSD and MDD, 0.44 (0.03 to 0.84) for those with PTSD alone, and 0.50 (-0.38 to 1.38) for workers with MDD alone compared to those without depression or PTSD. WTC workers with PTSD and depression, PTSD alone, and depression alone had mean (95% CI) adjusted differences in AQLQ scores of -1.67 (-2.22 to -1.12), -0.56 (-2.23 to -1.12), and -1.21 (-2.23 to -0.18) compared to workers without depression or PTSD. Similar patterns were observed for acute resource utilization.

CONCLUSION: PTSD and depression appear to have a synergistic effect that worsens asthma control and quality of life. Efforts to improve asthma outcomes in this population should address the negative impacts of these common mental health conditions.

Zeig-Owens R, Singh A, Triplett S, et al. 2021. Assembling the career firefighter health study cohort: A methods overview. Am J Ind Med. 64 (8):680–687.

HTTPS://DOI.ORG/10.1002/AJIM.23266

BACKGROUND: Studies of World Trade Center (WTC)-exposed rescue/recovery workers report the increased occurrence of health conditions after work at the WTC disaster site. However, the extent to which these associations are due to WTC exposure is unclear, in part due to the lack of suitable comparison groups. Accordingly, we identified a previously assembled National Institute for Occupational Safety and Health (NIOSH) cohort of career firefighters from three US cities (n = 29,992). Here, we document the challenges in establishing this non-WTC-exposed firefighter cohort for the goal of tracking and comparing cancer and chronic health conditions in WTC-exposed and non-WTC-exposed firefighters.

METHODS: Follow-up process included institutional review board applications, data use agreements, state cancer registry linkages and vital status determination for the NIOSH firefighter cohort. After completion of these steps, we undertook outreach to the three original city fire departments and union officials, before contact tracing and direct recruitment of 14,566 living firefighters to complete a confidential health survey. We staggered recruitment efforts by the city, using letters, postcards, emails, videos, and telephone outreach. Participants who completed the survey received $10.

RESULTS: A total of 4962 of 14,566 alive firefighters responded to the baseline survey (34.1% response rate). Respondents were older and more likely to be non-Hispanic white than nonrespondents.

CONCLUSIONS: We provide an overview of the process for the first survey to collect information on physical and mental health conditions among US firefighters. The data collected will have an important impact on studies of WTC rescue/recovery work, firefighting, and related health conditions.

Year Published 2022 (18)

Baba RY, Zhang Y, Shao Y, et al. 2022. COPD in smoking and non-smoking community members exposed to the World Trade Center dust and fumes. International Journal of Environmental Research and Public Health. 19 (7):4249.

HTTPS://DOI.ORG/10.3390/IJERPH19074249

BACKGROUND: The characteristics of community members exposed to World Trade Center (WTC) dust and fumes with Chronic Obstructive Pulmonary Disease (COPD) can provide insight into mechanisms of airflow obstruction in response to an environmental insult, with potential implications for interventions.

METHODS: We performed a baseline assessment of respiratory symptoms, spirometry, small airway lung function measures using respiratory impulse oscillometry (IOS), and blood biomarkers. COPD was defined by the 2019 GOLD criteria for COPD. Patients in the WTC Environmental Health Center with <5 or >/=5 pack year smoking history were classified as nonsmoker-COPD (ns-COPD) or smoker-COPD (sm-COPD), respectively. MAI.

RESULTS: Between August 2005 and March 2018, 467 of the 3430 evaluated patients (13.6%) fit criteria for COPD. Among patients with COPD, 248 (53.1%) were ns-COPD. Patients with ns-COPD had measures of large airway function (FEV1) and small airway measures (R5-20, AX) that were less abnormal than those with sm-COPD. More ns-COPD compared to sm-COPD had a bronchodilator (BD) response measured by spirometry (24 vs. 14%, $p = 0.008$) or by IOS (36 vs. 21%, $p = 0.002$). Blood eosinophils did not differ between ns-COPD and sm-COPD, but blood neutrophils were higher in sm-COPD compared to ns-COPD ($p < 0.001$). Those with sm-COPD were more likely to be WTC local residents than ns-COPD ($p = 0.007$).

CONCLUSIONS: Spirometry findings and small airway measures, as well as inflammatory markers, differed between patients with ns-COPD and sm-COPD. These findings suggest potential for differing mechanisms of airway injury in patients with WTC environmental exposures and have potential therapeutic implications.

Boffetta P, Goldfarb DG, Zeig-Owens R, et al. 2022. Temporal aspects of the association between exposure to the World Trade Center disaster and risk of skin melanoma. Journal. 2 (1):100063.

HTTPS://DOI.ORG/10.1101/2021.03.10.21253261

BACKGROUND: Rescue/recovery workers who responded to the World Trade Center (WTC) attacks on 9/11/2001 were exposed to known/suspected carcinogens. Studies have identified an increased risk of skin melanoma in this population, but the temporal aspects of the association have not been investigated. A total of 44,540 non-Hispanic White workers from the WTC Combined Rescue/Recovery Cohort were observed between 3/12/2002 and 12/31/2015. Cancer data were obtained via linkages with 13 state registries. Poisson regression was used to estimate hazard ratios (HR) and 95% confidence intervals (CI), using the New York State population as reference; change points in the HRs were estimated using profile likelihood. We observed 247 incident cases of skin melanoma. No increase in incidence was detected between 2002 and 2004. Beginning in 2005, the HR was 1.34 (95% CI 1.18-1.52). A dose-response relationship was observed according to time worked on the WTC effort. Risk of melanoma among non-Hispanic White WTC rescue/recovery workers was elevated, beginning in 2005. While WTC-related exposure to ultraviolet radiation or other agents might have contributed to this result, exposures other than the WTC effort and enhanced medical surveillance cannot be discounted. Our results support the continued surveillance of this population for melanoma.

Boffetta P, Hall CB, Todd AC, et al. 2022. Cancer risk among World Trade Center rescue and recovery workers: A review. CA Cancer J Clin.

HTTPS://DOI.ORG/10.3322/CAAC.21723

BACKGROUND: Twenty years after the September 11th, 2001 terrorist attacks, the association between exposures present at the World Trade Center (WTC) site and the risk of several specific types of cancer has been reported among rescue and recovery workers. The authors' objective was to conduct an updated review of these data. Most studies have found elevated rates of both prostate and thyroid cancers compared with rates in the general population, and some have reported statistically significant differences for the rates of all cancers as well. Studies including a larger combined cohort of WTC-exposed rescue and recovery workers from 3 main cohorts have since replicated findings for these cancers, with additional years of follow-up. Among this combined cohort, although a lower-than-expected standardized incidence ratio for all cancers was observed, WTC exposure was also related to an increased risk of cutaneous melanoma and tonsil cancer. Importantly, another study found that WTC-exposed rescue and recovery workers who are enrolled in the federally funded medical monitoring and treatment program experienced improved survival post-cancer diagnosis compared with New York state patients with cancer. On the basis of these combined cohort studies, the full effect of WTC exposure on cancer risk is becoming clearer. Consequently, the authors believe that surveillance of those with WTC exposure should be continued, and in-depth analysis of epidemiologic, molecular, and clinical aspects of specific cancers in these workers should be pursued.

Clouston SAP, Hall CB, Kritikos M, et al. 2022. Cognitive impairment and world trade centre-related exposures. Nat Rev Neurol. 18 (2):103–116.

HTTPS://DOI.ORG/10.1038/S41582-021-00576-8

BACKGROUND: On 11 September 2001 the World Trade Center (WTC) in New York was attacked by terrorists, causing the collapse of multiple buildings including the iconic 110-story 'Twin Towers'. Thousands of people died that day from the collapse of the buildings, fires, falling from the buildings, falling debris, or other related accidents. Survivors of the attacks, those who worked in search and rescue during and after the buildings collapsed, and those working in recovery and clean-up operations were exposed to severe psychological stressors. Concurrently, these 'WTC-affected' individuals breathed and ingested a mixture of organic and particulate neurotoxins and pro-inflammogens generated as a result of the attack and building collapse. Twenty years later, researchers have documented neurocognitive and motor dysfunctions that resemble the typical features of neurodegenerative disease in some WTC responders at midlife. Cortical atrophy, which usually manifests later in life, has also been observed in this population. Evidence indicates that neurocognitive symptoms and corresponding brain atrophy are associated with both physical exposures at the WTC and chronic post-traumatic stress disorder, including regularly re-experiencing traumatic memories of the events while awake or during sleep. Despite these findings, little is understood about the long-term effects of these physical and mental exposures on the brain health of WTC-affected individuals, and the potential for neurocognitive disorders. Here, we review the existing evidence concerning neurological outcomes in WTC-affected individuals, with the aim of contextualizing this research for policymakers, researchers and clinicians and educating WTC-affected individuals and their friends and families. We conclude by providing a rationale and recommendations for monitoring the neurological health of WTC-affected individuals.

Clouston SAP, Kritikos M, Huang C, et al. 2022. Reduced cerebellar cortical thickness in World Trade Center responders with cognitive impairment. Transl Psychiatry. 12 (1):107.

HTTPS://DOI.ORG/10.1038/S41398-022-01873-6

BACKGROUND: Prior research has demonstrated high levels of cognitive and physical functional impairments in World Trade Center (WTC) responders. A follow-up neuroimaging study identified changes to white matter connectivity within the cerebellum in responders with cognitive impairment (CI). In the first study to examine cerebellar cortical thickness in WTC responders with CI, we fielded a structural magnetic resonance imaging protocol. WTC responders (N = 99) participated in a structural magnetic resonance imaging (MRI) study, of whom 48 had CI. Participants with CI did not differ demographically or by intracranial volume when compared to cognitively unimpaired participants. MRIs were processed using the CERES imaging pipeline; bilateral cortical thickness in 12 cerebellar lobules was reported. Analyses were completed comparing mean cerebellar cortical thickness across

groups. Lobules were examined to determine the location and functional correlates of reduced cerebellar cortical thickness. Multivariable-adjusted analyses accounted for the false discovery rate. Mean cerebellar cortical thickness was reduced by 0.17 mm in responders with CI. Decrements in cerebellar cortical thickness were symmetric and located in the Cerebellar Crus (I and II), and in Lobules IV, VI, VIIb, VIIIa, VIIIb, and IX. Cerebellar cortical thickness was associated with episodic memory, response speed, and tandem balance. WTC responders with CI had evidence of reduced cerebellar cortical thickness that was present across lobules in a pattern unique to this cohort.

Imbriano G, Waszczuk M, Rajaram S, et al. 2022. Association of attention and memory biases for negative stimuli with post-traumatic stress disorder symptoms. Journal of Anxiety Disorders. 85:102509.

HTTPS://DOI.ORG/10.1016/J.JANXDIS.2021.102509

BACKGROUND: Cognitive models have highlighted attentional and memory biases to negatively valenced emotional stimuli, and their association, in the development and maintenance of post-traumatic stress disorder (PTSD). However, research has focused mainly on attentional biases towards distracting (not task-relevant) negative stimuli and the links of attentional biases with memory remain underexplored. We manipulated attention during encoding of trauma-irrelevant negative and neutral words andexamined the differential relationship of their encoding and recall with PTSD symptoms. Responders to the World Trade Center disaster performed tasks in which they read negative and neural words (full attention, FA) and reported the color of another set of such words (divided-attention, DA). Subsequently, participants used word stems to aid retrieval of words shown in both tasks. PTSD symptoms were associated with slower performance for negative vs neutral words in FA but not DA tasks.Furthermore, greater PTSD symptoms severity was associated with more accurate recall of negative vs neutral words, irrespective of whether words were presented on FA or DA tasks. These findings suggest that PTSD symptoms in a trauma-exposed population are related to encoding of trauma-irrelevant negative information when attention is fully deployed and subsequent recall of negative information, irrespective of whether attention was fully deployed.

Iyengar-Kapuganti RL, Maceda CS, Croft LB, et al. 2022. Obstructive sleep apnoea and left ventricular diastolic dysfunction among first responders to the 9/11 World Trade Center terrorist attack: A cross-sectional study. BMJ Open. 12 (4):e058366.

HTTPS://DOI.ORG/10.1136/BMJOPEN-2021-058366

OBJECTIVES: Obstructive sleep apnoea (OSA) is often linked to cardiovascular disease. A limited number of studies have reported an association between OSA and left ventricular diastolic dysfunction (LVDD). However, prior studies were performed on small patient populations. Studies have shown a high prevalence of OSA among first responders to the 9/11 World Trade Center (WTC) terrorist attack. We investigated the relationship between OSA and LVDD in a large population of WTC responders.

STUDY DESIGN: Cross-sectional study.

SETTING: One-time screening programme as part of the WTC-CHEST Study (NCT10466218), performed at a quaternary medical centre in New York City, from November 2011 to June 2014.

PARTICIPANTS: A total of 1007 participants with mean age of 51 years of mostly non-Hispanic white men were evaluated. Patients from the WTC Health Program-Clinical Center of Excellence, who were over the age of 39 years, were eligible to participate.

RESULTS: Evaluation of those without OSA diagnosis showed no significant association with LVDD when comparing those screened (Berlin Questionnaire) as OSA high risk versus OSA low risk (p=0.101). Among those diagnosed with LVDD, there was a significant association when comparing those with and without patient-reported OSA (OR 1.50, 95% CI 1.13 to 2.00, p=0.005), but the significance was not maintained after adjusting for pertinent variables (OR 1.3, 0.94 to 1.75, p=0.119). Notably, comparing those with OSA diagnosis and those low risk of OSA, the OR for LVDD was significant (1.69, 1.24 to 2.31, p=0.001), and after adjusting for waist-hip ratio, diabetes and coronary artery calcium score percentile, the relationship remained significant (OR 1.45, 1.03 to 2.04, p=0.032).

CONCLUSION: The strong association of OSA with LVDD in this population may inform future guidelines to recommend screening for LVDD in high-risk asymptomatic patients with OSA.

Jasra S, Giricz O, Zeig-Owens R, et al. 2022. High burden of clonal hematopoiesis in first responders exposed to the World Trade Center disaster. Nature Medicine.

HTTPS://DOI.ORG/10.1038/S41591-022-01708-3

BACKGROUND: The terrorist attacks on the World Trade Center (WTC) created an unprecedented environmental exposure to aerosolized dust, gases and potential carcinogens. Clonal hematopoiesis (CH) is defined as the acquisition of somatic mutations in blood cells and is associated with smoking and exposure to genotoxic stimuli. Here we show that deep targeted sequencing of blood samples identified a significantly higher proportion of WTC-exposed first responders with CH (10%; 48 out of 481) when compared with non-WTC-exposed firefighters (6.7%; 17 out of 255; odds ratio, 3.14; 95% confidence interval, 1.64–6.03; P = 0.0006) after controlling for age, sex and race/ethnicity. The frequency of somatic mutations in WTC-exposed first responders showed an age-related increase and predominantly affected DNMT3A, TET2 and other CH-associated genes. Exposure of lymphoblastoid cells to WTC particulate matter led to dysregulation of DNA replication at common fragile sites in vitro. Moreover, mice treated with WTC particulate matter developed an increased burden of mutations in hematopoietic stem and progenitor cell compartments. In summary, the high burden of CH in WTC-exposed first responders provides a rationale for enhanced screening and preventative efforts in this population.

Kuan PF, Yang X, Kotov R, et al. 2022. Metabolomics analysis of post-traumatic stress disorder symptoms in World Trade Center responders. Transl Psychiatry. 12 (1):174.

HTTPS://DOI.ORG/10.1038/S41398-022-01940-Y

BACKGROUND: Metabolomics has yielded promising insights into the pathophysiology of post-traumatic stress disorder (PTSD). The current study expands understanding of the systems-level effects of metabolites by using global metabolomics and complex lipid profiling in plasma samples from 124 World Trade Center responders (56 PTSD, 68 control) on 1628 metabolites. Differential metabolomics analysis identified hexosylceramide HCER(26:1) associated with PTSD at FDR < 0.1. The multi-metabolite composite score achieved an AUC of 0.839 for PTSD versus unaffected control classification. Independent component analysis identified three metabolomic modules significantly associated with PTSD. These modules were significantly enriched in bile acid metabolism, fatty acid metabolism and pregnenolone steroids, which are involved in innate immunity, inflammatory process and neuronal excitability, respectively. Integrative analysis of metabolomics and our prior proteomics datasets on subsample of 96 responders identified seven proteomic modules significantly correlated with metabolic modules. Overall, our findings shed light on the molecular alterations and identify metabolomic-proteomic signatures associated with PTSD by using machine learning and network approaches to enhance understanding of the pathways implicated in PTSD. If present results are confirmed in follow-up studies, they may inform development of novel treatments.

Li J, Yung J, Qiao B, et al. 2022. Cancer incidence in World Trade Center rescue and recovery workers: 14 years of follow-up. J Natl Cancer Inst. 114 (2):210–219.

HTTPS://DOI.ORG/10.1093/JNCI/DJAB165

BACKGROUND: Statistically significantly increased cancer incidence has been reported from 3 cohorts of World Trade Center (WTC) disaster rescue and recovery workers. We pooled data across these cohorts to address ongoing public concerns regarding cancer risk 14 years after WTC exposure.

METHODS: From a combined deduplicated cohort of 69 102 WTC rescue and recovery workers, a sample of 57 402 workers enrolled before 2009 and followed through 2015 was studied. Invasive cancers diagnosed in 2002-2015 were identified from 13 state cancer registries. Standardized incidence ratios (SIRs) were used to assess cancer incidence. Adjusted hazard ratios (aHRs) were estimated from Cox regression to examine associations between WTC exposures and cancer risk.

RESULTS: Of the 3611 incident cancers identified, 3236 were reported as first-time primary (FP) cancers, with an accumulated 649 724 and 624 620 person-years of follow-up, respectively. Incidence for combined FP cancers was below expectation (SIR = 0.96, 95% confidence interval [CI] = 0.93 to 0.99). Statistically significantly elevated SIRs were observed for mela-

noma-skin (SIR = 1.43, 95% CI = 1.24 to 1.64), prostate (SIR = 1.19, 95% CI = 1.11 to 1.26), thyroid (SIR = 1.81, 95% CI = 1.57 to 2.09), and tonsil (SIR = 1.40, 95% CI = 1.00 to 1.91) cancer. Those arriving on September 11 had statistically significantly higher aHRs than those arriving after September 17, 2001, for prostate (aHR = 1.61, 95% CI = 1.33 to 1.95) and thyroid (aHR = 1.77, 95% CI = 1.11 to 2.81) cancers, with a statistically significant exposure-response trend for both.

CONCLUSIONS: In the largest cohort of 9/11 rescue and recovery workers ever studied, overall cancer incidence was lower than expected, and intensity of WTC exposure was associated with increased risk for specific cancer sites, demonstrating the value of long-term follow-up studies after environmental disasters.

Mears MJ, Aslaner DM, Barson CT, et al. 2022. Health effects following exposure to dust from the World Trade Center disaster: An update. Life Sciences. 289:120147.

HTTPS://DOI.ORG/10.1016/J.LFS.2021.120147

BACKGROUND: Exposure to dust, smoke, and fumes containing volatile chemicals and particulate matter (PM) from the World Trade Center (WTC) towers' collapse impacted thousands of citizens and first responders (FR; firefighters, medicals staff, police officers) of New York City. Surviving FR and recovery workers are increasingly prone to age-related diseases that their prior WTC dust exposures might expedite or make worse. This review provides an overview of published WTC studies concerning FR/recovery workers' exposure and causal mechanisms of age-related disease susceptibility, specifically those involving the cardiopulmonary and neurological systems. This review highlights the recent findings of the major health effects of cardiovascular, pulmonary, and neurological health sequelae from WTC dust exposure. To better treat those that risked their lives during and after the disaster of September 11, 2001, the deleterious mechanisms that WTC dust exposure exerted and continue to exert on the heart, lungs, and brain of FR must be better understood.

Park SH, Lu Y, Shao Y, et al. 2022. Longitudinal impact of WTC dust inhalation on rat cardiac tissue transcriptomic profiles. Int J Environ Res Public Health. 19 (2)

HTTPS://DOI.ORG/10.3390/IJERPH19020919

BACKGROUND: First responders (FR) exposed to the World Trade Center (WTC) Ground Zero air over the first week after the 9/11 disaster have an increased heart disease incidence compared to unexposed FR and the general population. To test if WTC dusts were causative agents, rats were exposed to WTC dusts (under isoflurane [ISO] anesthesia) 2 h/day on 2 consecutive days; controls received air/ISO or air only. Hearts were collected 1, 30, 240, and 360 d post-exposure, left ventricle total RNA was extracted, and transcription profiles were obtained. The data showed that differentially expressed genes (DEG) for WTC vs. ISO rats did not reach any significance with a false discovery rate (FDR) < 0.05 at days 1, 30, and 240, indicating that the dusts did not impart effects beyond any from ISO. However, at day 360, 14 DEG with a low FDR were identified, reflecting

potential long-term effects from WTC dust alone, and the majority of these DEG have been implicated as having an impact on heart functions. Furthermore, the functional gene set enrichment analysis (GSEA) data at day 360 showed that WTC dust could potentially impact the myocardial energy metabolism via PPAR signaling and heart valve development. This is the first study showing that WTC dust could significantly affect some genes that are associated with the heart/CV system, in the long term. Even > 20 years after the 9/11 disaster, this has potentially important implications for those FR exposed repeatedly at Ground Zero over the first week after the buildings collapsed.

Schwartz RM, Shaam P, Williams MS, et al. 2022. Understanding mental health needs and gathering feedback on transcutaneous auricular vagus nerve stimulation as a potential ptsd treatment among 9/11 responders living with ptsd symptoms 20 years later: A qualitative approach. Int J Environ Res Public Health. 19 (8)

HTTPS://DOI.ORG/10.3390/IJERPH19084847

BACKGROUND: Posttraumatic stress disorder (PTSD) remains one of the most prevalent diagnoses of World Trade Center (WTC) 9/11 responders. Transcutaneous auricular vagus nerve stimulation (taVNS) is a potential treatment for PTSD, as it can downregulate activity in the brain, which is known to be related to stress responses and hyperarousal. To understand barriers and facilitators to engagement in mental health care and the feasibility and acceptability of using the taVNS device as a treatment for PTSD symptoms, a focus group was conducted among patients from the Queens WTC Health Program who had elevated symptoms of PTSD. The focus group discussion was recorded, transcribed, and analyzed. Three themes and subthemes emerged: (1) the continued prevalence of mental health difficulties and systematic challenges to accessing care; (2) positive reception toward the taVNS device as a potential treatment option, including a discussion of how to increase usability; and (3) feedback on increasing the feasibility and acceptance of the research methodology associated with testing the device in a pilot clinical trial. The findings highlight the need for additional treatment options to reduce PTSD symptoms in this population and provide key formative phase input for the pilot clinical trial of taVNS.

Sigel K, de la Hoz RE, Markowitz SB, et al. 2022. Lung cancer incidence among World Trade Center rescue and recovery workers. Cancer Med.

HTTPS://DOI.ORG/10.1002/CAM4.4672

BACKGROUND: Many World Trade Center disaster (WTC) rescue and recovery workers (WTC RRWV)were exposed to toxic inhalable particles. The impact of WTC exposures on lung cancer risk is unclear.

METHODS: Data from the WTC Health Program General Responders Cohort (WTCGRC) were linked to health information from a large New York City health system to identify incident lung cancer cases. Incidence rates for lung cancer were then calculated. As a comparison group, we created a microsimulation model that generated expected lung

cancer incidence rates for a WTC- and occupationally-unexposed cohort with similar characteristics. We also fitted a Poisson regression model to determine specific lung cancer risk factors for WTC RRWV.

RESULTS: The incidence of lung cancer for WTC RRWV was 39.5 (95% confidence interval [CI]: 30.7-49.9) per 100,000 person-years. When compared to the simulated unexposed cohort, no significant elevation in incidence was found among WTC RRWV (incidence rate ratio [IRR] 1.34; 95% CI: 0.92-1.96). Predictors of lung cancer incidence included age, smoking intensity, and years since quitting for former smokers. In adjusted models evaluating airway obstruction and individual pre-WTC occupational exposures, only mineral dust work was associated with lung cancer risk (IRR: 2.03; 95% CI: 1.07-3.86).

DISCUSSION: In a sample from a large, prospective cohort of WTC RRWV we found a lung cancer incidence rate that was similar to that expected of a WTC- and occupationally-unexposed cohort with similar individual risk profiles. Guideline-concordant lung cancer surveillance and periodic evaluations of population-level lung cancer risk should continue in this group.

Spratlen MJ, Perera FP, Sjodin A, et al. 2022. Understanding the role of persistent organic pollutants and stress in the association between proximity to the World Trade Center disaster and birth outcomes. International Journal of Environmental Research and Public Health. 19 (4)

HTTPS://DOI.ORG/10.3390/IJERPH19042008

BACKGROUND: Fetal growth is affected by exposure to both prenatal stress and environmental contaminants. The attacks on the World Trade Center (WTC) resulted in exposure to chemicals and psychological stress amongst New York City residents. We measured prenatal maternal stress and exposure to persistent organic pollutants (polybrominated diphenyl ethers, polychlorinated biphenyls, and poly-chlorinated dibenzo-p-dioxins (PCDDs)) in 108 participants from a Columbia University WTC birth cohort. Principal component (PC) analyses were conducted to characterize the mixture of exposure to the three groups of chemicals. We evaluated the associations between geographical exposures (proximity to the WTC disaster) and both chemical exposures (PCs) and stress (demoralization). We then evaluated the effect these exposures (PCs and stress) had on previously reported associations between geographical WTC exposure and birth outcomes (birth weight and birth length) in this study population to understand their individual roles in the observed associations. Geographical exposure via proximity to the WTC was associated with the PC reflecting higher PCDD exposure (PC3) ($\beta = 0.60$, 95% CI: 0.03, 1.18 for living/working within 2 miles of the WTC; and $\beta = 0.73$, 95% CI = 0.08, 1.38 for living within 2 miles of WTC). Previously reported reductions in birth weight and length associated with WTC proximity ($\beta = -215.2$, 95% CI: −416.2, −14.3 and $\beta = -1.47$, 95% CI: −2.6, −0.34, respectively) were attenuated and no longer significant for birth weight ($\beta = -156.4$, 95% CI: −358.2, 45.4)

after adjusting for PC3, suggesting that PCDDs may act as partial mediators in this previously observed association. The results of this study can help focus future research on the long-term health effects of these prenatally exposed populations.

Tuminello S, Zhang Y, Yang L, et al. 2022. Global DNA methylation profiles in peripheral blood of WTC-exposed community members with breast cancer. International Journal of Environmental Research and Public Health. 19 (9):5104.

HTTPS://DOI.ORG/10.3390/IJERPH19095104

ABSTRACT: Breast cancer represents the most common cancer diagnosis among World Trade Center (WTC)-exposed community members, residents, and cleanup workers enrolled in the WTC Environmental Health Center (WTC EHC). The primary aims of this study were (1) to compare blood DNA methylation profiles of WTC-exposed community members with breast cancer and WTCunexposed pre-diagnostic breast cancer blood samples, and (2) to compare the DNA methylation differences among the WTC EHC breast cancer cases and WTC-exposed cancer-free controls. Gene pathway enrichment analyses were further conducted. There were significant differences in DNA methylation between WTC-exposed breast cancer cases and unexposed prediagnostic breast cancer cases. The top differentially methylated genes were Intraflagellar Transport 74 (IFT74), WD repeatcontaining protein 90 (WDR90), and Oncomodulin (OCM), which are commonly upregulated in tumors. Probes associated with established tumor suppressor genes (ATM, BRCA1, PALB2, and TP53) were hypermethylated among WTC-exposed breast cancer cases compared to the unexposed group. When comparing WTC EHC breast cancer cases vs. cancer-free controls, there appeared to be global hypomethylation among WTC-exposed breast cancer cases compared to exposed controls. Functional pathway analysis revealed enrichment of several gene pathways in WTC-exposed breast cancer cases including endocytosis, proteoglycans in cancer, regulation of actin cytoskeleton, axon guidance, focal adhesion, calcium signaling, cGMP-PKG signaling, mTOR, Hippo, and oxytocin signaling. The results suggest potential epigenetic links between WTC exposure and breast cancer in local community members enrolled in the WTC EHC program.

Wisnivesky JP, Becker JH, Ankam J, et al. 2022. The relationship between post traumatic stress disorder and self-management behaviors in World Trade Center workers with asthma. The Journal of Allergy and Clinical Immunology: In Practice. 10 (1):242–249.

HTTPS://DOI.ORG/10.1016/J.JAIP.2021.08.035

BACKGROUND: Comorbid post-traumatic stress disorder (PTSD) is highly prevalent and associated with increased morbidity among World Trade Center (WTC) rescue and recovery workers with asthma. However, the potential behavioral pathways underlying this relationship remain unclear. Objective To evaluate if PTSD is associated with lower adherence to asthma self-management behaviors among WTC workers with asthma.

METHODS: We used data from a prospective cohort of WTC workers with a physician diagnosis of asthma who were prescribed controller medications. Presence of comorbid PTSD was determined based on structured clinical interviews. Asthma self-management behaviors included medication adherence, inhaler technique, use of action plans, and trigger avoidance. We conducted unadjusted and multiple regression analyses to evaluate the association of PTSD with asthma self-management.

RESULTS: Overall, 30% of 276 WTC workers with asthma had comorbid PTSD. PTSD was associated with worse asthma control and poorer quality of life. However, PTSD was not significantly associated with medication adherence (odds ratio [OR]: -0.15, 95% confidence interval [CI]: -0.5-0.2), inhaler technique (OR: -0.12, 95% CI: -0.7-0.5), use of action plans (OR: 0.8, 95% CI: 0.4-1.8), or trigger avoidance (OR: 0.9, 95% CI: 0.4-1.8).

CONCLUSIONS: We did not find significant differences in key asthma self-management behaviors between WTC workers with and without PTSD. These results suggest that other mechanisms, such as differences in symptom perception or inflammatory pathways, may explain the association between PTSD and increased asthma morbidity.

Yu H, Tuminello S, Alpert N, et al. 2022. Global DNA methylation of WTC prostate cancer tissues show signature differences compared to non-exposed cases. Carcinogenesis.

HTTPS://DOI.ORG/10.1093/CARCIN/BGAC025

BACKGROUND: There is increased incidence of prostate cancer (PC) among World Trade Center (WTC)-exposed responders and community members, with preliminary evidence suggestive of more aggressive disease. While previous research is supportive of differences in DNA methylation and gene expression as a consequence of WTC exposure, as measured in blood of healthy individuals, the epigenetics of WTC PC tissues has yet to be explored. Patients were recruited from the World Trade Center Health Program. Non-WTC PC samples were frequency matched on age, race/ethnicity and Gleason score. Bisulfite-treated DNA was extracted from tumor tissue blocks and used to assess global DNA methylation with the MethylationEPIC BeadChip. Differential and pathway enrichment analysis were conducted. RNA from the same tumor blocks was used for gene expression analysis to further support DNA methylation findings. Methylation data were generated for 28 samples (13 WTC and 15 non-WTC). Statistically significant differences in methylation were observed for 3,586 genes; on average WTC samples were statistically significantly more hypermethylated (p=0.04131). Pathway enrichment analysis revealed hypermethylation in epithelial mesenchymal transition (EMT), hypoxia, mitotic spindle, TNFA signaling via NFKB, WNT signaling, and TGF beta signaling pathways in WTC compared to non-WTC samples. The androgen response, G2M and MYC target pathways were hypomethylated. These results correlated well with RNA gene expression.

CONCLUSIONS: In conclusion, long-term epigenic changes associated with WTC dust exposure were observed in PC tissues. These occurred in genes of critical pathways, likely increasing prostate tumorigenesis potential. This warrants analysis of larger WTC groups and other cancer types.

Appendix 2, Section 2

WTC Health Registry • Research Publications

WTC Health Registry Research Publications

(Excludes published conference abstracts, letters to the editor, book chapters and publications in press)

Year Published 2006 (1)

Brackbill RM, Thorpe LE, DiGrande L, et al. 2006. Surveillance for World Trade Center disaster health effects among survivors of collapsed and damaged buildings. MMWR Surveill Summ. 55 (2):1–18. PMID: 16601667

PROBLEM/CONDITION: Survivors of collapsed or damaged buildings from the attack on the World Trade Center (WTC) were among those most exposed to injury hazards, air pollution, and traumatic events.

REPORTING PERIOD: This report summarizes data from health outcomes collected during interviews conducted from September 5, 2003, to the close of the World Trade Center Health Registry (WTCHR) enrollment on November 20, 2004.

DESCRIPTION OF SYSTEM: WTCHR will be used to monitor periodically the mental and physical health of 71,437 enrollees for 20 years. The analysis is limited to 8,418 adult survivors of collapsed buildings (n = 5,095) and buildings with major or moderate damage (n = 3,323), excluding those who were involved in rescue and recovery.

RESULTS: A total of 62.4% of survivors of collapsed or damaged buildings were caught in the dust and debris cloud that resulted from the collapse of the WTC towers, and 63.8% experienced three or more potentially psychologically traumatizing events. Injuries were common (43.6%), but few survivors reported injuries that would have required extensive treatment. More than half (56.6%) of survivors reported experiencing new or worsening respiratory symptoms after the attacks, 23.9% had heartburn/reflux, and 21.0% had severe headaches. At the time of the interview, 10.7% of building survivors screened positive for serious psychological distress (SPD) using the K6 instrument. After multiple adjustments, data indicated that survivors caught in the dust and debris cloud were more likely to report any injuries (adjusted odds ratio [AOR] = 3.9; p< or =0.05); any respiratory symptom (AOR = 2.7; p< or =0.05); severe headaches (AOR = 2.0; p< or =0.05); skin rash/irritation (AOR = 1.7;

p< or =0.05); hearing problems or loss (AOR = 1.7; p< or =0.05); heartburn (AOR = 1.7; p< or =0.05); diagnosed stroke (AOR = 5.6; p< or =0.05); self-reported depression, anxiety, or other emotional problem (AOR = 1.4; p< or =0.05); and current SPD (AOR = 2.2; p< or =0.05). Adjustment for SPD did not diminish the observed associations between dust cloud exposure and physical health outcomes. Building type and time of evacuation were associated with injuries on September 11, 2001 and reported symptoms; building type (collapsed versus damaged) also was associated with mental distress.

INTERPRETATION: Two to three years after September 11, survivors of buildings that collapsed or that were damaged as a result of the WTC attack reported substantial physical and mental health problems. The long-term ramifications of these effects are unknown. Many survivors were caught directly in the dust and debris of collapsing towers, a dense cloud of particulate matter that might have produced or exacerbated these health effects.

PUBLIC HEALTH ACTION RECOMMENDED: Long-term follow-up of building survivors and all other persons enrolled in WTCHR should be maintained, with particular attention to those persons exposed to the dust cloud. Some of these findings might lead to building designs that can minimize injury hazards.

Year Published 2007 (3)

Registry Outputs

Murphy J, Brackbill RM, Thalji L, et al. 2007. Measuring and maximizing coverage in the World Trade Center Health Registry. Stat Med. 26 (8):1688–1701.

HTTPS://DOI.ORG/10.1002/SIM.2806

The World Trade Center Health Registry (WTCHR) is a database for following people who were exposed to the disaster of 11 September 2001. Hundreds of thousands of people were exposed to the immense cloud of dust and debris, the indoor dust, the fumes from persistent fires, and the mental trauma of the terrorist attacks on the WTC on 9/11. The purpose of the WTCHR is to evaluate the potential short- and long-term physical and mental health effects of the disaster. The definitions of the exposed groups are broad and defined based on an understanding of which groups had the highest exposures to the WTC disaster and its aftermath. The four exposure groups include rescue and recovery workers, residents, students and school staff, and building occupants and passersby in Lower Manhattan. While one goal of the WTCHR was to maximize coverage overall and for each exposure group, another was to ensure equal representation within exposure groups. Because of the multiple sample types pursued, several approaches were required to determine eligibility. Estimates of the number of eligible persons in each of the exposed populations were based on the best available information including Census, entity-specific employment figures, and public and private school enrollment data, among other publicly available sources. To address issues of undercoverage and overcoverage a variety of methods were assessed or applied,

including a capture-recapture analyses test of overlapping sample building list sources and automated deduplication of sample records. Estimates of the true eligible population indicate that over 400,000 unique individuals were eligible for the baseline health survey. Interviewer-administered surveys were completed with more than 71,000 persons, resulting in an overall enrollment rate of approximately 17 per cent. Coverage was highest among rescue and recovery workers, followed by residents, students and school staff, and building occupants. Both the accuracy of coverage estimates and the raw number and representativeness of enrollees were maximized by our approach to coverage. In designing a registry which relies on multiple pathways and sources of data to build the sample, it is important to develop a comprehensive approach that considers all sources of error and minimizes bias that may be introduced through the methodology.

Perrin MA, DiGrande L, Wheeler K, et al. 2007. Differences in PTSD prevalence and associated risk factors among World Trade Center disaster rescue and recovery workers. Am J Psychiatry. 164 (9):1385–1394.

HTTPS://DOI.ORG/10.1176/APPI.AJP.2007.06101645

OBJECTIVE: This study compared the prevalence and risk factors of current probable posttraumatic stress disorder (PTSD) across different occupations involved in rescue/recovery work at the World Trade Center site.

METHOD: Rescue and recovery workers enrolled in the World Trade Center Health Registry who reported working at the World Trade Center site (N=28,962) were included in the analysis. Interviews conducted 2-3 years after the disaster included assessments of demographic characteristics, within-disaster and work experiences related to the World Trade Center, and current probable PTSD.

RESULTS: The overall prevalence of PTSD among rescue/recovery workers was 12.4%, ranging from 6.2% for police to 21.2% for unaffiliated volunteers. After adjustments, the greatest risk of developing PTSD was seen among construction/engineering workers, sanitation workers, and unaffiliated volunteers. Earlier start date and longer duration of time worked at the World Trade Center site were significant risk factors for current probable PTSD for all occupations except police, and the association between duration of time worked and current probable PTSD was strongest for those who started earlier. The prevalence of PTSD was significantly higher among those who performed tasks not common for their occupation.

CONCLUSIONS: Workers and volunteers in occupations least likely to have had prior disaster training or experience were at greatest risk of PTSD. Disaster preparedness training and shift rotations to enable shorter duration of service at the site may reduce PTSD among workers and volunteers in future disasters.

Wheeler K, McKelvey W, Thorpe L, et al. 2007. Asthma diagnosed after 11 September 2001 among rescue and recovery workers: Findings from the World Trade Center Health Registry. Environ Health Perspect. 115 (11):1584–1590.

HTTPS://DOI.ORG/10.1289/EHP.10248

BACKGROUND: Studies have consistently documented declines in respiratory health after 11 September 2001 (9/11) among surviving first responders and other World Trade Center (WTC) rescue, recovery, and clean-up workers.

OBJECTIVES: The goal of this study was to describe the risk of newly diagnosed asthma among WTC site workers and volunteers and to characterize its association with WTC site exposures.

METHODS: We analyzed 2003-2004 interview data from the World Trade Center Health Registry for workers who did not have asthma before 9/11 (n = 25,748), estimating the risk of newly diagnosed asthma and its associations with WTC work history, including mask or respirator use.

RESULTS: Newly diagnosed asthma was reported by 926 workers (3.6%). Earlier arrival and longer duration of work were significant risk factors, with independent dose responses ($p < 0.001$), as were exposure to the dust cloud and pile work. Among workers who arrived on 11 September, longer delays in the initial use of masks or respirators were associated with increased risk of asthma; adjusted odds ratios ranged from 1.63 [95% confidence interval (CI), 1.03-2.56) for 1 day of delay to 3.44 (95% CI, 1.43-8.25) for 16-40 weeks delay.

CONCLUSIONS: The rate of self-reported newly diagnosed asthma was high in the study population and significantly associated with increased exposure to the WTC disaster site. Although we could not distinguish appropriate respiratory protection from inappropriate, we observed a moderate protective effect of mask or respirator use. The findings underscore the need for adequate and timely distribution of appropriate protective equipment and the enforcement of its use when other methods of controlling respiratory exposures are not feasible.

Registry Outputs

Year Published 2008 (3)

DiGrande L, Perrin MA, Thorpe LE, et al. 2008. Posttraumatic stress symptoms, PTSD, and risk factors among lower manhattan residents 2-3 years after the September 11, 2001 terrorist attacks. J Trauma Stress. 21 (3):264–273.

HTTPS://DOI.ORG/10.1002/JTS.20345

Manhattan residents living near the World Trade Center may have been particularly vulnerable to posttraumatic stress disorder (PTSD) after the September 11, 2001 (9/11) terrorist attacks. In 2003-2004, the authors administered the PTSD Checklist to 11,037 adults who lived south of Canal Street in New York City on 9/11. The prevalence of probable PTSD was 12.6% and associated with older age, female gender, Hispanic ethnicity, low education and income, and divorce. Injury, witnessing horror, and dust cloud exposure on 9/11 increased risk for chronic PTSD. Postdisaster risk factors included evacuation and rescue and recovery work. The results indicate that PTSD is a continued

health problem in the local community. The relationship between socioeconomic status and PTSD suggests services must target marginalized populations. Followup is necessary on the course and long-term consequences of PTSD.

Farfel M, DiGrande L, Brackbill R, et al. 2008. An overview of 9/11 experiences and respiratory and mental health conditions among World Trade Center Health Registry enrollees. J Urban Health. 85 (6):880–909.

HTTPS://DOI.ORG/10.1007/S11524-008-9317-4

To date, health effects of exposure to the September 11, 2001 disaster in New York City have been studied in specific groups, but no studies have estimated its impact across the different exposed populations. This report provides an overview of the World Trade Center Health Registry (WTCHR) enrollees, their exposures, and their respiratory and mental health outcomes 2-3 years post-9/11. Results are extrapolated to the estimated universe of people eligible to enroll in the WTCHR to determine magnitude of impact. Building occupants, persons on the street or in transit in lower Manhattan on 9/11, local residents, rescue and recovery workers/volunteers, and area school children and staff were interviewed and enrolled in the WTCHR between September 2003 and November 2004. A total of 71,437 people enrolled in the WTCHR, for 17.4% coverage of the estimated eligible exposed population (nearly 410,000); 30% were recruited from lists, and 70% were self-identified. Many reported being in the dust cloud from the collapsing WTC Towers (51%), witnessing traumatic events (70%), or sustaining an injury (13%). After 9/11, 67% of adult enrollees reported new or worsening respiratory symptoms, 3% reported newly diagnosed asthma, 16% screened positive for probable posttraumatic stress disorder (PTSD), and 8% for serious psychological distress (SPD). Newly diagnosed asthma was most common among rescue and recovery workers who worked on the debris pile (4.1%). PTSD was higher among those who reported Hispanic ethnicity (30%), household income < $25,000 (31%), or being injured (35%). Using previously published estimates of the total number of exposed people per WTCHR eligibility criteria, we estimate between 3,800 and 12,600 adults experienced newly diagnosed asthma and 34,600-70,200 adults experienced PTSD following the attacks, suggesting extensive adverse health impacts beyond the immediate deaths and injuries from the acute event.

Thomas PA, Brackbill R, Thalji L, et al. 2008. Respiratory and other health effects reported in children exposed to the World Trade Center disaster of 11 September 2001. Environ Health Perspect. 116 (10):1383–1390.

HTTPS://DOI.ORG/10.1289/EHP.11205

BACKGROUND: Effects of the World Trade Center (WTC) disaster on children's respiratory health have not been definitively established.

OBJECTIVE: This report describes respiratory health findings among children who were < 18 years of age on 11 September 2001 (9/11) and examine associations between disaster-related exposures and respiratory health.

METHODS: Children recruited for the WTC

Health Registry (WTCHR) included child residents and students (kindergarten through 12th grade) in Manhattan south of Canal Street, children who were south of Chambers Street on 9/11, and adolescent disaster-related workers or volunteers. We collected data via computer-assisted telephone interviews in 2003-2004, with interview by adult proxy for children still < 18 years of age at that time. We compared age-specific asthma prevalence with National Health Interview Survey estimates.

RESULTS: Among 3,184 children enrolled, 28% were < 5 years of age on 9/11; 34%, 5-11 years; and 39%, 12-17 years. Forty-five percent had a report of dust cloud exposure on 9/11. Half (53%) reported at least one new or worsened respiratory symptom, and 5.7% reported new asthma diagnoses. Before 9/11, age-specific asthma prevalence in enrolled children was similar to national estimates, but prevalence at interview was elevated among enrollees < 5 years of age. Dust cloud exposure was associated with new asthma diagnosis (adjusted odds ratio = 2.3; 95% confidence interval, 1.5-3.5).

CONCLUSIONS: Asthma prevalence after 9/11 among WTCHR enrollees < 5 years of age was higher than national estimates, and new asthma diagnosis was associated with dust cloud exposure in all age groups. We will determine severity of asthma and persistence of other respiratory symptoms on follow-up surveys.

Year Published 2009 (2)

Registry Outputs

Brackbill RM, Hadler JL, DiGrande L, et al. 2009. Asthma and posttraumatic stress symptoms 5 to 6 years following exposure to the World Trade Center terrorist attack. JAMA. 302 (5):502–516.

HTTPS://DOI.ORG/10.1001/JAMA.2009.1121

CONTEXT: The World Trade Center Health Registry provides a unique opportunity to examine long-term health effects of a large-scale disaster.

OBJECTIVE: To examine risk factors for new asthma diagnoses and event-related posttraumatic stress (PTS) symptoms among exposed adults 5 to 6 years following exposure to the September 11, 2001, World Trade Center (WTC) terrorist attack.

DESIGN, SETTING, AND PARTICIPANTS: Longitudinal cohort study with wave 1 (W1) enrollment of 71,437 adults in 2003-2004, including rescue/recovery worker, lower Manhattan resident, lower Manhattan office worker, and passersby eligibility groups; 46,322 adults (68%) completed the wave 2 (W2) survey in 2006-2007.

MAIN OUTCOME MEASURES: Self-reported diagnosed asthma following September 11; event-related current PTS symptoms indicative of probable posttraumatic stress disorder (PTSD), assessed using the PTSD Checklist (cutoff score > or = 44).

RESULTS: Of W2 participants with no stated asthma history, 10.2% (95% confidence interval [CI], 9.9%-10.5%) reported new

asthma diagnoses postevent. Intense dust cloud exposure on September 11 was a major contributor to new asthma diagnoses for all eligibility groups: for example, 19.1% vs 9.6% in those without exposure among rescue/recovery workers (adjusted odds ratio, 1.5 [95% CI, 1.4-1.7]). Asthma risk was highest among rescue/recovery workers on the WTC pile on September 11 (20.5% [95% CI, 19.0%-22.0%]). Persistent risks included working longer at the WTC site, not evacuating homes, and experiencing a heavy layer of dust in home or office. Of participants with no PTSD history, 23.8% (95% CI, 23.4%-24.2%) reported PTS symptoms at either W1 (14.3%) or W2 (19.1%). Nearly 10% (9.6% [95% CI, 9.3%-9.8%]) had PTS symptoms at both surveys, 4.7% (95% CI, 4.5%-4.9%) had PTS symptoms at W1 only, and 9.5% (95% CI, 9.3%-9.8%) had PTS symptoms at W2 only. At W2, passersby had the highest rate of PTS symptoms (23.2% [95% CI, 21.4%-25.0%]). Event-related loss of spouse or job was associated with PTS symptoms at W2.

CONCLUSION: Acute and prolonged exposures were both associated with a large burden of asthma and PTS symptoms 5 to 6 years after the September 11 WTC attack.

Murphy J. 2009. Estimating the World Trade Center tower population on September 11, 2001: A capture-recapture approach. Am J Public Health. 99 (1):65–67.

HTTPS://DOI.ORG/10.2105/AJPH.2007.124768

Applied the capture-recapture method to estimate the World Trade Center tower population at the time of the September 11, 2001, terrorist attacks. Available lists helped identify 8965 survivors and 2152 confirmed casualties. The capture-recapture model suggested that an additional 4435 survivors were present, putting the total count of all present at 15,552 (95% confidence interval=15,216, 15,897). An accurate estimate represents the potential number at risk for trauma as a result of direct exposure to the events of the day.

Year Published 2010 (2)

Bowler RM, Han H, Gocheva V, et al. 2010. Gender differences in probable posttraumatic stress disorder among police responders to the 2001 World Trade Center terrorist attack. Am J Ind Med. 53 (12):1186–1196.

HTTPS://DOI.ORG/10.1002/AJIM.20876

BACKGROUND: Police responders to the 2001 World Trade Center (WTC) disaster were previously reported to have an increased prevalence of probable posttraumatic stress disorder (PTSD).

METHODS: Four thousand seventeen police responders (3,435 men and 582 women) were interviewed 2-3 years after 9/11/01 as part of the World Trade Center Health Registry. Demographic, occupational, and event-specific risk factors were evaluated for probable PTSD, determined by DSM-IV criteria using the Posttraumatic Stress Checklist (PCL).

RESULTS: Overall prevalence of probable PTSD was 8.3% (women: 13.9%; men: 7.4%, $P < 0.001$). Risk factors for both genders

included 9/11-related injury and older age. For men, specific risk factors were: presence in WTC Towers on 9/11 and Hispanic ethnicity; and for women, witnessing horror and education less than a college degree.

CONCLUSIONS: Significantly higher prevalence of probable PTSD was found for female police responders. Although consistent with civilian populations, this finding contrasts with other studies of PTSD and WTC rescue and recovery workers, and police prior to 9/11.

Lipkind HS, Curry AE, Huynh M, et al. 2010. Birth outcomes among offspring of women exposed to the September 11, 2001, terrorist attacks. Obstet Gynecol. 116 (4):917–925.

HTTPS://DOI.ORG/10.1097/AOG.0B013E3181F2F6A2

OBJECTIVE: To evaluate the effects of the September 11, 2001, World Trade Center attacks on birth outcomes.

METHODS: Live singleton births between September 11, 2001, and October 31, 2002, to women enrolled in a World Trade Center Health Registry (the Registry, n=446) were compared with births to women residing more than 5 miles from the World Trade Center (n=49,616). Birth weight, gestational age, low birth weight, and preterm delivery were evaluated using linear and logistic regression. Births before September 11, 2001, were analyzed to assess possible seasonal biases of associations with pregnancy trimester on September 11. Associations of birth outcomes with September 11-related psychologic stress and physical exposures were assessed among births to women within the Registry (n=499).

RESULTS: Birth weight and gestational age distributions were similar for births to women enrolled in the Registry and comparison births. Although mean gestational age and birth weight varied with trimester on September 11, a similar association was found among births in previous years, consistent with a seasonal effect not related to exposure. Registry-linked births to mothers with probable posttraumatic stress disorder (n=61) had a higher odds of low birth weight (adjusted odds ratio [OR] 2.49, 95% confidence interval [CI] 1.02-6.08) and preterm delivery (adjusted OR 2.48, 95% CI 1.05-5.84) compared with births to women without posttraumatic stress disorder.

CONCLUSION: Women who lived, worked, or were near the World Trade Center on or soon after September 11 had pregnancy outcomes similar to women residing more than 5 miles away. However, among exposed women, probable posttraumatic stress disorder was associated with low birth weight and preterm delivery.

LEVEL OF EVIDENCE: II.

Year Published 2011 (12)

Antao VC, Pallos LL, Shim YK, et al. 2011. Respiratory protective equipment, mask use, and re-

spiratory outcomes among World Trade Center rescue and recovery workers. Am J Ind Med. 54 (12):897–905.

HTTPS://DOI.ORG/10.1002/AJIM.21009

BACKGROUND: Serious respiratory illnesses have been reported among rescue/recovery workers (RRW) following the World Trade Center (WTC) attacks.

METHODS: We studied RRW enrolled in the WTC Health Registry to assess the effects of different respiratory protection equipment (RPE) types on respiratory outcomes, such as recurrent respiratory symptoms and diseases possibly associated with 9/11 exposures. We performed descriptive and multivariate analyses adjusting for demographics and exposure variables.

RESULTS: A total of 9,296 RRW met inclusion criteria. The strongest predictors of using adequate RPE were being affiliated with construction, utilities or environmental remediation organizations and having received RPE training. Workers who used respirators were less likely to report adverse respiratory outcomes compared to those who reported no/lower levels of respiratory protection.

CONCLUSIONS: Level of respiratory protection was associated with the odds of reporting respiratory symptoms and diseases. Training, selection, fit testing, and consistent use of RPE should be emphasized among emergency responders.

Cone JE and Farfel M. 2011. World Trade Center Health Registry--a model for a nanomaterials exposure registry. J Occup Environ Med. 53 (0):S48–51.

HTTPS://DOI.ORG/10.1097/JOM.0B013E31821B177A

OBJECTIVE: To describe the development of and some of the early results from the World Trade Center Health Registry (WTCHR). Is the WTCHR a model for a nanomaterials exposure registry? What lessons may be learned from the WTCHR?

METHODS: We describe the steps involved in creation of the WTCHR, from design through implementation.

RESULTS: The lessons learned from the WTCHR include thorough documentation of exposure early in the registry, using multimode surveys to maximize response rate, establishing an institutional home with sufficient resources for core as well as in-depth longitudinal and intervention studies, meeting with stakeholders regularly, making data accessible, and timely publication of findings, including wide dissemination of clinical guidelines.

CONCLUSIONS: The process of creating and maintaining the WTCHR provides important lessons for the possible creation of a nanomaterials exposure registry.

Debchoudhury I, Welch AE, Fairclough MA, et al. 2011. Comparison of health outcomes among affiliated and lay disaster volunteers enrolled in the World Trade Center Health Registry. Prev Med. 53 (6):359–363.

HTTPS://DOI.ORG/10.1016/J.YPMED.2011.08.034

BACKGROUND: Volunteers (non-professional rescue/recovery workers) are universally present at man-made and natural disasters

and share experiences and exposures with victims. Little is known of their disaster-related health outcomes.

METHODS: We studied 4974 adult volunteers who completed the World Trade Center Health Registry 2006-07 survey to examine associations between volunteer type (affiliated vs. lay) and probable posttraumatic stress disorder (PTSD); new or worsening respiratory symptoms; post-9/11 first diagnosis of anxiety disorder, depression, and/or PTSD; and asthma or reactive airway dysfunction syndrome (RADS). Affiliated volunteers reported membership in a recognized organization. Lay volunteers reported no organizational affiliation and occupations unrelated to rescue/recovery work. Adjusted odds ratios (OR(adj)) were calculated using multinomial regression.

RESULTS: Lay volunteers were more likely than affiliated volunteers to have been present in lower Manhattan, experience the dust cloud, horrific events and injury on 9/11 and subsequently to report unmet healthcare needs. They had greater odds of early post-9/11 mental health diagnosis (OR(adj) 1.6; 95% CI: 1.4-2.0) and asthma/RADS (1.8; 1.2-2.7), chronic PTSD (2.2; 1.7-2.8), late-onset PTSD (1.9; 1.5-2.5), and new or worsening lower respiratory symptoms (2.0; 1.8-2.4).

CONCLUSIONS: Lay volunteers' poorer health outcomes reflect earlier, more intense exposure to and lack of protection from physical and psychological hazards. There is a need to limit volunteers' exposures during and after disasters, as well as to provide timely screening and health care post-disaster.

DiGrande L, Neria Y, Brackbill RM, et al. 2011. Long-term posttraumatic stress symptoms among 3,271 civilian survivors of the September 11, 2001, terrorist attacks on the World Trade Center. Am J Epidemiol. 173 (3):271–281.

HTTPS://DOI.ORG/10.1093/AJE/KWQ372

Although the September 11, 2001, terrorist attacks were the largest human-made disaster in US history, there is little extant research documenting the attacks' consequences among those most directly affected, that is, persons who were in the World Trade Center towers. Data from a cross-sectional survey conducted 2-3 years after the attacks ascertained the prevalence of long-term, disaster-related posttraumatic stress symptoms and probable posttraumatic stress disorder (PTSD) in 3,271 civilians who evacuated World Trade Center towers 1 and 2. Overall, 95.6% of survivors reported at least 1 current posttraumatic stress symptom. The authors estimated the probable rate of PTSD at 15.0% by using the PTSD Checklist. Women and minorities were at an increased risk of PTSD. A strong inverse relation with annual income was observed. Five characteristics of direct exposure to the terrorist attacks independently predicted PTSD: being on a high floor in the towers, initiating evacuation late, being caught in the dust cloud that resulted from the tower collapses, personally witnessing horror, and sustaining an injury. Working for an employer that sustained fatalities also increased risk. Each addition of an experience of direct exposure resulted in a 2-fold increase in the risk of PTSD (odds ratio = 2.09, 95% confidence interval: 1.84, 2.36). Identification of these risk factors may be useful when screening survivors of large-scale ter-

rorist events for long-term psychological sequelae.

Ekenga CC, Scheu KE, Cone JE, et al. 2011. 9/11-related experiences and tasks of landfill and barge workers: Qualitative analysis from the World Trade Center Health Registry. BMC Public Health. 11:321.

HTTPS://DOI.ORG/10.1186/1471-2458-11-321

BACKGROUND: Few studies have documented the experiences of individuals who participated in the recovery and cleanup efforts at the World Trade Center Recovery Operation at Fresh Kills Landfill, on debris loading piers, and on transport barges after the September 11, 2001 terrorist attack.

METHODS: Semi-structured telephone interviews were conducted with a purposive sample of workers and volunteers from the World Trade Center Health Registry. Qualitative methods were used to analyze the narratives.

RESULTS: Twenty workers and volunteers were interviewed. They described the transport of debris to the Landfill via barges, the tasks and responsibilities associated with their post-9/11 work at the Landfill, and their reflections on their post-9/11 experiences. Tasks included sorting through debris, recovering human remains, searching for evidence from the terrorist attacks, and providing food and counseling services. Exposures mentioned included dust, fumes, and odors. Eight years after the World Trade Center disaster, workers expressed frustration about poor risk communication during recovery and cleanup work. Though proud of their contributions in the months after 9/11, some participants were concerned about long-term health outcomes.

CONCLUSIONS: This qualitative study provided unique insight into the experiences, exposures, and concerns of understudied groups of 9/11 recovery and cleanup workers. The findings are being used to inform the development of subsequent World Trade Center Health Registry exposure and health assessments.

Friedman SM, Maslow CB, Reibman J, et al. 2011. Case-control study of lung function in World Trade Center Health Registry area residents and workers. Am J Respir Crit Care Med. 184 (5):582–589.

HTTPS://DOI.ORG/10.1164/RCCM.201011-19090C

RATIONALE: Residents and area workers who inhaled dust and fumes from the World Trade Center disaster reported lower respiratory symptoms in two World Trade Center Health Registry surveys (2003-2004 and 2006-2007), but lung function data were lacking.

OBJECTIVES: To examine the relationship between persistent respiratory symptoms and pulmonary function in a nested case-control study of exposed adult residents and area workers 7-8 years after September 11, 2001.

METHODS: Registrants reporting post September 11th onset of a lower respiratory symptom in the first survey and the same symptom in the second survey were solicited as potential cases. Registrants without lower respiratory symptoms in either Registry survey were solicited as potential control subjects. Final case-control status

was determined by lower respiratory symptoms at a third interview (the study), when spirometry and impulse oscillometry were also performed.

MEASUREMENTS AND MAIN RESULTS: We identified 180 cases and 473 control subjects. Cases were more likely than control subjects to have abnormal spirometry (19% vs. 11%; P < 0.05), and impulse oscillometry measurements of elevated airway resistance (R5; 68% vs. 27%; P < 0.0001) and frequency dependence of resistance (R(5)(-)(2)(0); 36% vs. 7%; P < 0.0001). When spirometry was normal, cases were more likely than control subjects to have elevated R(5) and R(5)(-)(2)(0) (62% vs. 25% and 27% vs. 6%, respectively; both P < 0.0001). Associations between symptoms and oscillometry held when factors significant in bivariate comparisons (body mass index, spirometry, and exposures) were analyzed using logistic regression.

CONCLUSIONS: This study links persistent respiratory symptoms and oscillometric abnormalities in World Trade Center-exposed residents and area workers. Elevated R(5) and R(5)(-)(2)(0) in cases despite normal spirometry suggested distal airway dysfunction as a mechanism for symptoms.

Jordan HT, Brackbill RM, Cone JE, et al. 2011. Mortality among survivors of the Sept 11, 2001, World Trade Center disaster: Results from the World Trade Center Health Registry cohort. Lancet. 378 (9794):879–887.

HTTPS://DOI.ORG/10.1016/S0140-6736(11)60966-5

BACKGROUND: The Sept 11, 2001 (9/11) World Trade Center (WTC) disaster has been associated with several subacute and chronic health effects, but whether excess mortality after 9/11 has occurred is unknown. We tested whether excess mortality has occurred in people exposed to the WTC disaster.

METHODS: In this observational cohort study, deaths occurring in 2003-09 in WTC Health Registry participants residing in New York City were identified through linkage to New York City vital records and the National Death Index. Eligible participants were rescue and recovery workers and volunteers; lower Manhattan area residents, workers, school staff and students; and commuters and passers-by on 9/11. Study participants were categorised as rescue and recovery workers (including volunteers), or non-rescue and non-recovery participants. Standardised mortality ratios (SMR) were calculated with New York City rates from 2000-09 as the reference. Within the cohort, proportional hazards were used to examine the relation between a three-tiered WTC-related exposure level (high, intermediate, or low) and total mortality.

FINDINGS: We identified 156 deaths in 13,337 rescue and recovery workers and 634 deaths in 28,593 non-rescue and non-recovery participants. All-cause SMRs were significantly lower than that expected for rescue and recovery participants (SMR 0.45, 95% CI 0.38-0.53) and non-rescue and non-recovery participants (0.61, 0.56-0.66). No significantly increased SMRs for diseases of the respiratory system or heart, or for haematological malignancies were found. In non-rescue and non-recovery participants, both intermediate and high

levels of WTC-related exposure were significantly associated with mortality when compared with low exposure (adjusted hazard ratio 1.22, 95% CI 1.01-1.48, for intermediate exposure and 1.56, 1.15-2.12, for high exposure). High levels of exposure in non-rescue and non-recovery individuals, when compared with low exposed non-rescue and non-recovery individuals, were associated with heart-disease-related mortality (adjusted hazard ratio 2.06, 1.10-3.86). In rescue and recovery participants, level of WTC-related exposure was not significantly associated with all-cause mortality (adjusted hazard ratio 1.25, 95% CI 0.56-2.78, for high exposure and 1.03, 0.52-2.06, for intermediate exposure when compared with low exposure).

INTERPRETATION: This exploratory study of mortality in a well defined cohort of 9/11 survivors provides a baseline for continued surveillance. Additional follow-up is needed to establish whether these associations persist and whether a similar association over time will occur in rescue and recovery participants.

FUNDING: US Centers for Disease Control and Prevention (National Institute for Occupational Safety and Health, Agency for Toxic Substances and Disease Registry, and National Center for Environmental Health); New York City Department of Health and Mental Hygiene.

Jordan HT, Miller-Archie SA, Cone JE, et al. 2011. Heart disease among adults exposed to the September 11, 2001 World Trade Center disaster: Results from the World Trade Center Health Registry. Prev Med. 53 (6):370–376.

HTTPS://DOI.ORG/10.1016/J.YPMED.2011.10.014

OBJECTIVE: To examine associations between 9/11-related exposures, posttraumatic stress disorder (PTSD), and subsequent development of heart disease (HD).

METHODS: We prospectively followed 39,324 WTC Health Registry participants aged >/=18 on 9/11 for an average of 2.9 years. HD was defined as self-reported physician-diagnosed angina, heart attack, and/or other HD reported between study enrollment (2003-2004) and a follow-up survey (2006-2008) in enrollees without previous HD. A PTSD Checklist (PCL) score >/=44 was considered PTSD. We calculated adjusted hazard ratios (AHR) and 95% confidence intervals (CI) to examine relationships between 9/11-related exposures and HD.

RESULTS: We identified 1162 HD cases (381 women, 781 men). In women, intense dust cloud exposure was significantly associated with HD (AHR 1.28, 95% CI 1.02-1.61). Injury on 9/11 was significantly associated with HD in women (AHR 1.46, 95% CI 1.19-1.79) and in men (AHR 1.33, 95% CI 1.15-1.53). Participants with PTSD at enrollment had an elevated HD risk (AHR 1.68, 95% CI 1.33-2.12 in women, AHR 1.62, 95% CI 1.34-1.96 in men). A dose-response relationship was observed between PCL score and HD risk.

CONCLUSION: This exploratory study suggests that exposure to the WTC dust cloud, injury on 9/11 and 9/11-related PTSD may be risk factors for HD.

Jordan HT, Stellman SD, Prezant D, et al. 2011. Sarcoidosis diagnosed after September 11, 2001, among adults exposed to the World Trade Center disaster. J Occup Environ Med. 53 (9):966–974.

HTTPS://DOI.ORG/10.1097/JOM.0B013E31822A3596

OBJECTIVE: Explore relationships between World Trade Center (WTC) exposures and sarcoidosis.

METHODS: Sarcoidosis has been reported after exposure to the WTC disaster. We ascertained biopsy-proven post-9/11 sarcoidosis among WTC Health Registry enrollees. Cases diagnosed after Registry enrollment were included in a nested case-control study. Controls were matched to cases on age, sex, race or ethnicity, and eligibility group (eg, rescue or recovery worker).

RESULTS: We identified 43 cases of post-9/11 sarcoidosis. Twenty-eight incident cases and 109 controls were included in the case-control analysis. Working on the WTC debris pile was associated with sarcoidosis (odds ratio 9.1, 95% confidence interval 1.1 to 74.0), but WTC dust cloud exposure was not (odds ratio 1.0, 95% confidence interval 0.4 to 2.8).

CONCLUSIONS: Working on the WTC debris pile was associated with an elevated risk of post-9/11 sarcoidosis. Occupationally exposed workers may be at increased risk.

Li J, Brackbill RM, Stellman SD, et al. 2011. Gastroesophageal reflux symptoms and comorbid asthma and posttraumatic stress disorder following the 9/11 terrorist attacks on World Trade Center in New York City. Am J Gastroenterol. 106 (11):1933–1941.

HTTPS://DOI.ORG/10.1038/AJG.2011.300

OBJECTIVES: Excess gastroesophageal reflux disease (GERD) was reported in several populations exposed to the September 11 2001 (9/11) terrorist attacks on the World Trade Center (WTC). We examined new onset gastroesophageal reflux symptoms (GERS) since 9/11 and persisting up to 5-6 years in relation to 9/11-related exposures among the WTC Health Registry enrollees, and potential associations with comorbid asthma and posttraumatic stress disorder (PTSD).

METHODS: This is a retrospective analysis of 37,118 adult enrollees (i.e., rescue/recovery workers, local residents, area workers, and passersby in lower Manhattan on 9/11) who reported no pre-9/11 GERS and who participated in two Registry surveys 2-3 and 5-6 years after 9/11. Post-9/11 GERS (new onset since 9/11) reported at first survey, and persistent GERS (post-9/11 GERS reported at both surveys) were analyzed using log-binomial regression.

RESULTS: Cumulative incidence was 20% for post-9/11 GERS and 13% for persistent GERS. Persistent GERS occurred more often among those with comorbid PTSD (24%), asthma (13%), or both (36%) compared with neither of the comorbid conditions (8%). Among enrollees with neither asthma nor PTSD, the adjusted risk ratio (aRR) for persistent GERS was elevated among: workers arriving at the WTC pile on 9/11

(aRR=1.6; 95% confidence interval (CI) 1.3-2.1) or working at the WTC site > 90 days (aRR=1.6; 1.4-2.0); residents exposed to the intense dust cloud on 9/11 (aRR=1.5; 1.0-2.3), or who did not evacuate their homes (aRR=1.7; 1.2-2.3); and area workers exposed to the intense dust cloud (aRR=1.5; 1.2-1.8).

CONCLUSIONS: Disaster-related environmental exposures may contribute to the development of GERS. GERS may be accentuated in the presence of asthma or PTSD.

Perlman SE, Friedman S, Galea S, et al. 2011. Short-term and medium-term health effects of 9/11. Lancet. 378 (9794):925–934.

HTTPS://DOI.ORG/10.1016/S0140-6736(11)60967-7

The New York City terrorist attacks on Sept 11, 2001 (9/11), killed nearly 2800 people and thousands more had subsequent health problems. In this Review of health effects in the short and medium terms, strong evidence is provided for associations between experiencing or witnessing events related to 9/11 and post-traumatic stress disorder and respiratory illness, with a correlation between prolonged, intense exposure and increased overall illness and disability. Rescue and recovery workers, especially those who arrived early at the World Trade Center site or worked for longer periods, were more likely to develop respiratory illness than were other exposed groups. Risk factors for post-traumatic stress disorder included proximity to the site on 9/11, living or working in lower Manhattan, rescue or recovery work at the World Trade Center site, event-related loss of spouse, and low social support. Investigators note associations between 9/11 exposures and additional disorders, such as depression and substance use; however, for some health problems association with exposures related to 9/11 is unclear.

Thorpe LE and Friedman S. 2011. Health consequences of the World Trade Center disaster: A 10th anniversary perspective. Jama. 306 (10):1133–1134.

HTTPS://DOI.ORG/10.1001/JAMA.2011.1289

NO ABSTRACT AVAILABLE

Registry Outputs

Year Published 2012 (6)

Bowler RM, Harris M, Li J, et al. 2012. Longitudinal mental health impact among police responders to the 9/11 terrorist attack. Am J Ind Med. 55 (4):297–312.

HTTPS://DOI.ORG/10.1002/AJIM.22000

BACKGROUND: Among police responders enrolled in the World Trade Center Health Registry (WTCHR), Post-traumatic Stress Disorder (PTSD) was almost twice as prevalent among women as men 2-3 years after the 9/11 attacks.

METHODS: Police participants in the WTCHR Wave 1 survey 2-3 years after 9/11/01, were reassessed for probable PTSD at Wave 2, 5-6 years after 9/11/01, using PCL DSM-IV criteria.

RESULTS: Police participants in the Wave 2

survey included 2,527 men, 413 women. The prevalence of "Probable PTSD" was 7.8% at Wave 1 and 16.5% at Wave 2. Mean PCL scores increased from 25.1 to 29.9 for men and 28.6 to 32.2 for women. Prevalence of PTSD was higher for women than for men at Wave 1 (chi(2) = 10.882, P = 0.002), but not Wave 2 (chi(2) = 2.416, P = 0.133). Other risk factors included losing one's job after 9/11 and being disabled.

CONCLUSIONS: Prevalence of probable PTSD among police doubled between 2003-2004 and 2006-2007. After the 2-year time span, the gender difference was no longer significant; prevalence of PTSD symptoms increased and there was a substantial amount of co-morbidity with other mental health problems. Further development of prevention and intervention strategies for police responders with symptoms of PTSD is needed. The observed upward trend in PCL scores over time in police officers with PCL scores less than 44, suggests that PTSD prevention and intervention strategies should be applied to all police affected by the 9/11 attacks, not limited just to those with PTSD symptoms.

Huang MJ, Li J, Liff JM, et al. 2012. Self-reported skin rash or irritation symptoms among World Trade Center Health Registry participants. J Occup Environ Med. 54 (4):451–458.

HTTPS://DOI.ORG/10.1097/JOM.0B013E318245242B

OBJECTIVES: We described self-reported skin rash 2 to 3 and 5 to 6 years after 9/11 and examined its association with exposures to 9/11 dust/debris.

METHODS: We analyzed a longitudinal study of New York City World Trade Center Health Registry participants who resided or worked in Lower Manhattan or worked in rescue/recovery in two surveys (W1 and W2).

RESULTS: Among 42,025 participants, 12% reported post-9/11 skin rash at W1, 6% both times, 16% at W2. Among participants without posttraumatic stress disorder or psychological distress, W1 self-reported post-9/11 skin rash was associated with intense dust cloud exposure (adjusted odds ratio [OR] = 1.6; 95% confidence interval [CI] = 1.3 to 1.9), home/workplace damage (adjusted OR = 1.8; 95% CI, 1.4 to 2.3), and working more than 90 days (adjusted OR = 1.7; 95% CI, 1.3 to 2.2) or 31 to 90 days (adjusted OR = 1.6; 95% CI, 1.3 to 2.1) at the World Trade Center site.

CONCLUSIONS: Post-9/11 skin rash may be related to acute and long-term exposure to dust, though subjectivity of skin symptoms may bias findings.

Li J, Cone JE, Kahn AR, et al. 2012. Association between World Trade Center exposure and excess cancer risk. JAMA. 308 (23):2479–2488.

HTTPS://DOI.ORG/10.1001/JAMA.2012.110980

CONTEXT: The terrorist attacks of September 11, 2001, resulted in the release of known and suspected carcinogens into the environment. There is public concern that exposures may have resulted in increased cancers.

OBJECTIVE: To evaluate cancer incidence among persons enrolled in the World Trade

Center Health Registry.

DESIGN, SETTING, AND PARTICIPANTS: Observational study of 55,778 New York State residents enrolled in the World Trade Center Health Registry in 2003-2004, including rescue/recovery workers (n = 21,850) and those not involved in rescue/recovery (n = 33,928), who were followed up from enrollment through December 31, 2008. Within-cohort comparisons using Cox proportional hazards models assessed the relationship between intensity of World Trade Center exposure and selected cancers.

MAIN OUTCOME MEASURES: Cases were identified through linkage with 11 state cancer registries. Standardized incidence ratios (SIRs) adjusted for age, race/ethnicity, and sex were computed with 2003-2008 New York State rates as the reference, focusing on cancers diagnosed in 2007-2008 as being most likely to be related to exposure during September 11 and its aftermath. The total and site-specific incidence rate differences (RDs) per 100,000 person-years between the study population and the New York State population in 2007-2008 also were calculated.

RESULTS: There were 1187 incident cancers diagnosed, with an accumulated 253,269 person-years (439 cancers among rescue/recovery workers and 748 among those not involved in rescue/recovery). The SIR for all cancer sites combined in 2007-2008 was not significantly elevated (SIR, 1.14 [95% CI, 0.99 to 1.30]; RD, 67 [95% CI, -6 to 126] per 100,000 person-years among rescue/recovery workers vs SIR, 0.92 [95% CI, 0.83 to 1.03]; RD, -45 [95% CI, -106 to 15] per 100,000 person-years among those not involved in rescue/recovery). Among rescue/recovery workers, the SIRs had significantly increased by 2007-2008 for 3 cancer sites and were 1.43 (95% CI, 1.11 to 1.82) for prostate cancer (n = 67; RD, 61 [95% CI, 20 to 91] per 100,000 person-years), 2.02 (95% CI, 1.07 to 3.45) for thyroid cancer (n = 13; RD, 16 [95% CI, 2 to 23] per 100,000 person-years), and 2.85 (95% CI, 1.15 to 5.88) for multiple myeloma (n = 7; RD, 11 [95% CI, 2 to 14] per 100,000 person-years). No increased incidence was observed in 2007-2008 among those not involved in rescue/recovery. Using within-cohort comparisons, the intensity of World Trade Center exposure was not significantly associated with cancer of the lung, prostate, thyroid, non-Hodgkin lymphoma, or hematological cancer in either group.

CONCLUSIONS: Among persons enrolled in the World Trade Center Health Registry, there was an excess risk for prostate cancer, thyroid cancer, and myeloma in 2007-2008 compared with that for New York State residents; however, these findings were based on a small number of events and multiple comparisons. No significant associations were observed with intensity of World Trade Center exposures. Longer follow-up for typically long-latency cancers and attention to specific cancer sites are needed.

Maslow CB, Friedman SM, Pillai PS, et al. 2012. Chronic and acute exposures to the World Trade Center disaster and lower respiratory symptoms: Area residents and workers. Am J Public Health. 102 (6):1186–1194.

HTTPS://DOI.ORG/10.2105/AJPH.2011.300561

OBJECTIVES: We assessed associations between new-onset (post-September 11, 2001 [9/11]) lower respiratory symptoms reported on 2 surveys, administered 3 years apart, and acute and chronic 9/11-related exposures among New York City World Trade Center-area residents and workers enrolled in the World Trade Center Health Registry.

METHODS: World Trade Center-area residents and workers were categorized as case participants or control participants on the basis of lower respiratory symptoms reported in surveys administered 2 to 3 and 5 to 6 years after 9/11. We created composite exposure scales after principal components analyses of detailed exposure histories obtained during face-to-face interviews. We used multivariate logistic regression models to determine associations between lower respiratory symptoms and composite exposure scales.

RESULTS: Both acute and chronic exposures to the events of 9/11 were independently associated, often in a dose-dependent manner, with lower respiratory symptoms among individuals who lived and worked in the area of the World Trade Center.

CONCLUSIONS: Study findings argue for detailed assessments of exposure during and after events in the future from which potentially toxic materials may be released and for rapid interventions to minimize exposures and screen for potential adverse health effects.

Nair HP, Ekenga CC, Cone JE, et al. 2012. Co-occurring lower respiratory symptoms and posttraumatic stress disorder 5 to 6 years after the World Trade Center terrorist attack. Am J Public Health. 102 (10):1964–1973.

HTTPS://DOI.ORG/10.2105/AJPH.2012.300690

OBJECTIVES: We have described the epidemiology of co-occurring lower respiratory symptoms (LRS) and probable posttraumatic stress disorder (PTSD) 5 to 6 years after exposure to the 9/11 disaster.

METHODS: We analyzed residents, office workers, and passersby (n = 16,363) in the World Trade Center Health Registry. Using multivariable logistic regression, we examined patterns of reported respiratory symptoms, treatment sought for symptoms, diagnosed respiratory conditions, mental health comorbidities, quality of life, and unmet health care needs in relation to comorbidity.

RESULTS: Among individuals with either LRS or PTSD, 24.6% had both conditions. The odds of comorbidity was significantly higher among those with more severe 9/11 exposures. Independent of 9/11 exposures, participants with LRS had 4 times the odds of those without it of meeting criteria for PTSD, and those with PTSD had 4 times the odds of those without it of meeting criteria for LRS. Participants with comorbidity had worse quality of life and more unmet mental health care needs than did all other outcome groups.

CONCLUSIONS: Respiratory and mental illness are closely linked in individuals exposed to 9/11 and should be considered jointly in public health outreach and treat-

ment programs.

Welch AE, Caramanica K, Debchoudhury I, et al. 2012. A qualitative examination of health and health care utilization after the September 11th terror attacks among World Trade Center Health Registry enrollees. BMC Public Health. 12:721.

HTTPS://DOI.ORG/10.1186/1471-2458-12-721

BACKGROUND: Many individuals who have 9/11-related physical and mental health symptoms do not use or are unaware of 9/11-related health care services despite extensive education and outreach efforts by the World Trade Center (WTC) Health Registry (the Registry) and various other organizations. This study sought to evaluate Registry enrollees' perceptions of the relationship between physical and mental health outcomes and 9/11, as well as utilization of and barriers to 9/11-related health care services.

METHODS: Six focus groups were conducted in January 2010 with diverse subgroups of enrollees, who were likely eligible for 9/11-related treatment services. The 48 participants were of differing race/ethnicities, ages, and boroughs of residence. Qualitative analysis of focus group transcripts was conducted using open coding and the identification of recurring themes.

RESULTS: Participants described a variety of physical and mental symptoms and conditions, yet their knowledge and utilization of 9/11 health care services were low. Participants highlighted numerous barriers to accessing 9/11 services, including programmatic barriers (lack of program visibility and accessibility), personal barriers such as stigmatization and unfamiliarity with 9/11-related health problems and services, and a lack of referrals from their primary care providers. Moreover, many participants were reluctant to connect their symptoms to the events of 9/11 due to lack of knowledge, the amount of time that had elapsed since 9/11, and the attribution of current health symptoms to the aging process.

CONCLUSIONS: Knowledge of the barriers to 9/11-related health care has led to improvements in the Registry's ability to refer eligible enrollees to appropriate treatment programs. These findings highlight areas for consideration in the implementation of the new federal WTC Health Program, now funded under the James Zadroga 9/11 Health and Compensation Act (PL 111-347), which includes provisions for outreach and education.

Year Published 2013 (6)

Brackbill RM, Stellman SD, Perlman SE, et al. 2013. Mental health of those directly exposed to the World Trade Center disaster: Unmet mental health care need, mental health treatment service use, and quality of life. Soc Sci Med. 81:110–114.

HTTPS://DOI.ORG/10.1016/J.SOCSCIMED.2012.12.016

Mental health service utilization several years following a man-made or natural disaster can be lower than expect-

ed, despite a high prevalence of mental health disorders among those exposed. This study focused on factors associated with subjective unmet mental health care need (UMHCN) and its relationship to a combination of diagnostic history and current mental health symptoms, 5-6 years after the 9-11-01 World Trade Center (WTC) disaster in New York City, USA. Two survey waves of the WTC Health Registry, after exclusions, provided a sample of 36,625 enrollees for this analysis. Important differences were found among enrollees who were categorized according to the presence or absence of a self-reported mental health diagnosis and symptoms indicative of post-traumatic stress disorder or serious psychological distress. Persons with diagnoses and symptoms had the highest levels of UMHCN, poor mental health days, and mental health service use. Those with symptoms only were a vulnerable group much less likely to use mental health services yet reporting UMHCN and poor mental health days. Implications for delivering mental health services include recognizing that many persons with undiagnosed but symptomatic mental health symptoms are not using mental health services, despite having perceived need for mental health care.

Friedman SM, Farfel MR, Maslow CB, et al. 2013. Comorbid persistent lower respiratory symptoms and posttraumatic stress disorder 5-6 years post-9/11 in responders enrolled in the World Trade Center Health Registry. Am J Ind Med. 56 (11):1251–1261.

HTTPS://DOI.ORG/10.1002/AJIM.22217

BACKGROUND: Co-occurrence of lower respiratory symptoms (LRS) and posttraumatic stress disorder (PTSD) has been increasingly recognized among responders and survivors of the World Trade Center (WTC) disaster. Information is limited on the degree which comorbidity intensifies symptoms and compromises quality of life across exposed groups.

METHODS: Among responders who completed the first and second Registry surveys, measures of respiratory illness, psychological distress, and diminished quality of life were compared between responders comorbid for LRS and PTSD and responders with only LRS or PTSD.

RESULTS: Of 14,388 responders, 40% of those with LRS and 57% of those with PTSD were comorbid. When demographic and WTC exposure-related factors were controlled, comorbid responders compared to those with LRS alone were twice as likely to have frequent dyspnea and to have sought care for dyspnea. Compared to responders with PTSD alone, comorbid responders were 2.1 times more likely to report intense re-experiencing of the disaster, 2.5 times more likely to express feelings of significant non-specific psychological distress, and 1.4 times more likely to have received mental health care. Comorbid responders were approximately three times more likely to report only fair or poor general health and more than twice as likely to report being unable to perform usual activities for >/=14 of 30 days before interview.

CONCLUSIONS: Outcomes in comorbid responders were similar to or more severe

than in comorbid survivors. Health care and disaster relief providers must suspect comorbid illness when evaluating responders' respiratory or mental illnesses and consider treatment for both.

Groeger JL, Stellman SD, Kravitt A, et al. 2013. Evacuating damaged and destroyed buildings on 9/11: Behavioral and structural barriers. Prehosp Disaster Med. 28 (6):556–566.

HTTPS://DOI.ORG/10.1017/S1049023X13008996

INTRODUCTION: Evacuation of the World Trade Center (WTC) twin towers and surrounding buildings damaged in the September 11, 2001 attacks provides a unique opportunity to study factors that affect emergency evacuation of high rise buildings. Problem The goal of this study is to understand the extent to which structural and behavioral barriers and limitations of personal mobility affected evacuation by occupants of affected buildings on September 11, 2001.

METHODS: This analysis included 5,023 civilian, adult enrollees within the World Trade Center Health Registry who evacuated the two World Trade Center towers and over 30 other Lower Manhattan buildings that were damaged or destroyed on September 11, 2001. Multinomial logistic regression was used to predict total evacuation time (<30 to </=60 minutes, >1 hour to <2 hours relative to </=30 minutes) in relation to number of infrastructure barriers and number of behavioral barriers, adjusted for demographic and other factors.

RESULTS: A higher percentage of evacuees reported encountering at least one behavioral barrier (84.9%) than reported at least one infrastructure barrier (51.9%). This pattern was consistent in all buildings except WTC 1, the first building attacked, where >90% of evacuees reported encountering both types of barriers. Smoke and poor lighting were the most frequently-reported structural barriers. Extreme crowding, lack of communication with officials, and being surrounded by panicked crowds were the most frequently-reported behavioral barriers. Multivariate analyses showed evacuation time to be independently associated with the number of each type of barrier as well as gender (longer times for women), but not with the floor from which evacuation began. After adjustment, personal mobility impairment was not associated with increased evacuation time.

CONCLUSION: Because most high-rise buildings have unique designs, infrastructure factors tend to be less predictable than behavioral factors, but both need to be considered in developing emergency evacuation plans in order to decrease evacuation time and, consequently, risk of injury and death during an emergency evacuation.

Jordan HT, Stellman SD, Morabia A, et al. 2013. Cardiovascular disease hospitalizations in relation to exposure to the September 11, 2001 World Trade Center disaster and posttraumatic stress disorder. J Am Heart Assoc. 2 (5):e000431.

HTTPS://DOI.ORG/10.1161/JAHA.113.000431

BACKGROUND: A cohort study found that 9/11-related environmental exposures and posttraumatic stress disorder increased

self-reported cardiovascular disease risk. We attempted to replicate these findings using objectively defined cardiovascular disease hospitalizations in the same cohort.

METHODS AND RESULTS: Data for adult World Trade Center Health Registry enrollees residing in New York State on enrollment and no cardiovascular disease history (n = 46,346) were linked to a New York State hospital discharge-reporting system. Follow-up began at Registry enrollment (2003-2004) and ended at the first cerebrovascular or heart disease (HD) hospitalization, death, or December 31, 2010, whichever was earliest. We used proportional hazards models to estimate adjusted hazard ratios (AHRs) for HD (n = 1151) and cerebrovascular disease (n = 284) hospitalization during 302,742 person-years of observation (mean follow-up, 6.5 years per person), accounting for other factors including age, race/ethnicity, smoking, and diabetes. An elevated risk of HD hospitalization was observed among women (AHR 1.32, 95% CI 1.01 to 1.71) but not men (AHR 1.16, 95% CI 0.97 to 1.40) with posttraumatic stress disorder at enrollment. A high overall level of World Trade Center rescue and recovery-related exposure was associated with an elevated HD hospitalization risk in men (AHR 1.82, 95% CI 1.06 to 3.13; P for trend = 0.05), but findings in women were inconclusive (AHR 3.29, 95% CI 0.85 to 12.69; P for trend = 0.09). Similar associations were observed specifically with coronary artery disease hospitalization. Posttraumatic stress disorder increased the cerebrovascular disease hospitalization risk in men but not in women.

CONCLUSIONS: 9/11-related exposures and posttraumatic stress disorder appeared to increase the risk of subsequent hospitalization for HD and cerebrovascular disease. This is consistent with findings based on self-reported outcomes.

Stellman SD and Li J. 2013. Exposure on September 11, 2001, and cancer risk—reply. JAMA. 309 (13):1344.

HTTPS://DOI.ORG/10.1001/JAMA.2013.2249

NO ABSTRACT AVAILABLE

Stellman SD, Thomas PA, S SO, et al. 2013. Respiratory health of 985 children exposed to the World Trade Center disaster: Report on World Trade Center Health Registry wave 2 follow-up, 2007-2008. J Asthma. 50 (4):354–363.

HTTPS://DOI.ORG/10.3109/02770903.2013.776073

BACKGROUND: The World Trade Center (WTC) disaster of September 11, 2001, has been associated with early respiratory problems including asthma in workers, residents, and children. Studies on adults have documented persistence of longer term, 9/11-related respiratory symptoms. There are no comparable reports on children.

METHODS: We surveyed 985 children aged 5-17 years who enrolled in the WTC Health Registry in 2003-04, and who were re-surveyed in 2007-08. Health data were provided by parents in both surveys and focused on respiratory symptoms suggestive of reactive airway impairment (wheezing or the combination of cough and shortness of breath) in the preceding 12 months. At

follow-up, adolescents aged 11-17 years completed separate surveys that screened for post-traumatic stress symptoms and behavior problems (Strengths and Difficulties Questionnaire, SDQ). Associations between respiratory symptoms in the prior 12 months with 9/11 exposures and behavioral outcomes were evaluated with univariate and multivariate methods.

RESULTS: Of the 985 children, 142 (14.4%) children reported respiratory symptoms in the prior 12 months; 105 (73.9%) children with respiratory symptoms had previously been diagnosed with asthma. Among children aged 5-10 years, respiratory symptoms were significantly elevated among African-Americans (adjusted odds ratio, (aOR) 3.8; 95% confidence interval (CI) 1.2-11.5) and those with household income below $75,000 (aOR 1.9; CI 1.0-3.7), and was more than twice as great in children with dust cloud exposure (aOR 2.2; CI 1.2-3.9). Among adolescents aged 11-17 years, respiratory symptoms were significantly associated with household income below $75,000 (aOR 2.4; CI 1.2-4.6), and with a borderline or abnormal SDQ score (aOR 2.7, 95% CI 1.4-5.2). Symptoms were reported more than twice as often by adolescents with vs. without dust cloud exposure (24.8% vs. 11.5%) but the adjusted odds ratio was not statistically significant (aOR 1.7; CI 0.9-3.2).

CONCLUSIONS: Most Registry children exposed to the 9/11 disaster in New York City reported few respiratory problems. Respiratory symptoms were associated with 9/11 exposures in younger children and with behavioral difficulties in adolescents. Our findings support the need for continued surveillance of 9/11 affected children as they reach adolescence and young adulthood, and for awareness of both physical and behavioral difficulties by treating clinicians.

Year Published 2014 (9)

Brackbill RM, Caramanica K, Maliniak M, et al. 2014. Nonfatal injuries 1 week after hurricane sandy--New York City metropolitan area, october 2012. MMWR Morb Mortal Wkly Rep. 63 (42):950–954.

On October 29, 2012, Hurricane Sandy (Sandy) made landfall in densely populated areas of New York, New Jersey, and Connecticut. Flooding affected 51 square miles (132 square kilometers) of New York City (NYC) and resulted in 43 deaths, many caused by drowning in the home, along with numerous storm-related injuries. Thousands of those affected were survivors of the World Trade Center (WTC) disaster of September 11, 2001 (9/11) who had previously enrolled in the WTC Health Registry (Registry) cohort study. To assess Sandy-related injuries and associated risk factors among those who lived in Hurricane Sandy-flooded areas and elsewhere, the NYC Department of Health and Mental Hygiene surveyed 8,870 WTC survivors, who had provided physical and mental health updates 8 to 16 months before Sandy. Approximately 10% of the respondents in flooded areas reported injuries in the first week af-

ter Sandy; nearly 75% of those had more than one injury. Injuries occurred during evacuation and clean-up/repair of damaged or destroyed homes. Hurricane preparation and precautionary messages emphasizing potential for injury hazards during both evacuation and clean-up or repair of damaged residences might help mitigate the occurrence and severity of injury after a hurricane.

Brackbill RM, Cone JE, Farfel MR, et al. 2014. Chronic physical health consequences of being injured during the terrorist attacks on World Trade Center on September 11, 2001. Am J Epidemiol. 179 (9):1076–1085.

HTTPS://DOI.ORG/10.1093/AJE/KWU022

Few studies have focused on injuries from the World Trade Center disaster on September 11, 2001. Severe injury has health consequences, including an increased mortality risk 10 years after injury and the risk of mental health problems, such as posttraumatic stress disorder (PTSD). The World Trade Center Health Registry identified 14,087 persons with none of a selected group of preexisting chronic conditions before 2002 who were present during and soon after the World Trade Center attacks, 1,980 of whom reported sustaining 1 or more types of injury (e.g., a broken bone or burn). Survey data obtained during 2003-2004 and 2006-2007 were used to assess the odds of reporting a diagnosis of chronic conditions (heart disease, respiratory disease, diabetes, cancer) up to 5-6 years after the attacks. Number of injury types and probable PTSD were significantly associated with having any chronic conditions diagnosed in 2002-2007. Persons with multiple injuries and PTSD had a 3-fold higher risk of heart disease than did those with no injury and no PTSD, and persons with multiple injuries and with no PTSD had a 2-fold higher risk of respiratory diseases. The present study shows that injured persons with or without comorbid PTSD have a higher risk of developing chronic diseases. Clinicians should be aware of the heightened risk of chronic heart and respiratory conditions among injured persons.

Caramanica K, Brackbill RM, Liao T, et al. 2014. Comorbidity of 9/11-related PTSD and depression in the World Trade Center Health Registry 10-11 years postdisaster. J Trauma Stress. 27 (6):680–688.

HTTPS://DOI.ORG/10.1002/JTS.21972

Many studies report elevated prevalence of posttraumatic stress disorder (PTSD) and depression among persons exposed to the September 11, 2001 (9/11) disaster compared to those unexposed; few have evaluated long-term PTSD with comorbid depression. We examined prevalence and risk factors for probable PTSD, probable depression, and both conditions 10-11 years post-9/11 among 29,486 World Trade Center Health Registry enrollees who completed surveys at Wave 1 (2003-2004), Wave 2 (2006-2007), and Wave 3 (2011-2012). Enrollees reporting physician diagnosed pre-9/11 PTSD or depression were excluded. PTSD was defined as scoring >/= 44 on the PTSD Checklist and depression as scoring >/= 10 on the 8-item Patient Health Questionnaire. We

examined 4 groups: comorbid PTSD and depression, PTSD only, depression only, and neither. Among enrollees, 15.2% reported symptoms indicative of PTSD at Wave 3, 14.9% of depression, and 10.1% of both. Comorbid PTSD and depression was associated with high 9/11 exposures, low social integration, health-related unemployment, and experiencing >/= 1 traumatic life event post-9/11. Comorbid persons experienced poorer outcomes on all PTSD-related impairment measures, life satisfaction, overall health, and unmet mental health care need compared to those with only a single condition. These findings highlight the importance of ongoing screening and treatment for both conditions, particularly among those at risk for mental health comorbidity.

Ghuman SJ, Brackbill RM, Stellman SD, et al. 2014. Unmet mental health care need 10-11 years after the 9/11 terrorist attacks: 2011-2012 results from the World Trade Center Health Registry. BMC Public Health. 14:491.

HTTPS://DOI.ORG/10.1186/1471-2458-14-491

BACKGROUND: There is little current information about the unmet mental health care need (UMHCN) and reasons for it among those exposed to the World Trade Center (WTC) terrorist attacks. The purpose of this study was to assess the level of UMHCN among symptomatic individuals enrolled in the WTC Health Registry (WTCHR) in 2011-2012, and to analyze the relationship between UMHCN due to attitudinal, cost, and access factors and mental health symptom severity, mental health care utilization, health insurance availability, and social support.

METHODS: The WTCHR is a prospective cohort study of individuals with reported exposure to the 2001 WTC attacks. This study used data from 9,803 adults who completed the 2003-2004 (Wave 1) and 2011-2012 (Wave 3) surveys and had posttraumatic stress disorder (PTSD) or depression in 2011-2012. We estimated logistic regression models relating perceived attitudinal, cost and access barriers to symptom severity, health care utilization, a lack of health insurance, and social support after adjusting for sociodemographic characteristics.

RESULTS: Slightly more than one-third (34.2%) of study participants reported an UMHCN. Symptom severity was a strong predictor of UMHCN due to attitudinal and perceived cost and access reasons. Attitudinal UMHCN was common among those not using mental health services, particularly those with relatively severe mental health symptoms. Cost-related UMHCN was significantly associated with a lack of health insurance but not service usage. Access-related barriers were significantly more common among those who did not use any mental health services. A higher level of social support served as an important buffer against cost and access UMHCN.

CONCLUSIONS: A significant proportion of individuals exposed to the WTC attacks with depression or PTSD 10 years later reported an UMHCN, and individuals with more severe and disabling conditions, those who lacked health insurance, and those with low

levels of social support were particularly vulnerable.

Mann M, Li, Jiehui., Farfel, Mark R., Maslow, Carey B., Osahan, Sukhminder., Stellman, Steven D.. 2014. Adolescent behavior and PTSD 6–7 years after the World Trade Center terrorist attacks of September 11, 2001. Disaster Health. 2 (44624):1–9.

BACKGROUND: Behavioral problems and psychopathologies were reported in children exposed to the World Trade Center (WTC) attacks in New York City within 2–3 y post-disaster. Little is known of subsequent 9/11 related behavioral and emotional problems. We assessed risk factors for behavioral difficulties and probable posttraumatic stress disorder (PTSD) in 489 adolescent enrollees ages 11–18 y of age in the World Trade Center Health Registry cohort using the Strengths and Difficulties Questionnaire (SDQ) and DISC Predictive Scales (DPS), respectively, as reported by the adolescents. Associations between parental PTSD and adolescent PTSD and behavioral problems were studied in a subset of 166 adolescent-parent pairs in which the parent was also a Registry enrollee. Nearly one-fifth (17.4%) of the adolescents, all; of whom were 5–12 y old at the time of the attacks, scored in the abnormal (5.7%) or borderline (11.7%) range of total SDQ. Problems were more frequent in minority, low-income, and single-parent adolescents. Abnormal and borderline SDQ scores were significantly associated with direct WTC exposures and with WTC-related injury or death of a family member. Adolescent PTSD was significantly associated with WTC exposure and with fear of one's own injury or death, and with PTSD in the parent (OR D 5.6; 95% CI 1.1–28.4). This adolescent population should be monitored for persistence or worsening of these problems. Co-occurrence of parent and child mental health symptoms following a disaster may have implications for healthcare practitioners and for disaster response planners.

Miller-Archie SA, Jordan HT, Ruff RR, et al. 2014. Posttraumatic stress disorder and new-onset diabetes among adult survivors of the World Trade Center disaster. Prev Med. 66:34–38.

HTTPS://DOI.ORG/10.1016/J.YPMED.2014.05.016

OBJECTIVE: To explore the temporal relationship between 9/11-related posttraumatic stress disorder (PTSD) and new-onset diabetes in World Trade Center (WTC) survivors up to 11 years after the attack in 2001.

METHODS: Three waves of surveys (conducted from 2003 to 2012) from the WTC Health Registry cohort collected data on physical and mental health status, sociodemographic characteristics, and 9/11-related exposures. Diabetes was defined as self-reported, physician-diagnosed diabetes reported after enrollment. After excluding prevalent cases, there were 36,899 eligible adult enrollees. Logistic regression and generalized multilevel growth models were used to assess the association between PTSD measured at enrollment and subsequent diabetes.

RESULTS: We identified 2143 cases of diabetes. After adjustment, we observed a significant association between PTSD and diabetes in the logistic model [adjusted odds ratio (AOR) 1.28, 95% confidence interval (CI) 1.14-1.44]. Results from the

growth model were similar (AOR 1.37, 95% CI 1.23-1.52).

CONCLUSION: This exploratory study found that PTSD, a common 9/11-related health outcome, was a risk factor for self-reported diabetes. Clinicians treating survivors of both the WTC attacks and other disasters should be aware that diabetes may be a long-term consequence.

Schwarzer R, Bowler RM, and Cone JE. 2014. Social integration buffers stress in New York police after the 9/11 terrorist attack. Anxiety Stress Coping. 27 (1):18–26.

HTTPS://DOI.ORG/10.1080/10615806.2013.806652

Being socially integrated is regarded as a protective factor enabling people to cope with adversity. The stress-buffering effect reflects an interaction between stress and a social coping resource factor on subsequent outcomes. This study, based on 2943 police officers, examines mental health outcomes among officers who responded to the 9/11 terrorist attack on the World Trade Center. The Wave 1 data collection took place between September 2003 and November 2004 with a follow-up study (Wave 2) conducted from November 2006 through December 2007. A moderated mediation model was specified that uses event exposure as a distal predictor, earlier stress response as a mediator, and later stress response as an outcome, and social integration as a moderator of this relationship. The mediation hypothesis was confirmed, and moderation occurred at two stages. First, there was a multiplicative relationship between exposure levels and social integration: The higher the exposure level, the more stress responses occur, but this effect was buffered by a high level of social integration. Second, Wave 1 stress interacted with social integration on Wave 2 stress: The more the police officers were socially integrated, the lower the Wave 2 stress, which happened in a synergistic manner. The findings contribute to the understanding of mediating and moderating mechanisms that result in health outcomes such as posttraumatic stress disorder or resilience.

Welch AE, Caramanica K, Maslow CB, et al. 2014. Frequent binge drinking five to six years after exposure to 9/11: Findings from the World Trade Center Health Registry. Drug Alcohol Depend. 140:1–7.

HTTPS://DOI.ORG/10.1016/J.DRUGALCDEP.2014.04.013

BACKGROUND: Exposure to 9/11 may have considerable long-term impact on health behaviors, including increased alcohol consumption. We examined the association between frequent binge drinking, posttraumatic stress disorder (PTSD), and number of 9/11-specific experiences among World Trade Center Health Registry (Registry) enrollees five-to-six years after 9/11.

METHODS: Participants included 41,284 lower Manhattan residents, workers, passers-by, and rescue/recovery workers aged 18 or older without a pre-9/11 PTSD diagnosis who completed Wave 1 (2003-2004) and Wave 2 (2006-2007) interviews. Frequent binge drinking was defined as consuming five or more drinks on five or more occasions in the prior 30 days at Wave 2. Probable

PTSD was defined as scoring 44 or greater on the PTSD Checklist. 9/11 exposure was measured as the sum of 12 experiences and grouped as none/low (0-1), medium (2-3), high (4-5) and very high (6+).

RESULTS: Frequent binge drinking was significantly associated with increasing 9/11 exposure and PTSD. Those with very high and high exposures had a higher prevalence of frequent binge drinking (13.7% and 9.8%, respectively) than those with medium and low exposures (7.5% and 4.4%, respectively). Upon stratification, very high and high exposures were associated with frequent binge drinking in both the PTSD and no PTSD subgroups.

CONCLUSIONS: Our findings suggest that 9/11 exposure had an impact on frequent binge drinking five-to-six years later among Registry enrollees. Understanding the effects of traumatic exposure on alcohol use is important to identify risk factors for post-disaster alcohol misuse, inform policy, and improve post-disaster psychological and alcohol screening and counseling.

Welch AE, Debchoudhury I, Jordan HT, et al. 2014. Translating research into action: An evaluation of the World Trade Center Health Registry's treatment referral program. Disaster Health. 2 (2):97–105.

HTTPS://DOI.ORG/10.4161/DISH.28219

This manuscript describes the design, implementation and evaluation of the World Trade Center (WTC) Health Registry's Treatment Referral Program (TRP), created to respond to enrollees' self-reported 9/11-related physical and mental health needs and promote the use of WTC-specific health care. In 2009-2011, the TRP conducted personalized outreach, including an individualized educational mailing and telephone follow-up to 7,518 selected enrollees who resided in New York City, did not participate in rescue/recovery work, and reported symptoms of 9/11-related physical conditions or posttraumatic stress disorder (PTSD) on their most recently completed Registry survey. TRP staff spoke with enrollees to address barriers to care and schedule appointments at the WTC Environmental Health Center for those eligible. We assessed three nested outcomes: TRP participation (e.g., contact with TRP staff), scheduling appointments, and keeping scheduled appointments. A total of 1,232 (16.4%) eligible enrollees participated in the TRP; 32% of them scheduled a first-time appointment. We reached 84% of participants who scheduled appointments; 79.4% reported having kept the appointment. Scheduling an appointment, but not keeping it, was associated with self-reported unmet health care need, PTSD, and poor functioning (>/=14 days of poor physical or mental health in the past 30 days) ($P < 0.05$). Neither scheduling nor keeping an appointment was associated with demographic characteristics. Successful outreach to disaster-exposed populations may require a sustained effort that employs a variety of methods in order to encourage and facilitate use of post-disaster services. Findings from this evaluation can inform outreach to the population exposed to 9/11 being conducted by other organizations.

Year Published 2015 (10)

Berger KI, Turetz M, Liu M, et al. 2015. Oscillometry complements spirometry in evaluation of subjects following toxic inhalation. ERJ Open Res. 1 (2)

HTTPS://DOI.ORG/10.1183/23120541.00043-2015

The World Trade Center (WTC) destruction released dust and fumes into the environment. Although many community members developed respiratory symptoms, screening spirometry was usually normal. We hypothesised that forced oscillation testing would identify functional abnormalities undetected by spirometry and that symptom severity would relate to magnitude of abnormalities measured by oscillometry. A symptomatic cohort (n=848) from the Bellevue Hospital WTC Environmental Health Center was evaluated and compared to an asymptomatic cohort (n=475) from the New York City Department of Health WTC Health Registry. Spirometry and oscillometry were performed. Oscillometry measurements included resistance (R5) and frequency dependence of resistance (R5-20). Spirometry was normal for the majority of subjects (73.2% symptomatic versus 87.6% asymptomatic, p<0.0001). In subjects with normal spirometry, R5 and R5-20 were higher in symptomatic versus asymptomatic subjects (median (interquartile range) R5 0.436 (0.206) versus 0.314 (0.129) kPa.L-1.s-1, p<0.001; R5-20 0.075 (0.085) versus 0.004 (0.042) kPa.L-1.s-1, p<0.0001). In symptomatic subjects, R5 and R5-20 increased with increasing severity and frequency of wheeze (p<0.05). Measurement of R5-20 correlated with the presence and severity of symptoms even when spirometry was within normal limits. These findings are in accord with small airway abnormalities as a potential explanation of the respiratory symptoms.

Caramanica K, Brackbill RM, Stellman SD, et al. 2015. Posttraumatic stress disorder after hurricane sandy among persons exposed to the 9/11 disaster. Int J Emerg Ment Health. 17 (1):356–362.

BACKGROUND: Traumatic exposure during a hurricane is associated with adverse mental health conditions post-event. The World Trade Center Health Registry provided a sampling pool for a rapid survey of persons directly affected by Hurricane Sandy in the New York City (NYC) metropolitan area in late October 2012. This study evaluated the relationship between Sandy experiences and Sandy-related posttraumatic stress disorder (PTSD) among individuals previously exposed to the September 11, 2001 (9/11) disaster.

METHODS: A total of 4,558 surveys were completed from April 10-November 7, 2013. After exclusions for missing data, the final sample included 2,214 (53.5%) respondents from FEMA-defined inundation zones and 1,923 (46.5%) from non-inundation zones. Sandy exposures included witnessing terrible events, Sandy-related injury, fearing for own life or safety of others, evacuation, living in a home that

was flooded or damaged, property loss, and financial loss. Sandy-related PTSD was defined as a score of >/=44 on a Sandy-specific PTSD Checklist.

RESULTS: PTSD prevalence was higher in the inundation zones (11.3%) and lower in the non-inundation zones (4.4%). The highest prevalence of Sandy-related PTSD was among individuals in the inundation zone who sustained an injury (31.2%), reported a history of 9/11-related PTSD (28.8%), or had low social support prior to the event (28.6%). In the inundation zones, significantly elevated adjusted odds of Sandy-related PTSD were observed among persons with a prior history of 9/11-related PTSD, low social support, and those who experienced a greater number of Sandy traumatic events.

CONCLUSIONS: Sandy-related stress symptoms indicative of PTSD affected a significant proportion of persons who lived in flooded areas of the NYC metropolitan area. Prior 9/11-related PTSD increased the likelihood of Sandy-related PTSD, while social support was protective. Public health preparation for events similar to Sandy should incorporate outreach and linkages to care for persons with prior disaster-related trauma.

Cone JE, Li J, Kornblith E, et al. 2015. Chronic probable PTSD in police responders in the World Trade Center Health Registry ten to eleven years after 9/11. Am J Ind Med. 58 (5):483–493.

HTTPS://DOI.ORG/10.1002/AJIM.22446

BACKGROUND: Police enrolled in the World Trade Center Health Registry (WTCHR) demonstrated increased probable post-traumatic stress disorder (PTSD) after the terrorist attack of 9/11/2001.

METHODS: Police enrollees without pre-9/11 PTSD were studied. Probable PTSD was assessed by Posttraumatic Stress Check List (PCL). Risk factors for chronic, new onset or resolved PTSD were assessed using multinomial logistic regression.

RESULTS: Half of police with probable PTSD in 2003-2007 continued to have probable PTSD in 2011-2012. Women had higher prevalence of PTSD than men (15.5% vs. 10.3%, P = 0.008). Risk factors for chronic PTSD included decreased social support, unemployment, 2+ life stressors in last 12 months, 2+ life-threatening events since 9/11, 2+ injuries during the 9/11 attacks, and unmet mental health needs.

CONCLUSION: Police responders to the WTC attacks continue to bear a high mental health burden. Improved early access to mental health treatment for police exposed to disasters may be needed.

Fairclough MA, Miller-Archie, S.A., Cone, J.E., et al. 2015. Relationship between persistent posttraumatic stress disorder and human remains exposure for staten island barge and landfill recovery and clean-up workers after 9/11. International Journal of Emergency Mental Health and Human Resilience. 0 (0):661–663.

After the September 11, 2001 World Trade Center (WTC) disaster, recovery and clean-up efforts were concentrated at the WTC site and the Staten Island (SI) Fresh Kills landfill and barges. Research is limited regarding the long-term health effects of human remains exposure dur-

ing clean-up and recovery work at the SI landfill and barges. We studied 1,592 WTC Health Registry enrollees who worked at the SI landfill, loading piers and barges after the 9/11/01 attacks to assess the relationship between human remains exposure and persistent posttraumatic stress disorder (PTSD) 10-11 years later. A dose-response relationship was found between frequency of human remains exposure and persistent PTSD (adjusted odds ratio (AOR): every day (AOR) = 4.77; 95% confidence interval (CI): 2.00-11.52, almost every day (AOR) = 4.35; 95% CI: 1.75-10.80), and some days (AOR) = 2.98; 95% CI: 1.43-6.22). When exposed to human remains, sanitation workers had higher odds of persistent PTSD, compared to firefighters and police. In addition, respondents who scored lower on a social support scale had higher odds of persistent PTSD. The findings highlight the need for strategies to reduce the risk of PTSD associated with exposure to human remains in future disasters.

Gargano LM, Caramanica K, Sisco S, et al. 2015. Exposure to the World Trade Center disaster and 9/11-related post-traumatic stress disorder and household disaster preparedness. Disaster Med Public Health Prep. 9 (6):625–633.

HTTPS://DOI.ORG/10.1017/DMP.2015.71

OBJECTIVE: In a population with prior exposure to the World Trade Center disaster, this study sought to determine the subsequent level of preparedness for a new disaster and how preparedness varied with population characteristics that are both disaster-related and non-disaster-related.

METHODS: The sample included 4496 World Trade Center Health Registry enrollees who completed the Wave 3 (2011-2012) and Hurricane Sandy (2013) surveys. Participants were considered prepared if they reported possessing at least 7 of 8 standard preparedness items. Logistic regression was used to determine associations between preparedness and demographic and medical factors, 9/11-related post-traumatic stress disorder (PTSD) assessed at Wave 3, 9/11 exposure, and social support.

RESULTS: Over one-third (37.5%) of participants were prepared with 18.8% possessing all 8 items. The item most often missing was an evacuation plan (69.8%). Higher levels of social support were associated with being prepared. High levels of 9/11 exposure were associated with being prepared in both the PTSD and non-PTSD subgroups.

CONCLUSIONS: Our findings indicate that prior 9/11 exposure favorably impacted Hurricane Sandy preparedness. Future preparedness messaging should target people with low social support networks. Communications should include information on evacuation zones and where to find information about how to evacuate.

Jordan HT, Stellman SD, Reibman J, et al. 2015. Factors associated with poor control of 9/11-related asthma 10-11 years after the 2001 World Trade Center terrorist attacks. J Asthma. 52 (6):630–637.

HTTPS://DOI.ORG/10.3109/02770903.2014.999083

OBJECTIVE: To identify key factors associated with poor asthma control among adults

in the World Trade Center (WTC) Health Registry, a longitudinal study of rescue/recovery workers and community members who were directly exposed to the 2001 WTC terrorist attacks and their aftermath.

METHODS: We studied incident asthma diagnosed by a physician from 12 September 2001 through 31 December 2003 among participants aged >/=18 on 11 September 2001, as reported on an enrollment (2003-2004) or follow-up questionnaire. Based on modified National Asthma Education and Prevention Program criteria, asthma was considered controlled, poorly-controlled, or very poorly-controlled at the time of a 2011-2012 follow-up questionnaire. Probable post-traumatic stress disorder, depression, and generalized anxiety disorder were defined using validated scales. Self-reported gastroesophageal reflux symptoms (GERS) and obstructive sleep apnea (OSA) were obtained from questionnaire responses. Multinomial logistic regression was used to examine factors associated with poor or very poor asthma control.

RESULTS: Among 2445 participants, 33.7% had poorly-controlled symptoms and 34.6% had very poorly-controlled symptoms in 2011-2012. Accounting for factors including age, education, body mass index, and smoking, there was a dose-response relationship between the number of mental health conditions and poorer asthma control. Participants with three mental health conditions had five times the odds of poor control and 13 times the odds of very poor control compared to participants without mental health comorbidities. GERS and OSA were significantly associated with poor or very poor control.

CONCLUSIONS: Rates of poor asthma control were very high in this group with post-9/11 diagnosed asthma. Comprehensive care of 9/11-related asthma should include management of mental and physical health comorbidities.

Maslow CB, Caramanica K, Welch AE, et al. 2015. Trajectories of scores on a screening instrument for PTSD among World Trade Center rescue, recovery, and clean-up workers. J Trauma Stress. 28 (3):198–205.

HTTPS://DOI.ORG/10.1002/JTS.22011

The longitudinal course of posttraumatic stress disorder (PTSD) over 8-9 years was examined among 16,488 rescue and recovery workers who responded to the events of September 11, 2001 (9/11) at the World Trade Center (WTC; New York, NY), and were enrolled in the World Trade Center Health Registry. Latent class growth analysis identified 5 groups of rescue and recovery workers with similar score trajectories at 3 administrations of the PTSD Checklist (PCL): low-stable (53.3%), moderate- stable (28.7%), moderate-increasing (6.4%), high-decreasing (7.7%), and high-stable (4.0%). Relative to the low-stable group, membership in higher risk groups was associated with 9/11-related exposures including duration of WTC work, with adjusted odds ratios ranging from 1.3 to 2.0, witnessing of horrific events (range = 1.3 to 2.1), being injured (range = 1.4 to 2.3), perceiving threat to life or safety (range = 2.2 to 5.2), bereavement (range = 1.6 to 4.8), and job loss due to 9/11 (range = 2.4 to 15.8).

Within groups, higher PCL scores were associated with adverse social circumstances including lower social support, with B coefficients ranging from 0.2 to 0.6, divorce, separation, or widowhood (range = 0.4-0.7), and unemployment (range = 0.4-0.5). Given baseline, exposure-related, and contextual influences that affect divergent PTSD trajectories, screening for both PTSD and adverse circumstances should occur immediately, and at regular intervals postdisaster.

Welch AE CK, Yip J, Petrsoric LJ and Cone JE. 2015. A qualitative analysis of New York City based primary care and specialty providers' knowledge of 9/11-related health conditions and health care services. Austin Journal of Emergency and Critical Care Medicine. 2 (5):1–7.

INTRODUCTION: More than 10 years after 9/11, thousands of directly exposed persons have myriad disaster-related physical and mental health conditions. Previous studies suggest affected persons may not be utilizing any of the health; programs that were created expressly to address 9/11-related health conditions due, in part, to a lack of referrals from primary care physicians.; ; Aim: To understand providers' knowledge of 9/11-related medical conditions, views on and referrals to 9/11 health programs, and how best to provide educational resources to providers and patients.

METHODS: We conducted semi-structured in-depth individual telephone interviews with 20 New York City based primary care and relevant specialty; providers. The interviews were recorded, transcribed and inductively open coded for thematic analysis.

RESULTS: Providers were fairly knowledgeable about psychiatric and respiratory conditions commonly associated with 9/11, but less so regarding conditions whose relationships to 9/11 are still under investigation. Most; providers considered 9/11 exposure an important part of patients' medical histories, but did not typically screen for exposure, believing patients would self-report exposure or that exposure was no longer relevant. The majority of; providers had positive perceptions of the 9/11 programs, though only some had referred their patients. Providers expressed interest in learning more about 9/11-related health programs and conditions.

CONCLUSION: NYC based medical providers are an under-utilized source of referrals to the 9/11 health programs. Furnishing providers with detailed information on program locations, eligibility requirements, services, and; advantages along with summaries of 9/11 research and patient educational materials may increase provider referrals to the programs.; ;

Welch AE, Jasek JP, Caramanica K, et al. 2015. Cigarette smoking and 9/11-related posttraumatic stress disorder among World Trade Center Health Registry enrollees, 2003-12. Prev Med. 73:94–99.

HTTPS://DOI.ORG/10.1016/J.YPMED.2015.01.023

OBJECTIVE: Numerous studies have observed higher rates of smoking among adults with mental health conditions. We examined posttraumatic stress disorder (PTSD) and smoking over a 7-9year period

among adults with firsthand exposure to the 9/11 attacks enrolled in the World Trade Center Health Registry.

METHOD: Data were collected at three waves: W1 (2003-04), W2 (2006-07), and W3 (2011-12). Enrollees aged >/=25 at W1 and who completed all three waves (n=34,458) were categorized by smoker-type: non-smoker, non-daily (smoked some days in last 30days), light (1-10 cigarettes per day (CPD)), or heavy (11+ CPD). Enrollees who smoked at W1 but not W3 were considered to have quit. PTSD was defined as a score of >/=44 on the PTSD Checklist-Civilian Version.

RESULTS: Smoking declined significantly from W1 (12.6%) to W3 (9.2%). Smoking prevalence was higher among enrollees with PTSD. In multivariable models, odds of quitting were 25-39% lower among heavy, light, and non-daily smokers with PTSD compared to those without.

CONCLUSION: PTSD was associated with reduced odds of quitting regardless of smoker-type. Disaster-exposed smokers with PTSD are likely in need of more supportive services in order to abstain from smoking.

Yu S, Brackbill RM, Stellman SD, et al. 2015. Evaluation of non-response bias in a cohort study of World Trade Center terrorist attack survivors. BMC Res Notes. 8:42.

HTTPS://DOI.ORG/10.1186/S13104-015-0994-2

BACKGROUND: Few longitudinal studies of disaster cohorts have assessed both non-response bias in prevalence estimates of health outcomes and in the estimates of associations between health outcomes and disaster exposures. We examined the factors associated with non-response and the possible non-response bias in prevalence estimates and association estimates in a longitudinal study of World Trade Center (WTC) terrorist attack survivors.

METHODS: In 2003-04, 71,434 enrollees completed the WTC Health Registry wave 1 health survey. This study is limited to 67,670 adults who were eligible for both wave 2 and wave 3 surveys in 2006-07 and 2011-12. We first compared the characteristics between wave 3 participants (wave 3 drop-ins and three-wave participants) and non-participants (wave 3 drop-outs and wave 1 only participants). We then examined potential non-response bias in prevalence estimates and in exposure-outcome association estimates by comparing one-time non-participants (wave 3 drop-ins and drop-outs) at the two follow-up surveys with three-wave participants.

RESULTS: Compared to wave 3 participants, non-participants were younger, more likely to be male, non-White, non-self enrolled, non-rescue or recovery worker, have lower household income, and less than post-graduate education. Enrollees' wave 1 health status had little association with their wave 3 participation. None of the disaster exposure measures measured at wave 1 was associated with wave 3 non-participation. Wave 3 drop-outs and drop-ins (those who participated in only one of the two follow-up surveys) reported somewhat poorer health outcomes than the three-wave participants. For example,

compared to three-wave participants, wave 3 drop-outs had a 1.4 times higher odds of reporting poor or fair health at wave 2 (95% CI 1.3-1.4). However, the associations between disaster exposures and health outcomes were not different significantly among wave 3 drop-outs/drop-ins as compared to three-wave participants.

CONCLUSION: Our results show that, despite a downward bias in prevalence estimates of health outcomes, attrition from the WTC Health Registry follow-up studies does not lead to serious bias in associations between 9/11 disaster exposures and key health outcomes. These findings provide insight into the impact of non-response on associations between disaster exposures and health outcomes reported in longitudinal studies.

Year Published 2016 (16)

Boffetta P, Zeig-Owens R, Wallenstein S, et al. 2016. Cancer in World Trade Center responders: Findings from multiple cohorts and options for future study. Am J Ind Med. 59 (2):96–105.

HTTPS://DOI.ORG/10.1002/AJIM.22555

BACKGROUND: Three longitudinal studies of cancer incidence in varied populations of World Trade Center responders have been conducted.

METHODS: We compared the design and results of the three studies.

RESULTS: Separate analyses of these cohorts revealed excess cancer incidence in responders for all cancers combined and for cancers of the thyroid and prostate. Methodological dissimilarities included recruitment strategies, source of cohort members, demographic characteristics, overlap between cohorts, assessment of WTC and other occupational exposures and confounders, methods and duration of follow-up, approaches for statistical analysis, and latency analyses.

CONCLUSIONS: The presence of three cohorts strengthens the effort of identifying and quantifying the cancer risk; the heterogeneity in design might increase sensitivity to the identification of cancers potentially associated with exposure. The presence and magnitude of an increased cancer risk remains to be fully elucidated. Continued long-term follow up with minimal longitudinal dropout is crucial to achieve this goal.

Bowler RM, Kornblith ES, Li J, et al. 2016. Police officers who responded to 9/11: Comorbidity of PTSD, depression, and anxiety 10-11 years later. Am J Ind Med. 59 (6):425–436.

HTTPS://DOI.ORG/10.1002/AJIM.22588

BACKGROUND: After the 9/11/2001 World Trade Center (WTC) attack, many police-responders developed PTSD and might be vulnerable to develop depression and/or anxiety. Comorbidity of PTSD, depression, and/or anxiety is examined.

METHOD: Police enrollees (N = 1,884) from

the WTC Health Registry were categorized into four groups based on comorbidity of PTSD, depression, and anxiety. DSM-IV diagnostic criteria for PTSD were used. Depression (PHQ-8) and anxiety (GAD-7) were assessed with standardized psychometric inventories. Multinomial logistic regression was used to identify putative risk factors associated with comorbidity of PTSD.

RESULTS: Of 243 (12.9% of total) police with probable PTSD, 21.8% had probable PTSD without comorbidity, 24.7% had depression, 5.8% had anxiety, and 47.7% had comorbid depression and anxiety. Risk factors for comorbid PTSD, depression, and anxiety include being Hispanic, decrease in income, experiencing physical injury on 9/11, experiencing stressful/traumatic events since 9/11, and being unemployed/retired.

CONCLUSION: Nearly half of police with probable PTSD had comorbid depression and anxiety.

Brown S, Gargano LM, Parton H, et al. 2016. Hurricane sandy evacuation among World Trade Center Health Registry enrollees in New York City. Disaster Med Public Health Prep. 10 (3):411–419.

HTTPS://DOI.ORG/10.1017/DMP.2016.57

OBJECTIVE: Timely evacuation is vital for reducing adverse outcomes during disasters. This study examined factors associated with evacuation and evacuation timing during Hurricane Sandy among World Trade Center Health Registry (Registry) enrollees.

METHODS: The study sample included 1162 adults who resided in New York City's evacuation zone A during Hurricane Sandy who completed the Registry's Hurricane Sandy substudy in 2013. Factors assessed included zone awareness, prior evacuation experience, community cohesion, emergency preparedness, and poor physical health. Prevalence estimates and multiple logistic regression models of evacuation at any time and evacuation before Hurricane Sandy were created.

RESULTS: Among respondents who evacuated for Hurricane Sandy (51%), 24% had evacuated before the storm. In adjusted analyses, those more likely to evacuate knew they resided in an evacuation zone, had evacuated during Hurricane Irene, or reported pre-Sandy community cohesion. Evacuation was less likely among those who reported being prepared for an emergency. For evacuation timing, evacuation before Hurricane Sandy was less likely among those with pets and those who reported 14 or more poor physical health days.

CONCLUSIONS: Higher evacuation rates were observed for respondents seemingly more informed and who lived in neighborhoods with greater social capital. Improved disaster messaging that amplifies these factors may increase adherence with evacuation warnings.

Cone JE, Osahan S, Ekenga CC, et al. 2016. Asthma among staten island fresh kills landfill and barge workers following the September 11, 2001 World Trade Center terrorist attacks. Am J Ind Med. 59 (9):795–804.

HTTPS://DOI.ORG/10.1002/AJIM.22645

BACKGROUND: Although airborne respiratory irritants at the World Trade Center (WTC) site have been associated with asthma among WTC Ground Zero workers, little is known about asthma associated with work at the Staten Island landfill or barges.

METHODS: To evaluate the risk of asthma first diagnosed among Staten Island landfill and barge workers, we conducted a survey and multivariable logistic regression analysis regarding the association between Staten Island landfill and barge-related work exposures and the onset of post-9/11 asthma.

RESULTS: Asthma newly diagnosed between September 11, 2001 and December 31, 2004 was reported by 100/1,836 (5.4%) enrollees. Jobs involving sifting, digging, welding, and steel cutting, enrollees with high landfill/barge exposure index scores or who were police and sanitation workers, and enrollees with probable posttraumatic stress disorder all had increased odds ratios for new-onset asthma.

CONCLUSIONS: Post-9/11 asthma cumulative incidence among Staten Island landfill/barge workers was similar to that of other WTC disaster rescue and recovery workers.

Friedman SM, Farfel MR, Maslow C, et al. 2016. Risk factors for and consequences of persistent lower respiratory symptoms among World Trade Center health registrants 10 years after the disaster. Occup Environ Med. 73 (10):676–684.

HTTPS://DOI.ORG/10.1136/OEMED-2015-103512

Wheezing; •Shortness of Breath; More than 12% of 18,913 adult enrollees reported lower respiratory symptoms during the 30 days prior to completing the surveys. Half of those with persistent lower respiratory symptoms screened positive for one or more mental health conditions such as PTSD, depression, or anxiety. Lower respiratory symptoms accompanied by mental health conditions decreased quality of life persistent for at least ten years after 9/11. We recommended that WTC exposed adults continue to be monitored for both respiratory and mental health conditions and treated for both categories of illness.

Gargano LM, Gershon RR, and Brackbill RM. 2016. Quality of life of persons injured on 9/11: Qualitative analysis from the World Trade Center Health Registry. PLoS Curr. 8

HTTP://DOI.ORG/10.1371/CURRENTS.DIS.7C70F-66C1E6C5F41B43C797CB2A04793

INTRODUCTION: A number of studies published by the World Trade Center Health Registry (Registry) document the prevalence of injuries sustained by victims of the World Trade Center Disaster (WTCD) on 9/11. Injury occurrence during or in the immediate aftermath of this event has been shown to be a risk factor for long-term adverse physical and mental health status. More recent reports of ongoing physical health and mental health problems and overall poor quality of life among survivors led us to undertake this qualitative study to explore the long-term impact of having both disaster-related injuries and peri-event traumatic exposure on quality of life in disaster survivors.

METHODS: Semi-structured, in-depth individual telephone interviews were conducted with 33 Registry enrollees who reported being injured on 9/11/01. Topics included: extent and circumstance of the injury(ies), description of medical treatment for injury, current health and functional status, and lifestyle changes resulting from the WTCD. The interviews were recorded, transcribed, and inductively open-coded for thematic analysis.

RESULTS: Six themes emerged with respect to long term recovery and quality of life: concurrent experience of injury with exposure to peri-event traumatic exposure (e.g., witnessing death or destruction, perceived life threat, etc.); sub-optimal quality and timeliness of short- and long-term medical care for the injury reported and mental health care; poor ongoing health status, functional limitations, and disabilities; adverse impact on lifestyle; lack of social support; and adverse economic impact. Many study participants, especially those reporting more serious injuries, also reported self-imposed social isolation, an inability to participate in or take enjoyment from previously enjoyable leisure and social activities and greatly diminished overall quality of life.

DISCUSSION: This study provided unique insight into the long-term impact of disasters on survivors. Long after physical injuries have healed, some injured disaster survivors report having serious health and mental health problems, economic problems due to loss of livelihood, limited sources of social support, and profound social isolation. Strategies for addressing the long-term health problems of disaster survivors are needed in order to support recovery.

Gargano LM, Nguyen A, DiGrande L, et al. 2016. Mental health status of World Trade Center tower survivors compared to other survivors a decade after the September 11, 2001 terrorist attacks. Am J Ind Med. 59 (9):742–751.

HTTPS://DOI.ORG/10.1002/AJIM.22636

BACKGROUND: Studies of individuals directly exposed to the World Trade Center (WTC) terrorist attacks of September 11, 2001 have found increased risk for post-traumatic stress disorder (PTSD) and binge drinking (BD). No long-term studies have been conducted on one highly exposed group, WTC tower evacuees.

METHODS: The study sample included 7,695 adult civilians in the WTC Health Registry. Logistic regression was used to examine the odds of PTSD and BD in 1,946 towers evacuees compared to 5,749 others in nearby buildings or on the street.

RESULTS: WTC tower survivors were at increased risk for PTSD and BD compared to the others. Infrastructure and behavioral barriers experienced during evacuation were significantly associated with PTSD.

CONCLUSIONS: WTC tower evacuees are at increased risk for PTSD and BD. Understanding the effects of disaster-related evacuation barriers on the long-term mental health status of survivors can help in the planning of continuing post-disaster treatment.

Gargano LM, Welch AE, and Stellman SD. 2016. Substance use in adolescents 10 years after the World Trade Center attacks in New York City. Journal of Child & Adolescent Substance Abuse. 26 (1):66–74.

HTTPS://DOI.ORG/10.1080/1067828X.2016.1210551

We examined prevalence of and factors associated with substance use 10 to 11 years post-9/11 among adolescents in the World Trade Center Health Registry. Logistic regression analyses showed that adolescents who witnessed a disturbing event on 9/11 were twice as likely to report ever drinking and almost three times as likely to have ever used marijuana. Among those >=5 years of age on 9/11, fear for personal safety on 9/11 was significantly associated with having ever smoked cigarettes, ever drank, and ever used marijuana. Intervention and education for adolescents particularly focused on substance use and coping strategies may be warranted after large-scale disasters.

Li J, Brackbill RM, Jordan HT, et al. 2016. Effect of asthma and PTSD on persistence and onset of gastroesophageal reflux symptoms among adults exposed to the September 11, 2001, terrorist attacks. Am J Ind Med. 59 (9):805–814.

HTTPS://DOI.ORG/10.1002/AJIM.22644

BACKGROUND: Little is known about the direction of causality among asthma, posttraumatic stress disorder (PTSD), and onset of gastroesophageal reflux symptoms (GERS) after exposure to the 9/11/2001 World Trade Center (WTC) disaster.

METHODS: Using data from the WTC Health Registry, we investigated the effects of early diagnosed post-9/11 asthma and PTSD on the late onset and persistence of GERS using log-binomial regression, and examined whether PTSD mediated the asthma-GERS association using structural equation modeling.

RESULTS: Of 29,406 enrollees, 23% reported GERS at follow-up in 2011-2012. Early post-9/11 asthma and PTSD were each independently associated with both the persistence of GERS that was present at baseline and the development of GERS in persons without a prior history. PTSD mediated the association between early post-9/11 asthma and late-onset GERS.

CONCLUSIONS: Clinicians should assess patients with post-9/11 GERS for comorbid asthma and PTSD, and plan medical care for these conditions in an integrated fashion.

Li J, Brackbill RM, Liao TS, et al. 2016. Ten-year cancer incidence in rescue/recovery workers and civilians exposed to the September 11, 2001 terrorist attacks on the World Trade Center. Am J Ind Med. 59 (9):709–721.

HTTPS://DOI.ORG/10.1002/AJIM.22638

BACKGROUND: Cancer incidence in exposed rescue/recovery workers (RRWs) and civilians (non-RRWs) was previously reported through 2008.

METHODS: We studied occurrence of first primary cancer among World Trade Center Health Registry enrollees through 2011 using adjusted standardized incidence

ratios (SIRs), and the WTC-exposure-cancer association, using Cox proportional hazards models.

RESULTS: All-cancer SIR was 1.11 (95% confidence interval (CI) 1.03-1.20) in RRWs, and 1.08 (95% CI 1.02-1.15) in non-RRWs. Prostate cancer and skin melanoma were significantly elevated in both populations. Thyroid cancer was significantly elevated only in RRWs while breast cancer and non-Hodgkin's lymphoma were significantly elevated only in non-RRWs. There was a significant exposure dose-response for bladder cancer among RRWs, and for skin melanoma among non-RRWs.

CONCLUSIONS: We observed excesses of total and specific cancers in both populations, although the strength of the evidence for causal relationships to WTC exposures is somewhat limited. Continued monitoring of this population is indicated.

Li J, Cone JE, Alt AK, et al. 2016. Performance of self-report to establish cancer diagnoses in disaster responders and survivors, World Trade Center Health Registry, New York, 2001–2007. Public Health Reports. 131 (3):420–429.

OBJECTIVE: Large-scale disasters may disrupt health surveillance systems, depriving health officials and researchers of timely and accurate information needed to assess disaster-related health effects and leading to use of less reliable self-reports of health outcomes. In particular, ascertainment of cancer in a population is ordinarily obtained through linkage of self-reported data with regional cancer registries, but exclusive reliance on these sources following a disaster may result in lengthy delays or loss of critical data. To assess the impact of such reliance, we validated self-reported cancer in a cohort of 59,340 responders and survivors of the World Trade Center disaster against data from 11 state cancer registries (SCRs). Methods. We focused on residents of the 11 states with SCRs and on cancers diagnosed from September 11, 2001, to the date of their last survey participation. Medical records were also sought in a subset of 595 self-reported cancer patients who were not recorded in an SCR.

RESULTS:. Overall sensitivity and specificity of self-reported cancer were 83.9% (95% confidence interval [CI] 81.9, 85.9) and 98.5% (95% CI 98.4, 98.6), respectively. Site-specific sensitivities were highest for pancreatic (90.9%) and testicular (82.4%) cancers and multiple myeloma (84.6%). Compared with enrollees with true-positive reports, enrollees with false-negative reports were more likely to be non-Hispanic black (adjusted odds ratio [aOR] 5 1.8, 95% CI 1.2, 2.9) or Asian (aOR52.2, 95% CI 1.2, 4.1). Among the 595 cases not recorded in an SCR, 13 of 62 (21%) cases confirmed through medical records were reportable to SCRs.

CONCLUSION:. Self-report of cancer had relatively high sensitivity among adults exposed to the World Trade Center disaster, suggesting that self-reports of other disaster-related conditions less amenable to external validation may also be reasonably valid.

Maslow CB, Caramanica K, Li J, et al. 2016. Reproductive outcomes following maternal exposure to the events of September 11, 2001, at the World

Trade Center, in New York City. Am J Public Health. 106 (10):1796–1803.

HTTPS://DOI.ORG/10.2105/AJPH.2016.303303

OBJECTIVES: To estimate associations between exposure to the events of September 11, 2001, (9/11) and low birth weight (LBW), preterm delivery (PD), and small size for gestational age (SGA).

METHODS: We matched birth certificates filed in New York City for singleton births between 9/11 and the end of 2010 to 9/11-related exposure data provided by mothers who were World Trade Center Health Registry enrollees. Generalized estimating equations estimated associations between exposures and LBW, PD, and SGA.

RESULTS: Among 3360 births, 5.8% were LBW, 6.5% were PD, and 9% were SGA. Having incurred at least 2 of 4 exposures, having performed rescue or recovery work, and probable 9/11-related posttraumatic stress disorder 2 to 3 years after 9/11 were associated with PD and LBW during the early study period.

CONCLUSIONS: Disasters on the magnitude of 9/11 may exert effects on reproductive outcomes for several years. Women who are pregnant during and after a disaster should be closely monitored for physical and psychological sequelae.

PUBLIC HEALTH IMPLICATIONS: In utero and maternal disaster exposure may affect birth outcomes. Researchers studying effects of individual disasters should identify commonalities that may inform postdisaster responses to minimize disaster-related adverse birth outcomes.

Richards A, Powell R, Murphy J, et al. 2016. Gridlocked: The impact of adapting survey grids for smartphones. Survey Practice (e-journal. 9 (2):1–14.

Paper and web surveys often include grid-style questions formatted to save space and avoid repetition. However, this format is often discouraged by methodologists because of data quality concerns, particularly when respondents are using small screens (e.g., smartphones). In the fourth wave of the World Trade Center Health Registry survey, we used grids to maintain comparability with prior waves. However, due to the rising number of respondents using smartphones to complete web surveys, we used responsive web design programming to automatically reformat grids into a series of individual items when a small screen device was detected. This method allowed us to retain grids used in previous years yet address the issue of grids displaying poorly on mobile devices. We compared indicators of data quality (e.g., missing data, straight-lining) across grid formats to see whether the smartphone-optimized version suggests poorer, equal, or better data quality than the traditional grid. We also compared consistency with data collected in previous waves of the survey. We found some evidence that the optimized grid format improved data quality, and the benefits we observed may even suggest that some variant of the mobile-optimized format should be considered for all devices, regardless of screen size.

Schwarzer R, Cone JE, Li J, et al. 2016. A

PTSD symptoms trajectory mediates between exposure levels and emotional support in police responders to 9/11: A growth curve analysis. BMC Psychiatry. 0 (201)

HTTPS://DOI.ORG/10.1186/S12888-016-0907-5

BACKGROUND: Exposure to the terrorist attack on the World Trade Center (WTC) on 9/11/2001 resulted in continuing stress experience manifested as Posttraumatic Stress Disorder (PTSD) Symptoms in a minority of the police responders. The WTC Health Registry has followed up a large number of individuals, including police officers, at three waves of data collection from 2003 to 2011. This analysis examines the relationship between initial exposure levels, long-term PTSD symptoms, and subsequent emotional support among police responders.

METHODS: The study population included police responders who had reported their 9/11 exposure levels at Wave 1 (2003/4), provided three waves of data on PTSD symptoms using the 17-item PCL scale, and rated their received emotional support at Wave 3 (N = 2,204, 1,908 men, 296 women, mean age: 38 years at exposure). A second-order growth curve reflected a PTSD symptom trajectory which was embedded in a structural equation model, with exposure level specified as an exogenous predictor, and emotional support specified as an endogenous outcome.

RESULTS: Exposure had a main effect on mean symptom levels (intercept) across three waves but it made no difference in changes in symptoms (slope), and no difference in emotional support. The symptom trajectory, on the other hand, had an effect on emotional support. Its intercept and slope were both related to support, indicating that changes in symptoms affected later emotional support.

CONCLUSIONS: Initial trauma exposure levels can have a long-term effect on mean symptom levels. Emotional support is lower in police responders when PTSD symptoms persist over seven years, but becomes higher when reduction in symptoms occurs.

Welch AE, Caramanica K, Maslow CB, et al. 2016. Trajectories of PTSD among lower manhattan residents and area workers following the 2001 World Trade Center disaster, 2003-2012. J Trauma Stress. 29 (2):158–166.

HTTPS://DOI.ORG/10.1002/JTS.22090

Group-based trajectory modeling was used to explore empirical trajectories of symptoms of posttraumatic stress disorder (PTSD) among 17,062 adult area residents/workers (nonrescue/recovery workers) enrolled in the World Trade Center (WTC) Health Registry using 3 administrations of the PTSD Checklist (PCL) over 9 years of observation. Six trajectories described PTSD over time: low-stable (48.9%), moderate-stable (28.3%), moderate-increasing (8.2%), high-stable (6.0%), high-decreasing (6.6 %), and very high-stable (2.0%). To examine factors associated with improving or worsening PTSD symptoms, groups with similar intercepts, but different trajectories were compared using bivariate analyses and logistic regression. The adjusted odds of being in the moderate-increasing rela-

tive to the moderate-stable group were significantly greater among enrollees reporting low social integration (OR = 2.18), WTC exposures (range = 1.34 to 1.53), job loss related to the September 11, 2001 disaster (OR = 1.41), or unmet mental health need/treatment (OR = 4.37). The odds of being in the high-stable relative to the high-decreasing group were significantly greater among enrollees reporting low social integration (OR = 2.23), WTC exposures (range = 1.39 to 1.45), or unmet mental health need/treatment (OR = 3.42). The influence of severe exposures, scarce personal/financial resources, and treatment barriers on PTSD trajectories suggest a need for early and ongoing PTSD screening postdisaster.

Yu S, Brackbill RM, Locke S, et al. 2016. Impact of 9/11-related chronic conditions and PTSD comorbidity on early retirement and job loss among World Trade Center disaster rescue and recovery workers. Am J Ind Med. 59 (9):731–741.

HTTPS://DOI.ORG/10.1002/AJIM.22640

BACKGROUND: The economic impact of the 9/11 terrorist attacks has rarely been studied. We examined the association between 9/11-related chronic health conditions with or without post-traumatic stress disorder (PTSD) and one important aspect of the economic impact, retirement, and job loss before age 60.

METHODS: A total of 7,662 workers who participated in the World Trade Center Health Registry surveys were studied. Logistic regression models examined the association of 9/11-related health and labor force exit.

RESULTS: Workers with chronic conditions were more likely to experience early retirement and job loss, and the association was stronger in the presence of PTSD comorbidity: the odds ratios for reporting early retirement or job loss were increased considerably when chronic conditions were comorbid with PTSD.

CONCLUSIONS: Disaster-related health burden directly impacts premature labor force exit and income. Future evaluation of disaster outcome should include its long-term impact on labor force.

Year Published 2017 (11)

Alper HE, Yu S, Stellman SD, et al. 2017. Injury, intense dust exposure, and chronic disease among survivors of the World Trade Center terrorist attacks of September 11, 2001. Inj Epidemiol. 4 (1):17.

HTTPS://DOI.ORG/10.1186/S40621-017-0115-X

BACKGROUND: The World Trade Center attack of September 11, 2001 in New York City (9/11) exposed thousands of people to intense concentrations of hazardous materials that have resulted in reports of increased levels of asthma, heart disease, diabetes, and other chronic diseases along with psychological illnesses such as post-traumatic stress disorder (PTSD). Few studies have discriminated between health consequences of immediate (short-term or acute) intense exposures versus chronic residential or workplace exposures.

METHODS: We used proportional hazards methods to determine adjusted hazard ratios (AHRs) for associations between several components of acute exposures (e.g., injury, immersion in the dust cloud) and four chronic disease outcomes: asthma, other non-neoplastic lung diseases, cardiovascular disease, and diabetes, in 8701 persons free of those conditions prior to exposure and who were physically present during or immediately after the World Trade Center attacks. Participants were followed prospectively up to 11 years post-9/11.

RESULTS: Heart disease exhibited a dose-response association with sustaining injury (1 injury type: AHR =2.0, 95% CI (Confidence Interval) 1.1-3.6; 2 injury types: AHR = 3.1, 95% CI 1.2-7.9; 3 or more injury types: AHR = 6.8, 95% CI 2.0-22.6), while asthma and other lung diseases were both significantly associated with dust cloud exposure (AHR = 1.3, 95% CI 1.0-1.6). Diabetes was not associated with any of the predictors assessed in this study.

CONCLUSION: In this study we demonstrated that the acute exposures of injury and dust cloud that were sustained on 9/11/2001 had significant associations with later heart and respiratory diseases. Continued monitoring of 9/11 exposed persons' health by medical providers is warranted for the foreseeable future.

Bowler RM, Adams SW, Gocheva VV, et al. 2017. Posttraumatic stress disorder, gender, and risk factors: World Trade Center tower survivors 10 to 11 years after the September 11, 2001 attacks. J Trauma Stress. 30 (6):564–570.

HTTPS://DOI.ORG/10.1002/JTS.22232

Ten to eleven years after the September 11, 2001 terrorist attacks, probable posttraumatic stress disorder (PTSD) was evaluated in 1,755 World Trade Center (WTC) evacuees based on data from the WTC Health Registry. Characteristics of men and women were compared and factors associated with PTSD symptom severity were examined using the PTSD Checklist (PCL). Compared with men (n = 1,015, 57.8%), women (n = 740, 42.2%) were younger and of lower socioeconomic

status. Ten to eleven years after September 11, 2001, 13.7% of men and 24.1% of women met criteria for PTSD. Results indicated that when considered with all other variables (i.e., demographic, socioeconomic and social resources, exposure to the attacks, life events), gender was not a significant predictor of PTSD symptom severity. Being younger on September 11, 2001, unemployed, less educated, and/or having higher exposure to the attacks, unmet mental health care needs, and less social support predicted higher PCL scores for both genders (betas = .077 to .239). Demographic characteristics and socioeconomic resources (DeltaR(2) = .113) accounted for the largest amount of variance in PCL scores over and above exposure/evacuation, mental healthcare needs, and social support variables (DeltaR(2) = .093 to .102). When trends of unmet mental healthcare needs were analyzed, the most prevalent response for men was that they preferred to manage their own symptoms (15.1%), whereas the most prevalent response for women was that they could not afford to pay for mental health care (14.7%). Although the prevalence of probable PTSD in women tower survivors was approximately twice as high as it was for men, this is attributable largely to demographic and socioeconomic resource factors and not gender alone. Implications for treatment and interventions are discussed.

Gargano LM, Dechen T, Cone JE, et al. 2017. Psychological distress in parents and school-functioning of adolescents: Results from the World Trade Center registry. J Urban Health. 94 (5):597–605.

HTTPS://DOI.ORG/10.1007/S11524-017-0143-4

Poor school-functioning can be indicative of parent and adolescent mental health and adolescent behavior problems. This study examined 472 adolescents enrolled in the World Trade Center (WTC) Health Registry, with a two-step path analysis, using regression-based models, to unravel the relationships between parent and adolescent mental health, adolescent behavior problems, and adolescent unmet healthcare need (UHCN) on the outcome school-functioning. WTC exposure was associated with UHCN and parental mental health was a significant mediator. There was no evidence that family WTC exposure was associated with UHCN independent of its effect on parental mental health. For the second path, after accounting for the effects of adolescent mental health, behavioral problems, and UHCN, there remained a significant association between parental mental health and school-functioning. Interventions for poor school-functioning should have multiple components which address UHCN, mental health, and behavioral problems, as efforts to address any of these alone may not be sufficient.

Gargano LM, Hosakote S, Zhi Q, et al. 2017. Resilience to post-traumatic stress among World Trade Center survivors: A mixed-methods study. J Emerg Manag. 15 (5):275–284.

HTTPS://DOI.ORG/10.5055/JEM.2017.0336

The purpose of this study was to identify individual characteristics, behaviors, and psychosocial factors associated with symptoms of post-traumatic stress disorder (PTSD) among World Trade Center (WTC) disaster evacuation survivors. The study utilized a mixed-method design. In-depth interviews were conducted using a prepared script. PTSD was assessed using the PTSD checklist-civilian (PCL-C; a score >/= 50 indicates probable PTSD). Thematic analysis was conducted to identify factors associated with PTSD. A purposive sample of 29 WTC evacuees was recruited using a multimodal recruitment strategy. Eligibility included: history of evacuation from the WTC (Tower 1 and/or Tower 2) on September 11, 2001, and decisional capacity for informed consent. Five participants had PCL-C scores >/= 50. Thematic analysis identified resiliency factors (protective for PTSD), including leadership, taking action based on "gut" feelings (to evacuate), social support (staying in a group), going on "automatic survival" mode, and previous training on emergency response. Risk factors for PTSD included lack of emergency response training, lack of sense of urgency, poor physical condition, lack of communication skills, lack of direction, peri-event physical injury, peri-event traumatic exposure (horror), and moral injury (guilt and remorse). Several modifiable factors that may confer resilience were identified. In particular, the role of emergency response training in preventing disaster-related mental illness should be explored as a possible strategy for enhancing resilience to disaster events.

Gargano LM, Locke S, and Brackbill RM. 2017. Parent physical and mental health comorbidity and adolescent behavior. International Journal of Emergency Mental Health. 19 (2)

HTTPS://DOI.ORG/10.4172/1522-4821.1000358

The objectives of this study were to ascertain behavioral outcomes 10-11 years after 9/11 in adolescents ages 11-18 years (0-8 years old at the time of 9/11) enrolled in the World Trade Center Health Registry (Registry), and relate these outcomes to their 9/11-exposures and to parent health. Behavioral difficulties among adolescents were assessed using the adolescent-reported Strengths and Difficulties Questionnaire (SDQ). Parental post-traumatic stress disorder (PTSD) was assessed using a 9/11-specific PTSD Checklist-Civilian Version, a cut-off score of 44 or greater was considered probable PTSD. Multivariable logistic regression was used to estimate associations of 9/11-exposure and parental health with abnormal/borderline SDQ scores, adjusting for demographic variables that were significantly associated with the SDQ score in bivariate analyses. Of the 449 adolescents, 12.5% (n=56) had abnormal/borderline SDQ scores. In the multivariable model, adolescents with severe/ moderate 9/11-exposures were 2.4 times more likely to have abnormal/borderline SDQ scores compared to adolescents with mild 9/11-exposures (95% Confidence Interval (CI): 1.1-6.4). Adolescents who had a parent with 9/11-related PTSD and at least one comorbid chronic condition were 4.2 times more likely to have abnormal/borderline SDQ scores compared to adolescents with a parent who had no reported chronic health conditions. Adolescents whose parent reported 14 or more poor mental health days in the preceding 30 days were 3.4 times more likely to have abnormal/borderline SDQ scores (95% CI: 1.2-9.5) The finding that par-

ents' health appears to influence adolescent behavior problems 10-11 years following a disaster may have implications for healthcare practitioners and disaster response planners.

Gargano LM, Thomas PA, and Stellman SD. 2017. Asthma control in adolescents 10 to 11 y after exposure to the World Trade Center disaster. Pediatr Res. 81 (44562):43–50.

HTTPS://DOI.ORG/10.1038/PR.2016.190

BACKGROUND: Little is known about asthma control in adolescents who were exposed to the World Trade Center (WTC) attacks of 11 September 2001 and diagnosed with asthma after 9/11. This report examines asthma and asthma control 10-11 y after 9/11 among exposed adolescents.

METHODS: The WTC Health Registry adolescent Wave 3 survey (2011-2012) collected data on asthma diagnosed by a physician after 11 September 2001, extent of asthma control based on modified National Asthma Education and Prevention Program criteria, probable mental health conditions, and behavior problems. Parents reported healthcare needs and 9/11-exposures. Logistic regression was used to evaluate associations between asthma and level of asthma control and 9/11-exposure, mental health and behavioral problems, and unmet healthcare needs.

RESULTS: Poorly/very poorly controlled asthma was significantly associated with a household income of </=$75,000 (adjusted odds ratio (AOR): 3.0; 95% confidence interval (CI): 1.1-8.8), having unmet healthcare needs (AOR: 6.2; 95% CI: 1.4-27.1), and screening positive for at least one mental health condition (AOR: 5.0; 95% CI: 1.4-17.7), but not with behavioral problems. The impact of having at least one mental health condition on the level of asthma control was substantially greater in females than in males.

CONCLUSIONS: Comprehensive care of post-9/11 asthma in adolescents should include management of mental health-related comorbidities.

Jordan HT, Friedman SM, Reibman J, et al. 2017. Risk factors for persistence of lower respiratory symptoms among community members exposed to the 2001 World Trade Center terrorist attacks. Occup Environ Med. 74 (6):449–455.

HTTPS://DOI.ORG/10.1136/OEMED-2016-104157

OBJECTIVES: We studied the course of lower respiratory symptoms (LRS; cough, wheeze or dyspnoea) among community members exposed to the 9/11/2001 World Trade Center (WTC) attacks during a period of 12-13 years following the attacks, and evaluated risk factors for LRS persistence, including peripheral airway dysfunction and post-traumatic stress disorder (PTSD).

METHODS: Non-smoking adult participants in a case-control study of post-9/11-onset LRS (exam 1, 2008-2010) were recruited for follow-up (exam 2, 2013-2014). Peripheral airway function was assessed with impulse oscillometry measures of R5 and R5-20. Probable PTSD was a PTSD checklist score >/=44 on a 2006-2007 questionnaire.

RESULTS: Of 785 exam 1 participants, 545 (69%) completed exam 2. Most (321, 59%)

were asymptomatic at all assessments. Among 192 participants with initial LRS, symptoms resolved for 110 (57%) by exam 2, 55 (29%) had persistent LRS and 27 (14%) had other patterns. The proportion with normal spirometry increased from 65% at exam 1 to 85% at exam 2 in the persistent LRS group ($p<0.01$) and was stable among asymptomatic participants and those with resolved LRS. By exam 2, spirometry results did not differ across symptom groups; however, R5 and R5-20 abnormalities were more common among participants with persistent LRS (56% and 46%, respectively) than among participants with resolved LRS (30%, $p<0.01$; 27%, $p=0.03$) or asymptomatic participants (20%, $p<0.001$; 8.2%, $p<0.001$). PTSD, R5 at exam 1, and R5-20 at exam 1 were each independently associated with persistent LRS.

CONCLUSIONS: Peripheral airway dysfunction and PTSD may contribute to LRS persistence. Assessment of peripheral airway function detected pulmonary damage not evident on spirometry. Mental and physical healthcare for survivors of complex environmental disasters should be coordinated carefully.

Miller-Archie SA, Jordan HT, Alper H, et al. 2017. Hospitalizations for asthma among adults exposed to the September 11, 2001 World Trade Center terrorist attack. J Asthma. 55 (4):0.

HTTPS://DOI.ORG/10.1080/02770903.2017.1337787

OBJECTIVE: We described patterns of asthma hospitalization among persons exposed to the 2001 World Trade Center (WTC) attacks, and assessed whether 9/11-related exposures or comorbidities, including posttraumatic stress disorder (PTSD) and gastroesophageal reflux symptoms (GERS), were associated with an increased rate of hospitalization.

METHODS: Data for adult enrollees in the WTC Health Registry, a prospective cohort study, with self-reported physician-diagnosed asthma who resided in New York State on 9/11 were linked to administrative hospitalization data to identify asthma hospitalizations during September 11, 2001-December 31, 2010. Multivariable zero-inflated Poisson regression was used to examine associations between 9/11 exposures, comorbid conditions, and asthma hospitalizations.

RESULTS: Of 11 471 enrollees with asthma, 406 (3.5%) had >1 asthma hospitalization during the study period (721 total hospitalizations). Among enrollees diagnosed before 9/11 (n = 6319), those with PTSD or GERS had over twice the rate of hospitalization (adjusted rate ratio (ARR) = 2.5, 95% CI = 1.4-4.1; ARR = 2.1, 95% CI = 1.3-3.2, respectively) compared to those without. This association was not statistically significant in enrollees diagnosed after 9/11. Compared to higher educational attainment, completing less than college was associated with an increased hospitalization rate among participants with both pre-9/11- and post-9/11-onset asthma (ARR = 1.9, 95% CI = 1.2-2.9; ARR = 2.6, 95% CI = 1.6-4.1, respectively). Sinus symptoms, exposure to the dust cloud, and having been a WTC responder were not associated with asthma hospitalization.

CONCLUSIONS: Among enrollees with pre-9/11 asthma, comorbid PTSD and GERS were associated with an increase in asthma hospitalizations. Management of these comorbidities may be an important factor in preventing hospitalization.

Stein CR, Lee DJ, Flamme GA, et al. 2017. Persistent post-9/11 hearing problems among World Trade Center Health Registry rescue and recovery workers, 2001 to 2007. J Occup Environ Med. 59 (12):1229–1234.

HTTPS://DOI.ORG/10.1097/JOM.0000000000001171

OBJECTIVE: To examine the association between 9/11-related exposures and self-reported hearing problems among 16,579 rescue/recovery workers in the World Trade Center (WTC) Health Registry.

METHODS: Using Registry Waves 1 (2003 to 2004) and 2 (2006 to 2007), we modeled the association between two metrics of 9/11-related exposures and hearing difficulties.

RESULTS: The prevalence of incident, persistent hearing problems was 4.4%. In a fully adjusted model, workers with higher environmental hazards scores were twice as likely (interquartile range OR 2.1; 95% confidence interval [CI] 1.8, 2.5) to report hearing problems. Based on the same fully adjusted model, workers unable to hear in the dust cloud were 2.3 (95% CI 1.8, 3.0) times more likely to report hearing problems as compared with workers not in the dust cloud.

CONCLUSIONS: We observed a consistent association between WTC-related exposures and self-reported hearing problems among rescue/recovery workers.

Welch AE, Caramanica Zweig K, McAteer JM, et al. 2017. Intensity of binge drinking a decade after the September 11th terror attacks among exposed individuals. Am J Prev Med. 52 (2):192–198.

HTTPS://DOI.ORG/10.1016/J.AMEPRE.2016.10.034

INTRODUCTION: The 9/11 terrorist attacks on the World Trade Center resulted in elevated post-traumatic stress disorder (PTSD) and alcohol use among exposed individuals. The relationship among traumatic exposure, PTSD, and excessive drinking is well documented; however, little is known about these relationships in the long term. This study examines factors increasing binge drinking risk among exposed individuals a decade post-9/11.

METHODS: In 2015-2016, data were analyzed from 28,592 World Trade Center Health Registry enrollees aged >/=18 years who completed the Wave 3 (2011-2012) survey. Women comprised 38.9% of participants. Binge drinking in the last 30 days was categorized as low (men, five to seven drinks; women, four to six drinks) or high intensity (men, eight or more drinks; women, seven or more drinks). Probable 9/11-related PTSD was defined as scoring >/=44 on the PTSD Checklist. Exposures to 9/11 (e.g., witnessing horror, sustaining an injury) were categorized as none/low (zero to two) or high (three or more).

RESULTS: Binge drinking was reported by 24.7% of participants, of whom 36.9% reported high-intensity binge drinking. Compared with non-binge drinkers, the odds of low- and high-intensity binge drinking were greater among enrollees who were male, aged 18-34 years, non-His-

panic white, had income >$75,000, were rescue/recovery workers, had high 9/11 exposure, or 9/11-related PTSD.

CONCLUSIONS: The observed associations among traumatic exposure, PTSD, and excessive drinking underscore the need for improved therapies addressing excessive drinking and PTSD concurrently, inclusion of repeated post-event screening for excessive drinking, and evidence-based population-level interventions to reduce alcohol consumption.

Yu S, Alper HE, Nguyen AM, et al. 2017. The effectiveness of a monetary incentive offer on survey response rates and response completeness in a longitudinal study. BMC Med Res Methodol. 17 (1):77.

HTTPS://DOI.ORG/10.1186/S12874-017-0353-1

BACKGROUND: Achieving adequate response rates is an ongoing challenge for longitudinal studies. The World Trade Center Health Registry is a longitudinal health study that periodically surveys a cohort of ~71,000 people exposed to the 9/11 terrorist attacks in New York City. Since Wave 1, the Registry has conducted three follow-up surveys (Waves 2-4) every 3-4 years and utilized various strategies to increase survey participation. A promised monetary incentive was offered for the first time to survey non-respondents in the recent Wave 4 survey, conducted 13-14 years after 9/11.

METHODS: We evaluated the effectiveness of a monetary incentive in improving the response rate five months after survey launch, and assessed whether or not response completeness was compromised due to incentive use. The study compared the likelihood of returning a survey for those who received an incentive offer to those who did not, using logistic regression models. Among those who returned surveys, we also examined whether those receiving an incentive notification had higher rate of response completeness than those who did not, using negative binomial regression models and logistic regression models.

RESULTS: We found that a $10 monetary incentive offer was effective in increasing Wave 4 response rates. Specifically, the $10 incentive offer was useful in encouraging initially reluctant participants to respond to the survey. The likelihood of returning a survey increased by 30% for those who received an incentive offer (AOR = 1.3, 95% CI: 1.1, 1.4), and the incentive increased the number of returned surveys by 18%. Moreover, our results did not reveal any significant differences on response completeness between those who received an incentive offer and those who did not.

CONCLUSIONS: In the face of the growing challenge of maintaining a high response rate for the World Trade Center Health Registry follow-up surveys, this study showed the value of offering a monetary incentive as an additional refusal conversion strategy. Our findings also suggest that an incentive offer could be particularly useful near the end of data collection period when an immediate boost in response rate is needed.

Year Published 2018 (14)

Gargano LM, Locke S, Jordan HT, et al. 2018. Lower respiratory symptoms associated with environmental and reconstruction exposures after hurricane sandy. Disaster Med Public Health Prep. 12 (6):697–702.

HTTPS://DOI.ORG/10.1017/DMP.2017.140

OBJECTIVE: In a population with prior exposure to the World Trade Center (WTC) disaster, this study sought to determine the relationship between Hurricane Sandy-related inhalation exposures and post-Sandy lower respiratory symptoms (LRS).

METHODS: Participants included 3835 WTC Health Registry enrollees who completed Wave 3 (2011-2012) and Hurricane Sandy (2013) surveys. The Sandy-related inhalational exposures examined were: (1) reconstruction exposure; (2) mold or damp environment exposure; and (3) other respiratory irritants exposure. LRS were defined as wheezing, persistent cough, or shortness of breath reported on >/=1 of the 30 days preceding survey completion. Associations between LRS and Sandy exposures, controlling for socio-demographic factors, post-traumatic stress disorder, and previously reported LRS and asthma were examined using multiple logistic regression.

RESULTS: Over one-third of participants (34.4%) reported post-Sandy LRS. Each of the individual exposures was also independently associated with post-Sandy LRS, each having approximately twice the odds of having post-Sandy LRS. We found a dose-response relationship between the number of types of Sandy-related exposures reported and post-Sandy LRS.

CONCLUSIONS: This study provides evidence that post-hurricane clean-up and reconstruction exposures can increase the risk for LRS. Public health interventions should emphasize the importance of safe remediation practices and recommend use of personal protective equipment. (Disaster Med Public Health Preparedness. 2018;12:697-702).

Gargano LM, Locke S, Li J, et al. 2018. Behavior problems in adolescence and subsequent mental health in early adulthood: Results from the World Trade Center Health Registry cohort. Pediatr Res. 84 (2):205–209.

HTTPS://DOI.ORG/10.1038/S41390-018-0050-8

BACKGROUND: The present study examined the association between 9/11-related adolescent behavioral problems on mental health outcomes in early adulthood.

METHODS: Data from enrollees of the World Trade Center Health Registry, who completed at least one adolescent (2006-2007 or 2011-2012) and adult survey (2011-2012 or 2015-2016), were analyzed. Adolescent behavioral difficulties were assessed using the adolescent-reported Strengths and Difficulties Questionnaire (SDQ). Adult mental health outcomes included binge drinking, smoking status history,

9/11-related post-traumatic stress disorder (PTSD), depression, and the self-reported number of physician mental health diagnoses. Multivariable regression was used to estimate associations of SDQ scores with mental health outcomes.

RESULTS: Of the 297 enrollees, 16.8% (n = 50) had abnormal/borderline SDQ scores as an adolescent. Binge drinking was not associated with adolescent SDQ scores. Enrollees with abnormal/borderline SDQ scores as an adolescent were more likely to be a consistent smoker (odds ratio (OR): 5.6, 95% confidence interval (CI): 1.2-25.2), have probable PTSD (OR: 3.5, 95% CI: 1.3-9.8), depression (OR: 6.2, 95% CI: 2.7-13.9), and to have two or more self-reported physician-diagnosed mental health conditions as an adult (OR 5.6, 95% CI: 2.0-12.5).

CONCLUSIONS: The findings of this study underscore the need to intervene early with children exposed to traumatic events so as to avert later adolescent and adult problem behaviors.

Gargano LM, Mantilla K, Fairclough M, et al. 2018. Review of non-respiratory, non-cancer physical health conditions from exposure to the World Trade Center disaster. Int J Environ Res Public Health. 15 (2)

HTTPS://DOI.ORG/10.3390/IJERPH15020253

After the World Trade Center attacks on 11 September 2001 (9/11), multiple cohorts were developed to monitor the health outcomes of exposure. Respiratory and cancer effects have been covered at length. This current study sought to review the literature on other physical conditions associated with 9/11-exposure. Researchers searched seven databases for literature published in English from 2002 to October 2017, coded, and included articles for health condition outcome, population, 9/11-exposures, and comorbidity. Of the 322 titles and abstracts screened, 30 studies met inclusion criteria, and of these, 28 were from three cohorts: the World Trade Center Health Registry, Fire Department of New York, and World Trade Center Health Consortium. Most studies focused on rescue and recovery workers. While many of the findings were consistent across different populations and supported by objective measures, some of the less studied conditions need additional research to substantiate current findings. In the 16 years after 9/11, longitudinal cohorts have been essential in investigating the health consequences of 9/11-exposure. Longitudinal studies will be vital in furthering our understanding of these emerging conditions, as well as treatment effectiveness.

Gershon RR, Zhi Q, Chin AF, et al. 2018. Adherence to emergency public health measures for bioevents: Review of us studies. Disaster Medicine and Public Health Preparedness. 12 (4):528–535.

HTTPS://DOI.ORG/10.1017/DMP.2017.96

The frequency of bioevents is increasing worldwide. In the United States, as elsewhere, control of contagion may require the cooperation of community members with emergency public health measures. The US general public is largely unfamiliar with these measures, and our under-

standing of factors that influence behaviors in this context is limited. The few previous reviews of research on this topic focused on non-US samples. For this review, we examined published research on the psychosocial influences of adherence in US sample populations. Of 153 articles identified, only 9 met the inclusion criteria. Adherence behaviors were categorized into 2 groups: self-protective behaviors (personal hygiene, social distancing, face mask use, seeking out health care advice, and vaccination) and protecting others (isolation, temperature screening, and quarantine). A lack of uniformity across studies regarding definitions and measures was noted. Only 5 of the 9 articles reported tests of association between adherence with emergency measures and psychosocial factors; perceived risk and perceived seriousness were found to be significantly associated with adherence or adherence intentions. Although it is well documented that psychosocial factors are important predictors of protective health behaviors in general, this has not been rigorously studied in the context of bioevents. .

Hirst A, Miller-Archie SA, Welch AE, et al. 2018. Post-9/11 drug- and alcohol- related hospitalizations among World Trade Center Health Registry enrollees, 2003-2010. Drug Alcohol Depend. 187:55–60. ***HTTPS://DOI.ORG/10.1016/J.DRUGALCDEP.2018.01.028***

OBJECTIVE: To describe patterns of drug- and alcohol-related hospitalizations among persons exposed to the 2001 World Trade Center (WTC) terrorist attacks and to assess whether 9/11-related exposures or post-9/11 post-traumatic stress disorder (PTSD) were associated with increased odds of hospitalization.

METHODS: Data for adult enrollees in the WTC Health Registry, a prospective cohort study, were linked to New York State (NYS) administrative hospitalization data to identify alcohol- and drug-related hospitalizations from enrollment to December 31, 2010. Logistic regression was used to analyze the associations between substance use-related hospitalization, 9/11-related exposure and PTSD.

RESULTS: Of 41,176 NYS resident enrollees, we identified 626 (1.5%) who had at least one alcohol- or drug-related hospitalization; 53.4% (n=591) of these hospitalizations were for alcohol only diagnoses and 46.6% (n=515) were drug-related. Witnessing >/=3 traumatic events on 9/11 was significantly associated with having a drug-related hospitalization (AOR 1.4, 95% CI=[1.1, 1.9]). PTSD was significantly associated with both having a drug-related hospitalization as well as an alcohol only-related hospitalization. (AOR 2.6, 95% CI=[2.0, 3.3], AOR 1.8, 95% CI=[1.4, 2.3], respectively).

CONCLUSIONS: Witnessing traumatic events and having PTSD were independently associated with substance use-related hospitalizations. Targeting people who witnessed traumatic events on 9/11 and/or who have PTSD for substance use- treatment could reduce alcohol and drug-related hospitalizations connected to 9/11.

Jacobson MH, Norman C, Nguyen A, et al. 2018. Longitudinal determinants of depression among World Trade Center Health Registry enrollees, 14–15 years after the 9/11 attacks. Journal of Affective Disorders. 229:483–490.

HTTPS://DOI.ORG/10.1016/J.JAD.2017.12.105

BACKGROUND: Exposure to the September 11, 2001 (9/11) terrorist attacks has been found to be associated with posttraumatic stress disorder (PTSD) and comorbid PTSD and depression up to 10-11 years post-disaster. However, little is known about the longitudinal predictors of mental health conditions over time.

METHODS: We examined longitudinal determinants of depression within strata of PTSD among 21,258 enrollees of the World Trade Center Health Registry who completed four questionnaires over 14 years of follow-up (Wave 1 in 2003-04; Wave 2 in 2005-06; Wave 3 in 2011-12; and Wave 4 in 2015-16). PTSD status was measured using the PTSD checklist on all four waves and defined as a score of >/= 44; depression was assessed using the 8-item Patient Health Questionnaire at Waves 3 and 4 and defined as a score of >/= 10.

RESULTS: Across Waves 3 and 4, 18.6% experienced depression, and it was more common among those who ever had PTSD (56.1%) compared with those who had not (5.6%). Across PTSD strata, predictors of depression included low income, unemployment, low social integration and support, post-9/11 traumatic life events, and chronic physical illness. These factors also decreased the likelihood of recovering from depression. LIMITATIONS: Depression symptoms were not measured at Waves 1 and 2; data was self-reported.

CONCLUSIONS: These findings highlight the substantial burden of depression in a trauma-exposed population 14-15 years post-disaster, especially among those with PTSD. Similar life stressors predicted the course of depression among those with and without PTSD which may inform public health and clinical interventions.

Jordan HT, Stein CR, Li J, et al. 2018. Mortality among rescue and recovery workers and community members exposed to the September 11, 2001 World Trade Center terrorist attacks, 2003–2014. Environmental Research. 163:270–279.

HTTPS://DOI.ORG/10.1016/J.ENVRES.2018.01.004

BACKGROUND: Multiple chronic health conditions have been associated with exposure to the September 11, 2001 World Trade Center (WTC) terrorist attacks (9/11). We assessed whether excess deaths occurred during 2003-2014 among persons directly exposed to 9/11, and examined associations of 9/11-related exposures with mortality risk.

MATERIALS AND METHODS: Deaths occurring in 2003-2014 among members of the World Trade Center Health Registry, a cohort of rescue/recovery workers and lower Manhattan community members who were exposed to 9/11, were identified via linkage to the National Death Index. Participants' overall levels of 9/11-related exposure were categorized as high, intermediate, or low. We calculated standardized mortality

ratios (SMR) using New York City reference rates from 2003 to 2012. Proportional hazards were used to assess associations of 9/11-related exposures with mortality, accounting for age, sex, race/ethnicity and other potential confounders.

RESULTS: We identified 877 deaths among 29,280 rescue/recovery workers (3.0%) and 1694 deaths among 39,643 community members (4.3%) during 308,340 and 416,448 person-years of observation, respectively. The SMR for all causes of death was 0.69 [95% confidence interval (CI) 0.65-0.74] for rescue/recovery workers and 0.86 (95% CI 0.82-0.90) for community members. SMRs for diseases of the cardiovascular and respiratory systems were significantly lower than expected in both groups. SMRs for several other causes of death were significantly elevated, including suicide among rescue recovery workers (SMR 1.82, 95% CI 1.35-2.39), and brain malignancies (SMR 2.25, 95% CI 1.48-3.28) and non-Hodgkin's lymphoma (SMR 1.79, 95% CI 1.24-2.50) among community members. Compared to low exposure, both intermediate [adjusted hazard ratio (AHR) 1.36, 95% CI 1.10-1.67] and high (AHR 1.41, 95% CI 1.06-1.88) levels of 9/11-related exposure were significantly associated with all-cause mortality among rescue/recovery workers (p-value for trend 0.01). For community members, intermediate (AHR 1.13, 95% CI 1.01-1.27), but not high (AHR 1.14, 95% CI 0.94-1.39) exposure was significantly associated with all-cause mortality (p-value for trend 0.03). AHRs for associations of overall 9/11-related exposure with heart disease- and cancer-related mortality were similar in magnitude to those for all-cause mortality, but with 95% CIs crossing the null value.

CONCLUSIONS: Overall mortality was not elevated. Among specific causes of death that were significantly elevated, suicide among rescue/recovery workers is a plausible long-term consequence of 9/11 exposure, and is potentially preventable. Elevated mortality due to other causes, including non-Hodgkin's lymphoma and brain cancer, and small but statistically significant associations of 9/11-related exposures with all-cause mortality hazard warrant additional surveillance.

Li J, Alper HE, Gargano LM, et al. 2018. Re-experiencing 9/11-related PTSD symptoms following exposure to hurricane sandy. Int J Emerg Ment Health. 20 (3)

HTTPS://DOI.ORG/10.4172/1522-4821.1000404

Registry Outputs

BACKGROUND: Understanding Pre-Existing Posttraumatic Stress Disorder (PTSD) symptoms and risk of PTSD following Hurricane Sandy (Sandy) has important implications for PTSD screening of persons exposed to multiple traumas. This study assessed the association between Sandy exposure and a subset of PTSD symptoms related to re-experiencing trauma from the events of the September 11, 2001 (9/11).

METHODS: We studied 4,220 respondents from a random 8,870 person sample of adult World Trade Center Health Registry enrollees who completed a post-Sandy survey between March 28 and November 7, 2013. The symptom cluster of re-experiencing 9/11 was defined using 3 out of 5 questions in the intrusion domain of the PTSD Checklist. Multivariable logistic regression,

adjusting for socio-demographics, social support and any post-9/11 life threatening events prior to Sandy, was performed separately in those symptomatic and non-symptomatic of re-experiencing 9/11 prior to Sandy.

RESULTS: A total of 688 enrollees (16.3%) reported re-experiencing 9/11 symptoms after Sandy (58.8% in those symptomatic prior to Sandy, and 8.7% in those non-symptomatic). A significant association between Sandy exposure and re-experiencing 9/11 was observed only among those non symptomatic prior to Sandy (adjusted odds ratio (AOR)=1.7, 95% confidence interval=1.2-2.3 for moderate Sandy exposure; AOR=2.8, 2.0-4.0 for high Sandy exposure).

CONCLUSIONS: Individuals with a history of trauma should be considered for early screening and counseling for mental health after a subsequent traumatic event, regardless of PTSD status, especially in 9/11 exposed populations.

Li J, Zweig KC, Brackbill RM, et al. 2018. Comorbidity amplifies the effects of post-9/11 posttraumatic stress disorder trajectories on health-related quality of life. Qual Life Res. 27 (3):651–660.

HTTPS://DOI.ORG/10.1007/S11136-017-1764-5

PURPOSE: The present study aims to examine the impact of physical and mental health comorbidities on the association between post-9/11 posttraumatic stress disorder (PTSD) trajectories over 10 years and health-related quality of life (HRQOL) among 9/11-exposed persons.

METHODS: 30,002 responding adult World Trade Center Health Registry enrollees reporting no pre-9/11 PTSD were studied. PTSD trajectories (chronic, delayed, remitted, no PTSD) were defined based on a 17-item PTSD Checklist-Specific to 9/11 across three waves of survey data. Three indicators of poor HRQOL were defined based on CDC HRQOL-4 measures. We computed age-adjusted prevalence of physical and mental health comorbidity (depression/anxiety) by PTSD trajectory and used modified Poisson regression to assess the effect of PTSD trajectory on poor HRQOL prevalence, accounting for comorbidity.

RESULTS: Age-adjusted prevalence of overall comorbid conditions was 95.8 and 61.4% among the chronic and no-PTSD groups, respectively. Associations between 9/11-related PTSD trajectories and poor HRQOL were significant and became greater when comorbidity was included. Adjusted prevalence ratios were elevated for fair/poor health status (APR 7.3, 95% CI 6.5, 8.2), >/= 14 unhealthy days (4.7; 95% CI 4.4, 5.1), and >/= 14 activity limitation days during the last 30 days (9.6; 95% CI 8.1, 11.4) in the chronic PTSD group with physical and mental health comorbidity compared to those without PTSD and comorbidity; similar associations were observed for delayed PTSD.

CONCLUSIONS: Ten years post-9/11 physical and mental health comorbidities have a

substantial impact on the PTSD trajectories and HRQOL association. The need for early identification and treatment of PTSD and comorbidity should be emphasized to potentially improve HRQOL.

Osahan SS. 2018. Sampling strategies for overlapping eligibility groups in the World Trade Center Health Registry. Model Assisted Statistics and Applications. 13 (2):133–140.

HTTPS://DOI.ORG/10.3233/MAS-180425

Sub-studies addressing specific research questions may necessitate selecting a random sample from different eligibility groups of The World Trade Center Health Registry (WTCHR) for estimating population parameter mean. In such a situation, Singh (1988) and Osahan (1997) proposed three two-stage sampling strategies in overlapping clusters. These sampling strategies are compared using WTCHR's overlapping eligibility groups, in terms of their bias and efficiency.

Petrsoric L, Miller-Archie SA, Welch A, et al. 2018. Considerations for future disaster registries: Effectiveness of treatment referral outreach in addressing long-term unmet 9/11 disaster needs. Disaster Prevention and Management: An International Journal. 27 (3):321–333.

HTTPS://DOI.ORG/10.1108/DPM-01-2018-0026

PURPOSE: The purpose of this paper is to evaluate the effectiveness of a targeted outreach program that referred World Trade Center Health Registry (Registry) enrollees, to specific post-disaster health care available through the World Trade Center Health Program (WTCHP) and evaluate differences in outreach effectiveness based on demographic and health characteristics.

DESIGN/METHODOLOGY/APPROACH: The Registry's Treatment Referral Program (TRP) targeted 22,981 enrollees based on symptoms and conditions known to be related to 9/11, reported on a 2011-2012 follow-up survey. A call vendor was utilized for the initial outreach phone call. Enrollees who requested a WTCHP application had follow-up from TRP staff, which typically included 4-6 interactions per enrollee until outreach was completed.

FINDINGS: As of 12/31/2015, the vendor had reached 8,778 (38 percent) of the targeted sample. TRP staff spoke to 6,016 (68 percent) enrollees reached by the vendor, 5,554 (92 percent) of whom requested a WTCHP application, and 2,425 (43 percent) reported having submitted the WTCHP application. Application requests and submissions differed by survivor or responder status, race, income and health symptoms.

ORIGINALITY/VALUE: Registries created for surveillance and research among disaster-exposed populations provide a unique and effective outreach approach. A dedicated treatment referral unit within a disaster registry is an effective means for conducting post-disaster outreach to a large, diverse sample of exposed individuals.

Welch AE, Zweig KC, Liao T, et al. 2018. Alcohol and drug-related mortality among enrollees in the World Trade Center Health Registry (WTChr), 2004 to 2012. J Occup Environ Med. 60 (10):875–879.

HTTPS://DOI.ORG/10.1097/JOM.0000000000001384

OBJECTIVE: Have World Trade Center Health Registry (WTCHR) enrollees experienced increased alcohol and drug-related mortality associated with exposures to the events of 9/11/01?

METHODS: Cases involving death due to alcohol or drugs between 2003 and 2012 in New York City (NYC) were obtained through a match of the Registry with NYC Vital Records. We compared ICD-10-coded deaths where alcohol and/or drug use was the underlying cause of death to deaths from all other causes.

RESULTS: Of 1193 deaths, 66 (5.5%) were alcohol/drug-related. Adjusted odds ratios for dying from alcohol/drug-related causes were significantly elevated for enrollees who were male, age 18 to 44 years, smoked at enrollment, had 9/11-related probable posttraumatic stress disorder, were rescue/recovery workers, or sustained an injury on 9/11/01.

CONCLUSION: Following a major disaster, alcohol and drug-related mortality may be increased.

Yu S, Alper HE, Nguyen AM, et al. 2018. Risk of stroke among survivors of the September 11, 2001 World Trade Center disaster. J Occup Environ Med. 60 (8):e371–e376.

HTTPS://DOI.ORG/10.1097/JOM.0000000000001361

OBJECTIVE: The aim of this study was to investigate the association between 9/11-related posttraumatic stress disorder (PTSD), dust cloud exposure, and subsequent development of stroke among 42,527 enrollees in the World Trade Center (WTC) Health Registry.

METHODS: Using four waves of longitudinal data from the WTC Health Registry surveys, we employed Cox proportional hazards regression models to assess the associations.

RESULTS: Incidence of stroke was higher among those with PTSD or intense dust cloud exposure than those without, and it was even higher for those who had experienced both. In fully adjusted models, participants with PTSD had an increased risk of developing stroke [adjusted hazards ratio (AHR) 1.69, 95% confidence interval (95% CI) 1.42 to 2.02], as did those with intense dust exposure (AHR 1.29, 95% CI 1.09 to 1.53).

CONCLUSION: We found that individuals with 9/11-related PTSD and/or intense dust exposure may have an increased risk of developing stroke.

Yung J, Li J, Jordan HT, et al. 2018. Prevalence of and factors associated with mammography and prostate-specific antigen screening among World Trade Center Health Registry enrollees, 2015-2016. Preventive Medicine Reports. 11:81–88.

HTTPS://DOI.ORG/10.1016/J.PMEDR.2018.05.004

To compare the prevalence of mammography and prostate-specific antigen (PSA) testing in 9/11-exposed persons with the prevalence among the US population, and examine the association between 9/11 exposures and these screening tests using data from

the World Trade Center Health Registry (WTCHR) cohort. We studied 8190 female and 13,440 male enrollees aged >=40 years at survey completion (2015-2016), who had a medical visit during the preceding year, had no self-reported breast or prostate cancer, and did not have screening for non-routine purposes. We computed age-specific prevalence of mammography (among women) and PSA testing (among men), and compared to the general population using 2015 National Health Interview Survey data (NHIS). We also computed the adjusted prevalence ratio (PR) and 95% confidence interval (95% CI) to examine the relationship between 9/11 exposures and screening uptakes using modified Poisson regression. Our enrollees had higher prevalences of mammogram and PSA testing than the US general population. 9/11 exposure was not associated with mammography uptake. Proximity to the WTC at the time of the attacks was associated with PSA testing in the age 60-74 group (PR = 1.06; 95% CI = 1.00-1.12). Among rescue/recovery workers and volunteers (RRW), being a firefighter was associated with higher PSA testing than other RRW across all age groups (40-49: PR = 1.45, 95% CI 1.16-1.81; 50-59: PR = 1.33, 95% CI 1.22-1.44; 60-74: PR = 1.14, 95% CI 1.06-1.23). Screening activities should be considered when studying cancer incidence and mortality in 9/11 exposed populations.

Year Published 2019 (17)

Adams SW, Bowler RM, Russell K, et al. 2019. PTSD and comorbid depression: Social support and self-efficacy in World Trade Center tower survivors 14-15 years after 9/11. Psychol Trauma. 11 (2):156–164.

HTTPS://DOI.ORG/10.1037/TRA0000404

OBJECTIVE: Following the World Trade Center (WTC) terrorist attack in New York City, prevalence rates of posttraumatic stress disorder (PTSD) and depression remain elevated. Although social support and self-efficacy have been associated with PTSD, little is known about their differential effect on PTSD and depressive comorbidity.

METHOD: WTC tower survivors (n = 1,304) were assessed at Wave 1 (2003-2004), Wave 2 (2006-2007), Wave 3 (2011-2012), and Wave 4 (2015-2016).

RESULTS: At Wave 4, 13.0% of participants had probable PTSD, a decrease from 16.5% at Wave 1. In addition, 4.1% (54) were identified as having PTSD alone, 6.8% (89) had depression alone, and 8.9% (116) had comorbid PTSD and depression. Of those with PTSD, 68.2% also had comorbid depression. WTC tower survivors with PTSD and comorbid depression reported greater PTSD symptom severity and were more likely to have had greater exposure to the events of 9/11 (adjusted odds ratio [aOR] = 1.14) and lower self-efficacy (aOR = 0.85) than those with depression alone. Less perceived social support predicted only depression and not PTSD, whereas less perceived self-efficacy equally predicted having PTSD or depression (aOR = 0.76).

CONCLUSIONS: Findings indicate that self-efficacy may be more important to the severity and chronicity of PTSD symptoms than social support. Multivariate comparisons suggest that PTSD with comorbid depression is a presentation of trauma-dependent psychopathologies, as opposed to depression alone following trauma, which was independent of trauma exposure and may be secondary to the traumatic event and posttraumatic response. Implications for assessment and treatment are discussed.

Antao CV, Pallos LL, Graham LS, et al. 2019. 9/11 residential exposures: The impact of World Trade Center dust on respiratory outcomes of lower manhattan residents. International Journal of Environmental Research and Public Health. 16 (5)

HTTPS://DOI.ORG/10.3390/IJERPH16050798

Thousands of lower Manhattan residents sustained damage to their homes following the collapse of the Twin Towers on 11 September 2001. Respiratory outcomes have been reported in this population. We sought to describe patterns of home damage and cleaning practices in lower Manhattan and their impacts on respiratory outcomes among World Trade Center Health Registry (WTCHR) respondents. Data were derived from WTCHR Wave 1 (W1) (9/2003 - 11/2004) and Wave 2 (W2) (11/2006 -12/2007) surveys. Outcomes of interest were respiratory symp-

toms (shortness of breath (SoB), wheezing, persistent chronic cough, upper respiratory symptoms (URS)) first occurring or worsening after 9/11 W1 and still present at W2 and respiratory diseases (asthma and chronic obstructive pulmonary disease (COPD)) first diagnosed after 9/11 W1 and present at W2. We performed descriptive statistics, multivariate logistic regression and geospatial analyses, controlling for demographics and other exposure variables. A total of 6447 residents were included. Mean age on 9/11 was 45.1 years (+-15.1 years), 42% were male, 45% had ever smoked cigarettes, and 44% reported some or intense dust cloud exposure on 9/11. The presence of debris was associated with chronic cough (adjusted OR (aOR) = 1.56, CI: 1.12 -2.17), and upper respiratory symptoms (aOR = 1.56, CI: 1.24 -1.95). A heavy coating of dust was associated with increased shortness of breath (aOR = 1.65, CI: 1.24 - 2.18), wheezing (aOR = 1.43, CI: 1.03 -1.97), and chronic cough (aOR = 1.59, CI: 1.09 - 2.28). Dusting or sweeping without water was the cleaning behavior associated with the largest number of respiratory outcomes, such as shortness of breath, wheezing, and URS. Lower Manhattan residents who suffered home damage following the 9/11 attacks were more likely to report respiratory symptoms and diseases compared to those who did not report home damage.

Brackbill RM, Alper HE, Frazier P, et al. 2019. An assessment of long-term physical and emotional quality of life of persons injured on 9/11/2001. Int J Environ Res Public Health. 16 (6)

HTTPS://DOI.ORG/10.3390/IJERPH16061054

Fifteen years after the disaster, the World Trade Center Health Registry (Registry) conducted The Health and Quality of Life Survey (HQoL) assessing physical and mental health status among those who reported sustaining an injury on 11 September 2001 compared with non-injured persons. Summary scores derived from the Short Form-12 served as study outcomes. United States (US) population estimates on the Physical Component Score (PCS-12) and Mental Component Score (MCS-12) were compared with scores from the HQoL and were stratified by Post-traumatic Stress Disorder (PTSD) and injury status. Linear regression models were used to estimate the association between both injury severity and PTSD and PCS-12 and MCS-12 scores. Level of injury severity and PTSD history significantly predicted poorer physical health (mean PCS-12). There was no significant difference between injury severity level and mental health (mean MCS-12). Controlling for other factors, having PTSD symptoms after 9/11 predicted a nearly 10-point difference in mean MCS-12 compared with never having PTSD. Injury severity and PTSD showed additive effects on physical and mental health status. Injury on 9/11 and a PTSD history were each associated with long-term decrements in physical health status. Injury did not predict long-term decrements in one's mental health status. Although it is unknown whether physical wounds of the injury healed, our results suggest that traumatic injuries appear to have a lasting negative effect on perceived physical functioning.

Cone JE, Stein CR, Lee DJ, et al. 2019. Persistent hearing loss among World Trade Center Health Registry residents, passersby and area workers, 2006-

2007. Int J Environ Res Public Health. 16 (20)
HTTPS://DOI.ORG/10.3390/IJERPH16203864

BACKGROUND: Prior studies have found that rescue and recovery workers exposed to the 9/11 World Trade Center (WTC) disaster have evidence of increased persistent hearing and other ear-related problems. The potential association between WTC disaster exposures and post-9/11 persistent self-reported hearing problems or loss among non-rescue and recovery survivors has not been well studied.

METHODS: We used responses to the World Trade Center Health Registry (Registry) enrollment survey (2003-2004) and first follow-up survey (2006-2007) to model the association between exposure to the dust cloud and persistent hearing loss (n = 22,741).

RESULTS: The prevalence of post-9/11 persistent hearing loss among survivors was 2.2%. The adjusted odds ratio (aOR) of hearing loss for those who were in the dust cloud and unable to hear was 3.0 (95% CI: 2.2, 4.0). Survivors with persistent sinus problems, headaches, PTSD and chronic disease histories had an increased prevalence of reported hearing problems compared to those without symptoms or chronic problems.

CONCLUSIONS: In a longitudinal study, we observed an association between WTC-related exposures and post-9/11 self-reported hearing loss among disaster survivors.

Flamme GA, Goldfarb DG, Zeig-Owens R, et al. 2019. Hearing loss among World Trade Center firefighters and emergency medical service workers. J Occup Environ Med. 61 (12):996–1003.
HTTPS://DOI.ORG/10.1097/JOM.0000000000001717

OBJECTIVE: To determine if World Trade Center (WTC) exposure is associated with hearing loss.

METHODS: Logistic regression to evaluate the immediate impact of WTC exposure and parametric survival analysis to assess longitudinal outcomes.

RESULTS: Those arriving on the morning of September 11, 2001 had elevated odds of low-frequency (odds ratio [OR]: 1.24; 95% confidence interval [CI]: 1.04 to 1.47) and high-frequency (OR: 1.16; 95% CI: 1.02 to 1.31) hearing loss at their first post-September 11, 2001 examination. Longitudinally, participants arriving before September 13, 2001 and spending more than or equal to 6 months at the WTC-site had greater risk of hearing loss in the low frequencies (risk ratio [RR]: 1.31; 95% CI: 1.05 to 1.60) and high frequencies (RR: 1.37; 95% CI: 1.22 to 1.54). By 2016, 3194 (37%) had abnormal hearing sensitivity in either ear and 1751 (20%) in both ears.

CONCLUSIONS: More heavily WTC-exposed workers were at increased risk of hearing loss, and group differences persisted for at least 15 years. Those with abnormal hearing sensitivity may benefit from interventions such as hearing aids and other rehabilitation.

Gargano LM, Gershon RR, Ogunyemi A, et al. 2019. Comorbid posttraumatic stress disorder

and lower respiratory symptoms in disaster survivors: Qualitative results of a 17-year follow-up of World Trade Center disaster survivors. Progress in Disaster Science. 4:100050.

HTTPS://DOI.ORG/10.1016/J.PDISAS.2019.100050

A better understanding of the experiences of disaster survivors with post-traumatic stress disorder (PTSD) and serious comorbid medical conditions may lead to improvements in treatment, and help reduce the public health and healthcare burden of affected individuals. The purpose of this qualitative study was threefold; first, to explore the relationship between PTSD and lower respiratory symptoms (LRS); second, to identify factors influencing self-management and treatment of both disorders; and third, to determine the impact of these comorbidities on quality of life. The goal was to identify strategies to improve coordination of medical and mental health management in order to reduce the symptomatic burden of these two health conditions. In-depth, semi-structured qualitative interviews were conducted among 34 World Trade Center Health Registry (WTCHR) rescue/recovery workers and community members with both active LRS (self-reported history of cough, wheeze or shortness of breath) and report of PTSD diagnosis on their 2015–2016 survey. Thematic analysis identified 14 themes grouped into six main categories: relationship between LRS and PTSD, impact of symptoms on quality of life, medical management, symptom management strategies, current health status, and exposure history and symptoms. Participants spoke of a wide range of both symptom triggers and management strategies, including self-management and some maladaptive management behaviors such as smoking and alcohol consumption. Participants also spoke of feeling like there were gaps in their healthcare, particularly for mental health. In addition, many spoke to a lack of coordinated care between physical and mental health. The majority of participants did not feel that there was a link between their PTSD and LRS, and among them a large portion also reported a lack of control over their symptoms. Proactive and collaborative planning steps at multiple levels (healthcare, public health, disaster management) are needed to prevent adverse impacts of disasters. Because of the increasing trend in disasters (both natural and man-made), with potentially wide-ranging exposures, it is important to plan for the complex treatment of PTSD and other co-morbidities.

Gargano LM, Li J, Millien L, et al. 2019. Exposure to multiple disasters: The long-term effect of hurricane sandy (october 29, 2012) on NYC survivors of the September 11, 2001 World Trade Center attack. Psychiatry Research. 273:719–724.

HTTPS://DOI.ORG/10.1016/J.PSYCHRES.2019.01.090

This study evaluated the impact of pre-Hurricane Sandy (Sandy) post-traumatic stress disorder (PTSD) trajectories on the relationship between Sandy exposures and post-Sandy 9/11-related PTSD among World Trade Center Health Registry (Registry) enrollees. The study population included 3,199 adult Registry enrollees who completed three surveys prior to Sandy in 2003–4, 2006–7, and 2011–12; a post-Hurricane Sandy survey (2013); and a follow-up survey in 2015–16. PTSD was assessed using the PTSD Checklist (PCL). Latent class growth analysis was used to identify

groups of enrollees who shared a similar trajectory of change in PCL score in the time period prior to Sandy. We compared enrollees in each trajectory group to assess the impact of Sandy-related PTSD, Sandy exposures, and optimism on 9/11-related PTSD status post-Sandy (2015–16) using bivariate analyses and multivariable log-binomial regression. Sandy-related PTSD was the strongest predictor of subsequent 9/11-related PTSD. Lower optimism and higher Sandy exposure significantly predicted 9/11-related PTSD only in some trajectory groups. Hurricane Sandy may have exacerbated previously resolved symptoms of 9/11-related PTSD. This indicates a need after a disaster to assess and address mental health sequelae from previous traumatic exposures.

Gargano LM, Mok HK, Jacobson MH, et al. 2019. Comparing life satisfaction and functioning 15 years after September 11, 2001 among survivors with and without injuries: A mixed-method study. Qual Life Res. 28 (10):2787–2797.

HTTPS://DOI.ORG/10.1007/S11136-019-02194-W

PURPOSE: This study compares life satisfaction and limited activity days among 9/11 survivors with and without physical injuries using quantitative and qualitative approaches.

METHODS: The study population included World Trade Center Health Registry enrollees who reported being injured on 9/11 in 2003-2004 and a sample of non-injured enrollees who participated in a cross-sectional substudy. We used multivariable logistic regression to examine differences in life satisfaction and number of limited activity days in the last 30 days between those with and without injuries. The free-response section of the survey was analyzed qualitatively to compare themes of those with and without injuries.

RESULTS: The final sample consisted of 2821 adult enrollees. Compared to those who were not injured, those who were injured on 9/11 were more likely to report being unsatisfied with their life (adjusted odds ratio (AOR): 1.5, 95% confidence intervals (CI) 1.1-2.0) and have 14 or more limited activity days in the last 30 days (AOR: 1.4, 95% CI 1.0-1.9). Among those who were injured, being partially or completely prevented from working increased the odds of being unsatisfied with life and having 14 or more limited activity days. In qualitative analysis, the emotional trauma experienced from 9/11 was a major and common theme, regardless of injury status. Those with injuries were more likely to express anger/lack of recognition/appreciation, describe substance use/abuse, and have financial/health care access issues.

CONCLUSIONS: More than 15 years after 9/11, those who were injured continue to be impacted, reporting lower life satisfaction and more functional impairment.

Jacobson MH, Brackbill RM, Frazier P, et al. 2019. Conducting a study to assess the long-term impacts of injury after 9/11: Participation, recall, and description. Injury Epidemiology. 6 (1):8.

HTTPS://DOI.ORG/10.1186/S40621-019-0186-Y

BACKGROUND: The World Trade Center (WTC) attacks on September 11, 2001 (9/11) resulted in over 2700 fatalities and thou-

sands injured. Injury on 9/11 has been identified as a risk factor for physical and mental health conditions, but the reasons for this are not well understood. In a population exposed to 9/11 and since followed, an in-depth study on the impacts of injury on 9/11 was conducted to identify factors that contribute to long-term functional issues. This report sought to examine factors influencing participation, participant recall of injury status over time, and determinants of injury severity.

METHODS: Enrollees from the World Trade Center Health Registry who completed all surveys between 2003 and 2016 and initially reported being injured (N= 2699) as well as a sample of non-injured (N= 2598) were considered to be eligible for the Health and Quality of Life 15 Years after 9/11 (HQoL) Study. Predictors of study non-participation and inconsistent recall of injury over time (i.e., discrepant reports) were identified through fitting log binomial models.

RESULTS: Participation rates were high overall (76.1%) and did not vary by initially reported injury status, although younger (vs. older), non-White (vs. White), and less educated (vs. more educated) enrollees were less likely to participate in the HQoL Study. Discrepant reporting of 9/11 injury status was much more common among enrollees who initially reported being injured on 9/11 (49.6%) compared with those who did not (7.3%). However, those who incurred more severe injuries on 9/11 were less likely to have discrepant reporting over time compared with those with more minor injuries (broken bone vs. sprain: risk ratio = 0.33, 95% Confidence Interval: 0.19, 0.57). Among those who consistently reported that they were injured on 9/11, most injuries occurred as a result of descending down stairs (31.5%) or by tripping and falling (19.9%); although being hit by a falling object was most often associated with high severity injuries (63.2%) compared with other modes of injury.

CONCLUSIONS: These findings highlight the methodological issues involved in conducting a study on the long-term impact of injury more than a decade after the initial incident and may be relevant to future investigators. Factors affecting participation rates, such as demographic characteristics, and those related to discrepant reporting over time, such as injury severity, may affect both the internal and external validity of studies examining the long-term impact of injury.

Jacobson MH, Norman C, Sadler P, et al. 2019. Characterizing mental health treatment utilization among individuals exposed to the 2001 World Trade Center terrorist attacks 14(-)15 years post-disaster. Int J Environ Res Public Health. 16 (4)

HTTPS://DOI.ORG/10.3390/IJERPH16040626

Following the World Trade Center (WTC) attacks in New York City (NYC) on 11 September 2001 (9/11), thousands in NYC experienced significant stress reactions and disorders, presenting an immediate need for counseling and treatment. While other studies documented post-9/11 mental health treatment utilization, none have data more than two years post-disaster. We used data from 35,629 enrollees of the WTC Health Registry, a longitudinal cohort study of those exposed to the

WTC attacks, to examine predictors of counseling after 9/11, the types of practitioners seen, and the perceived helpfulness of therapy up to 15 years post-disaster. Among enrollees, 37.7% reported receiving counseling at some time after 9/11. Predictors of seeking counseling included race/ethnicity, age at 9/11, education level, exposure to the WTC attacks, other traumatic experiences, mental health symptomology, and pre-9/11 counseling. Whites and Hispanics, those who were children on 9/11, and those with high levels of exposure to the WTC attacks sought counseling soonest after 9/11. Among those who sought counseling, Blacks, Asians, and those with lower education and income were less likely to see mental health specialists and more likely to see general practitioners or religious advisors. Finally, among those who sought recent counseling, women, Blacks, those aged >/=65 years, and those with very high WTC exposures were more likely to rate their recent counseling as very helpful. This study used data up to 15 years post-disaster to document mental health treatment utilization patterns, trends, and disparities that have implications for future preparedness plans and needs assessments.

Jordan HT, Osahan S, Li J, et al. 2019. Persistent mental and physical health impact of exposure to the September 11, 2001 World Trade Center terrorist attacks. Environ Health. 18 (1):12.

HTTPS://DOI.ORG/10.1186/S12940-019-0449-7

BACKGROUND: Asthma, gastroesophageal reflux disease (GERD), posttraumatic stress disorder (PTSD) and depression have each been linked to exposure to the September 11, 2001 World Trade Center (WTC) terrorist attacks (9/11). We described the prevalence and patterns of these conditions and associated health-related quality of life (HRQOL) fifteen years after the attacks.

METHODS: We studied 36,897 participants in the WTC Health Registry, a cohort of exposed rescue/recovery workers and community members, who completed baseline (2003-2004) and follow-up (2015-16) questionnaires. Lower respiratory symptoms (LRS; cough, dyspnea, or wheeze), gastroesophageal reflux symptoms (GERS) and self-reported clinician-diagnosed asthma and GERD history were obtained from surveys. PTSD was defined as a score > 44 on the PTSD checklist, and depression as a score > 10 on the Patient Health Questionnaire (PHQ). Poor HRQOL was defined as reporting limited usual daily activities for > 14 days during the month preceding the survey.

RESULTS: In 2015-16, 47.8% of participants had >/=1 of the conditions studied. Among participants without pre-existing asthma, 15.4% reported asthma diagnosed after 9/11; of these, 76.5% had LRS at follow up. Among those without pre-9/11 GERD, 22.3% reported being diagnosed with GERD after 9/11; 72.2% had GERS at follow-up. The prevalence of PTSD was 14.2%, and of depression was 15.3%. HRQOL declined as the number of comorbidities increased, and was particularly low among participants with mental health conditions. Over one quarter of participants with PTSD or depression reported unmet need for mental health care in the preceding year.

CONCLUSIONS: Nearly half of participants

reported having developed at least one of the physical or mental health conditions studied by 2015-2016; comorbidity among conditions was common. Poor HRQOL and unmet need for health were frequently reported, particularly among those with post-9/11 PTSD or depression. Comprehensive physical and mental health care are essential for survivors of complex environmental disasters, and continued efforts to connect 9/11-exposed persons to needed resources are critical.

Li J, Cone EJ, Brackbill MR, et al. 2019. Pulmonary fibrosis among World Trade Center responders: Results from the WTC Health Registry cohort. International Journal of Environmental Research and Public Health. 16 (5)

HTTPS://DOI.ORG/10.3390/IJERPH16050825

Dust created by the collapse of the World Trade Center (WTC) towers on 9/11 included metals and toxicants that have been linked to an increased risk of pulmonary fibrosis (PF) in the literature. Little has been reported on PF among WTC responders. This report used self-reported physician diagnosis of PF with an unknown sub-type to explore the association between levels of WTC dust exposure and PF. We included 19,300 WTC responders, enrolled in the WTC Health Registry in 2003 - 2004, who were followed for 11 years from 2004 to 2015. Exposure was defined primarily by intensity and duration of exposure to WTC dust/debris and work on the debris pile. Stratified Cox regression was used to assess the association. We observed 73 self-reported physician-diagnosed PF cases, with a PF incidence rate of 36.7/100,000 person-years. The adjusted hazard ratio (AHR) of PF was higher in those with a medium (AHR = 2.5, 95% CI = 1.1 - 5.8) and very high level of exposure (AHR = 4.5, 95% CI = 2.0-10.4), compared to those with low exposure. A test for exposure-response trend was statistically significant (Ptrend = 0.004). Future research on WTC dust exposure and PF would benefit from using data from multiple WTC Health Program responder cohorts for increased statistical power and clinically confirmed cases.

Morales-Raveendran E, Goodman E, West E, et al. 2019. Associations between asthma trigger reports, mental health conditions, and asthma morbidity among World Trade Center rescue and recovery workers. J Asthma. 56 (8):833–840.

HTTPS://DOI.ORG/10.1080/02770903.2018.1502300

AIM: There is limited information regarding asthma triggers in World Trade Center (WTC) rescue and recovery workers (RRW) or how mental health conditions affect the perception of triggers.

METHODS: We included 372 WTC workers with asthma. The Asthma Trigger Inventory (ATI) assessed triggers along five domains: psychological, allergens, physical activity, infection, and pollution. We administered the Structured Clinical Interview to diagnose post-traumatic stress disorder (PTSD), major depression and panic disorder (PD). The Asthma Control Questionnaire (ACQ) and Mini Asthma Quality of Life Questionnaire (AQLQ) measured asthma control and quality of life, respectively. Linear regression models were fitted to examine the association of ATI total and subdomain scores with mental health conditions as

well as the percent of ACQ and AQLQ variance explained by ATI subscales.

RESULTS: The most common triggers were air pollution (75%) and general allergens (68%). PTSD was significantly associated with psychological triggers (partial r(2)=0.05, p < 0.01), physical activity (partial r(2)=0.03, p < 0.01) and air pollution (partial r(2)=0.02, p = 0.04) subscales while PD was significantly associated with air pollution (partial r(2)=0.03, p = 0.03) and general allergens (partial r(2)=0.02, p = 0.03). ATI subscales explained a large percentage of variance in asthma control (r(2)=0.37, p < 0.01) and quality of life scores (r(2)=0.40, p < 0.01). Psychological subscale scores explained the largest portion of the total variability in ACQ (partial r(2)= 0.11, p = 0.72) and AQLQ (partial r(2)=0.14, p = 0.64) scores.

CONCLUSION: RRW with mental health conditions reported more asthma triggers and these triggers were associated with asthma morbidity. These data can help support interventions in RRW with asthma.

Schwartz RM, Rasul R, Gargano LM, et al. 2019. Examining associations between hurricane sandy exposure and posttraumatic stress disorder by community of residence. J Trauma Stress. 32 (5):677–687.

HTTPS://DOI.ORG/10.1002/JTS.22445

ABSTRACT: Exposure to 2012's Hurricane Sandy differed by community across New York City and nearby Long Island, and the differential impact of exposure on mental health concerns must be studied to enhance resilience in vulnerable communities. We assessed the association between self-reported Hurricane Sandy exposure and subsequent posttraumatic stress disorder (PTSD) symptoms, obtained through validated questionnaires completed by residents of lower Manhattan (n = 1,134), Queens/Long Island (LI)/Staten Island (SI; n = 622), and the Rockaways (n = 1,011); mean assessment times were 7, 14, and 32 months post-Sandy, respectively. The median number of hurricane exposures was similar for all communities; however, Rockaways residents had a higher proportion of likely PTSD symptoms (18.8%) compared to lower Manhattan (8.0%) and Queens/LI/SI residents (5.8%). Regarding likely PTSD, there was significant interaction between total hurricane exposure and community, p = .002, and flooding and community, p = .040. Number of hurricane exposures was associated with higher odds of likely PTSD in Queens/LI/SI, AOR = 1.61, 95% CI [1.34, 1.94]; lower Manhattan, AOR = 1.43, 95% CI [1.28, 1.59]; and the Rockaways, AOR = 1.25, 95% CI [1.16, 1.35]. Flooding was associated with increased odds of likely PTSD in the Rockaways, AOR = 1.65, 95% CI [1.01, 2.69]; and Queens/LI/SI, AOR = 3.29, 95% CI [1.08, 10.00]. This study emphasizes the differential impact of hurricane exposure on subsequent PTSD symptoms in three communities affected by Hurricane Sandy. Future preparedness and recovery efforts must understand community correlates of mental health concerns to promote resilience in vulnerable communities.

Seil K, Yu S, and Alper H. 2019. A cognitive reserve and social support-focused latent class analysis to predict self-reported confusion or memory loss among middle-aged World Trade Center Health Registry

enrollees. Int J Environ Res Public Health. 16 (8)

HTTPS://DOI.ORG/10.3390/IJERPH16081401

The World Trade Center Health Registry includes 9/11 survivors who have been surveyed about their health conditions over time. The prevalence of posttraumatic stress disorder (PTSD) remains high among the cohort and is a risk factor for cognitive impairment or dementia. We thus sought to examine the degree to which confusion or memory loss (CML)-potential symptoms of cognitive decline-are occurring among enrollees aged 35-64 years. Cognitive reserve theory suggests that higher levels of education and engaging in cognitively challenging activities can create stronger neural connections, offering protection against cognitive decline. We hypothesized that enrollees with less cognitive reserve would be more likely to report CML. In this study, we: (1) estimated the incidence of CML in our study sample; (2) identified indicators of cognitive reserve (e.g., indicators of educational attainment, social support); and (3) determined whether CML is associated with cognitive reserve level, stratified by PSTD status. First, we described demographics of the study sample (n = 14,574) and probable PTSD status, also stratifying by CML. Next, we conducted a latent class analysis on two groups: those with probable PTSD and those without probable PTSD, creating classes with varying cognitive reserve levels. Finally, using adjusted log binomial models, we predicted risk of CML based on cognitive reserve level. The probable PTSD group (n = 1213) and not probable PTSD group (n = 13,252) each had four latent classes: low, medium-low, medium-high, and high cognitive reserve. In the probable PTSD model, compared to the high cognitive reserve class, those with medium-low cognitive reserve were 35% more likely to report CML (relative risk (RR) = 1.4, 95% confidence interval (CI): 1.1, 1.7). Among the not probable PTSD group, those with low and medium levels of cognitive reserve were significantly more likely to report CML (RR = 1.8 and 1.4, respectively). Overall, those with less cognitive reserve were more likely to report CML regardless of PTSD status.

Yu S, Seil K, and Maqsood J. 2019. Impact of health on early retirement and post-retirement income loss among survivors of the 11 September 2001 World Trade Center disaster. Int J Environ Res Public Health. 16 (7)

HTTPS://DOI.ORG/10.3390/IJERPH16071177

The health consequences of the 9/11 World Trade Center (WTC) terrorist attacks are well documented, but few studies have assessed the disaster's impact on employment among individuals exposed to the disaster. We examined the association between 9/11-related health conditions and early retirement among residents and workers who resided and/or worked near the WTC site on 9/11, and the association between such conditions and post-retirement income loss. The study included 6377 residents and/or area workers who completed the WTC Health Registry longitudinal health surveys in 2003-2004 and 2006-2007, and the 2017-2018 Health and Employment Survey. Logistic regression models were used to examine the associations. We found that 9/11-related health conditions were significantly associated with the likelihood of early retirement. Res-

idents and/or area workers with more physical health conditions, especially when comorbid with posttraumatic stress disorder (PTSD), were more likely to retire before age 60 than those with no conditions. For retirees, having PTSD or PTSD comorbid with any number of physical conditions increased the odds of reporting substantial post-retirement income loss. Disaster-related outcomes can negatively impact aging individuals in the form of early retirement and income loss. Long-term effects of major disasters must continue to be studied.

Yung J, Osahan S, Friedman SM, et al. 2019. Air pollution/irritants, asthma control, and health-related quality of life among 9/11-exposed individuals with asthma. International Journal of Environmental Research and Public Health. 16 (11)

HTTPS://DOI.ORG/10.3390/IJERPH16111924

Registry Outputs

Asthma control is suboptimal among World Trade Center Health Registry (WTCHR) enrollees. Air pollution/irritants have been reported as the most prevalent trigger among World Trade Center responders. We examined the relationship between air pollution/irritants and asthma control. We also evaluated the association of asthma control with health-related quality of life (HRQoL). We included 6202 enrollees age >=18 with a history of asthma who completed the WTCHR asthma survey between 2015 and 2016. Based on modified National Asthma Education and Prevention Program criteria, asthma was categorized as controlled, poorly-controlled, or very poorly-controlled. HRQoL indicators include >=14 unhealthy days, >=14 activity limitation days, and self-rated general health. We used multinomial logistic regression for asthma control, and unconditional logistic regression for HRQoL, adjusting for covariates. Overall, 27.1% had poorly-controlled and 32.2% had very poorly-controlled asthma. Air pollution/irritants were associated with poorly-controlled (adjusted odds ratio (AOR) = 1.70; 95% CI = 1.45 - 1.99) and very poorly-controlled asthma (AOR = 2.15; 95% CI = 1.83 - 2.53). Poor asthma control in turn worsened the HRQoL of asthmatic patients. Very poorly-controlled asthma was significantly associated with >=14 unhealthy days (AOR = 3.60; 95% CI = 3.02 - 4.30), >=14 activity limitation days (AOR = 4.37; 95% CI = 3.48 - 5.50), and poor/fair general health status (AOR = 4.92; 95% CI = 4.11 - 5.89). Minimizing World Trade Center (WTC) asthmatic patients exposure to air pollution/irritants may improve their disease management and overall well-being.

Year Published 2020 (15)

Alper HE, Gargano LM, Cone JE, et al. 2020. Injury severity and psychological distress sustained in the aftermath of the attacks of 11 September 2001 predict somatic symptoms in World Trade Center Health Registry enrollees sixteen years later. International Journal of Environmental Research and Public Health. 17 (12):4232.

HTTPS://DOI.ORG/10.3390/IJERPH17124232

The World Trade Center attacks of 11 Sep-

tember 2001 (9/11) have been associated with the subsequent development of chronic diseases. Few studies have investigated the burden of somatic symptoms on attack victims, or the association of such symptoms with exposure to the 9/11 attacks. World Trade Center Health Registry (Registry) enrollees who were present south of Chambers Street during or immediately after the 9/11 attacks and who provided consistent answers regarding injury sustained on 9/11 were followed prospectively for up to 16 years post-9/11/01. We employed linear regression to evaluate the associations between injury severity, psychological distress and somatic symptoms in 2322 persons who completed all four Registry surveys and a subsequent Health and Quality of Life survey. Twenty-one percent of subjects had a "very high" burden of somatic symptoms, greater than in populations not exposed to a disaster. Somatic symptoms exhibited a dose-response association separately with injury severity and psychological distress trajectories. Victims of the 9/11 attacks suffer from a substantial burden of somatic symptoms which are associated with physical and psychological consequences of exposure to the attacks. Physical and mental health professionals need to work together when treating those exposed to complex disasters such as 9/11.

Alper HE, Tuly RA, Seil K, et al. 2020. Post-9/11 mental health comorbidity predicts self-reported confusion or memory loss in World Trade Center Health Registry enrollees. Int J Environ Res Public Health. 17 (19):7330.

HTTPS://DOI.ORG/10.3390/IJERPH17197330

Numerous studies report elevated levels of chronic mental health conditions in those exposed to the World Trade Center attacks of 11 September 2001 (9/11), but few studies have examined the incidence of confusion or memory loss (CML) or its association with mental health in 9/11 attack survivors. We investigated the incidence of CML and its association with the number of post-9/11 mental health conditions (PTSD, depression, and anxiety) in 10,766 World Trade Center Health Registry (Registry) enrollees aged 35-64 at the time of the wave 4 survey (2015-2016) that completed all four-wave surveys and met the study inclusion criteria. We employed log-binomial regression to evaluate the associations between CML and the number of mental health conditions. A total of 20.2% of enrollees in the sample reported CML, and there was a dose-response relationship between CML and the number of mental health conditions (one condition: RR = 1.85, 95% CI (1.65, 2.09); two conditions: RR = 2.13, 95% CI (1.85, 2.45); three conditions: RR = 2.51, 95% CI (2.17, 2.91)). Survivors may be experiencing confusion or memory loss partly due to the mental health consequences of the 9/11 attacks. Clinicians treating patients with mental health conditions should be aware of potential cognitive impairment.

Asher J, Resnick D, Brite J, et al. 2020. An introduction to probabilistic record linkage with a focus on linkage processing for WTC registries. Int J Environ Res Public Health. 17 (18):6937.

HTTPS://DOI.ORG/10.3390/IJERPH17186937

Since its post-World War II inception, the science of record linkage has grown exponentially and is used across industrial, governmental, and academic agencies. The academic fields that rely on record linkage are

diverse, ranging from history to public health to demography. In this paper, we introduce the different types of data linkage and give a historical context to their development. We then introduce the three types of underlying models for probabilistic record linkage: Fellegi-Sunter-based methods, machine learning methods, and Bayesian methods. Practical considerations, such as data standardization and privacy concerns, are then discussed. Finally, recommendations are given for organizations developing or maintaining record linkage programs, with an emphasis on organizations measuring long-term complications of disasters, such as 9/11.

Brite J, Alper HE, Friedman S, et al. 2020. Association between socioeconomic status and asthma-related emergency department visits among World Trade Center rescue and recovery workers and survivors. JAMA Netw Open. 3 (3):e201600.

HTTPS://DOI.ORG/10.1001/JAMANETWORKOPEN.2020.1600

IMPORTANCE: Although the association between poor economic or social standing and health is well established, few studies have attempted to examine the mediational pathways that produce adverse outcomes in disadvantaged populations.

OBJECTIVE: To determine whether barriers to care mediate the association between socioeconomic status (SES) and asthma-related emergency department (ED) visits.

DESIGN, SETTING, AND PARTICIPANTS: This cohort study used data from the World Trade Center Health Registry, which comprises rescue and recovery workers and community members who worked, lived, studied or were otherwise present in downtown Manhattan, New York, during or immediately after the September 11, 2001, disaster. Data were matched to an administrative database of ED visits. Those who experienced an asthma-related ED visit and those who did not were compared in bivariate analysis. A mediation analysis was conducted to determine the role of barriers to care in the association between number of ED visits and SES.

EXPOSURES: Education, income, and race/ethnicity, which were collected at first survey in 2003 to 2004.

MAIN OUTCOMES AND MEASURES: Asthma-related ED visits that occurred after survey responses regarding barriers to care were collected (2006-2007) but before 2016, the latest date that data were available.

RESULTS: The analytic sample included 30452 enrollees (18585 [61%] male; median [interquartile range] age, 42.0 [35.0-50.0] years; 20180 [66%] white, 3834 [13%] African American, and 3961 [13%] Hispanic or Latino [any race]). Approximately half (49%) had less than a bachelor's degree, and 15% had an annual income less than $35000. Those of lower SES were more likely to experience an asthma-related ED visit. Although number of barriers to care mediated this association, they explained only a small percentage of the overall health disparity (ranging from 3.0% [95% CI, 2.3%-3.9%]) of the differences between African American and white individuals to 9.8% [95% CI, 7.7%-11.9%]) comparing those with less than a high school diploma to those with at least a bachelor's

degree. However, the association varied by specific barrier to care. Lack of money, insurance, and transportation mediated up to 11.8% (95% CI, 8.1%-15.9%), 12.5% (95% CI, 8.5%-17.4%), and 4.3% (95% CI, 1.7%-8.4%), respectively, of the association between SES and number of ED visits. Lack of childcare, not knowing where to go for care, and inability to find a health care professional mediated a smaller or no percentage of the association.

CONCLUSIONS AND RELEVANCE: The identification of vulnerable subpopulations is an important goal to reduce the burden of asthma-related hospital care. More research is needed to fully understand all of the pathways that lead disaster survivors of lower SES to disproportionately experience ED visits due to asthma.

Brite J, Friedman S, de la Hoz RE, et al. 2020. Mental health, long-term medication adherence, and the control of asthma symptoms among persons exposed to the WTC 9/11 disaster. J Asthma. 57 (11):1253–1262.

HTTPS://DOI.ORG/10.1080/02770903.2019.1672722

OBJECTIVE: A positive association between mental health conditions and poor asthma control has been documented in the World Trade Center-exposed population. Whether factors such as medication adherence mediate this association is unknown.

METHODS: The study population was drawn from adult participants of the World Trade Center Health Registry Cohort who self-reported as asthmatic after the disaster and who were currently prescribed a long-term control medication (LTCM). Multivariable linear regression was used to estimate the associations between mental health condition (PTSD, depression, or anxiety) and continuous adherence and Asthma Control Test (ACT) scores.

RESULTS: In the study sample of 1,293, 49% were not adherent to their LTCM and two thirds reported poorly or very poorly controlled asthma. Presence of any mental health condition was associated with a 2-point decline in ACT and half a point decrease in adherence scores. However, in the multivariable model, better adherence was statistically significantly associated with slightly worse control.

CONCLUSIONS: The total effect of mental health on asthma control was opposite in sign from the product of the paths between mental health and adherence and adherence and asthma control; we therefore found no evidence to support the hypothesis that adherence mediated the negative association between poor mental health and adequate asthma control. More research is needed to understand the complex causal mechanisms that underlie the association between mental and respiratory health.

Flamme GA, Deiters KK, Stephenson MR, et al. 2020. Population-based age adjustment tables for use in occupational hearing conservation programs. Int J Audiol. 59 (0):S20–S30.

HTTPS://DOI.ORG/10.1080/14992027.2019.1698068

OBJECTIVE: In occupational hearing conservation programmes, age adjustments may be used to subtract expected age effects. Adjustments used in the U.S. came from a

small dataset and overlooked important demographic factors, ages, and stimulus frequencies. The present study derived a set of population-based age adjustment tables and validated them using a database of exposed workers.

DESIGN: Cross-sectional population-based study and retrospective longitudinal cohort study for validation.Study sample: Data from the U.S. National Health and Nutrition Examination Survey (unweighted n = 9937) were used to produce these tables. Male firefighters and emergency medical service workers (76,195 audiograms) were used for validation.

RESULTS: Cross-sectional trends implied less change with age than assumed in current U.S. regulations. Different trends were observed among people identifying with non-Hispanic Black race/ethnicity. Four age adjustment tables (age range: 18-85) were developed (women or men; non-Hispanic Black or other race/ethnicity). Validation outcomes showed that the population-based tables matched median longitudinal changes in hearing sensitivity well.

CONCLUSIONS: These population-based tables provide a suitable replacement for those implemented in current U.S. regulations. These tables address a broader range of worker ages, account for differences in hearing sensitivity across race/ethnicity categories, and have been validated for men using longitudinal data.

Garrey SK, Welch AE, Jacobson MH, et al. 2020. The intentional self-medication of 9/11-related PTSD symptoms with alcohol: 15 years after the disaster. International Journal of Environmental Research and Public Health. 17 (15)

HTTPS://DOI.ORG/10.3390/IJERPH17155327

The self-medication hypothesis may explain the co-morbidity of affective and substance use disorders. Research shows increased prevalence, frequency, and intensity of binge drinking and post-traumatic stress disorder (PTSD) among those directly exposed to the 9/11 terrorist attacks on the World Trade Center (WTC), however, little is known about PTSD symptomology and intentional self-medication with alcohol (ISMA) among this group. We used WTC Health Registry data (N = 28,935) to describe the relationship between ISMA and specific symptom clusters of probable 9/11-related PTSD, the number of PTSD symptom clusters endorsed, and binge drinking intensity. Multivariable logistic regression models were used to estimate the adjusted odds ratios (AORs) and 95% confidence intervals (CI). ISMA was most strongly associated with the hyperarousal PTSD symptom cluster (AOR = 2.04 [1.88, 2.21]) and the endorsement of one (AOR = 1.80 CI [1.65, 1.95]), two (AOR = 2.51 CI [2.28, 2.77]), or three (AOR = 2.84 CI [2.55, 3.17]) PTSD symptom clusters, indicating a clear dose–response relationship. A significant number of 9/11-exposed persons continue to experience PTSD symptoms and engage in ISMA as a potential coping mechanism. Repeated screenings for self-medicative alcohol use among survivors of mass traumas with PTSD symptoms is of public health importance.

Giesinger I, Li J, Takemoto E, et al. 2020. Association between posttraumatic stress disorder and mortality among responders and civilians following

the September 11, 2001, disaster. JAMA Netw Open. 3 (2):e1920476.

HTTPS://DOI.ORG/10.1001/JAMA-NETWORKOPEN.2019.20476

IMPORTANCE: Posttraumatic stress disorder (PTSD) has been associated with increased mortality, primarily in studies of veterans. The World Trade Center Health Registry (Registry) provides a unique opportunity to study the association between PTSD and mortality among a population exposed to the World Trade Center attacks in New York, New York, on September 11, 2001 (9/11). Objectives: To assess whether 9/11-related probable PTSD (PTSD) is associated with increased mortality risk, as well as whether this association differs when including repeated measures of PTSD over time vs a single baseline assessment.

DESIGN, SETTING, AND PARTICIPANTS: A longitudinal cohort study of 63666 Registry enrollees (29270 responders and 34396 civilians) was conducted from September 5, 2003, to December 31, 2016, with PTSD assessments at baseline (wave 1: 2003-2004) and 3 follow-up time points (wave 2: 2006-2007, wave 3: 2011-2012, wave 4: 2015-2016). Data analyses were conducted from December 4, 2018, to May 20, 2019. Exposures: Posttraumatic stress disorder was defined using the 17-item PTSD Checklist-Specific (PCL-S) self-report measure (score >/=50) at each wave (waves 1-4). Baseline PTSD was defined using wave 1 PCL-S, and time-varying PTSD was defined using the PCL-S assessments from all 4 waves.

MAIN OUTCOMES AND MEASURES: Mortality outcomes were ascertained through National Death Index linkage from 2003 to 2016 and defined as all-cause, cardiovascular, and external-cause mortality.

RESULTS: Of 63666 enrollees (38883 men [61.1%]; mean [SD] age at 9/11, 40.4 [10.4] years), 6689 (10.8%) had PTSD at baseline (responders: 2702 [9.5%]; civilians: 3987 [12.0%]). Participants who were middle aged (2022 [12.5%]), female (3299 [13.8%]), non-Latino black (1295 [17.0%]), or Latino (1835 [22.2%]) were more likely to have PTSD. During follow-up, 2349 enrollees died (including 230 external-cause deaths and 487 cardiovascular deaths). Among all enrollees in time-varying analyses, PTSD was associated with all-cause, cardiovascular, and external-cause mortality, with adjusted hazard ratios (AHRs) of greater magnitude compared with analyses examining baseline PTSD. Among responders, time-varying PTSD was significantly associated with increased risk of all-cause (AHR, 1.91; 95% CI, 1.58-2.32), cardiovascular (AHR, 1.95; 95% CI, 1.25-3.04), and external-cause (AHR, 2.40; 95% CI, 1.47-3.91) mortality. Among civilians, time-varying PTSD was significantly associated with increased risk of all-cause (AHR, 1.54; 95% CI, 1.28-1.85), cardiovascular (AHR, 1.72; 95% CI, 1.15-2.58), and external-cause (AHR, 2.11; 95% CI, 1.06-4.19) mortality.

CONCLUSIONS AND RELEVANCE: The risk of mortality differed in examination of baseline PTSD vs repeated measures of PTSD over time, suggesting that longitudinal data should be used where possible. Comparable findings between responders and civilians suggest that 9/11-related PTSD is associated with an increased mortality risk.

Hamwey MK, Gargano LM, Friedman LG, et al. 2020. Post-traumatic stress disorder among survivors of the September 11, 2001 World Trade Center attacks: A review of the literature. International Journal of Environmental Research and Public Health. 17 (12):4344.

HTTPS://DOI.ORG/10.3390/IJERPH17124344

Prior reviews of 9/11-related post-traumatic stress disorder (PTSD) have not focused on the civilian survivors most directly exposed to the attacks. Survivors include those individuals who were occupants of buildings in or near the World Trade Center (WTC) towers, those whose primary residence or workplace was in the vicinity, and persons who were on the street passing through the area. This review reports published information on the prevalence of and risk factors for PTSD, as well as comorbidities associated with PTSD among 9/11 survivors. Articles selected for inclusion met the following criteria: (1) full-length, original peer-reviewed empirical articles; (2) published in English from 2002-2019; (3) collected data from persons directly exposed; (4) adult populations; and (5) focused on non-rescue or recovery workers (i.e., survivors). Data were extracted with focus on study design, sample size, time frame of data collection post-9/11, PTSD assessment instrument, and PTSD prevalence, risk factors, and comorbidities. Our review identified the use of cross-sectional and longitudinal designs, finding multiple direct comorbidities with PTSD, as well as the prevalence and persistence of PTSD. Future research would benefit from incorporating more mixed methods designs, and exploring the mediating mechanisms and protective factors of the known associations of PTSD among the 9/11 survivor population.

Jacobson M, Crossa A, Liu SY, et al. 2020. Residential mobility and chronic disease among World Trade Center Health Registry enrollees, 2004-2016. Health Place. 61:102270.

HTTPS://DOI.ORG/10.1016/J.HEALTHPLACE.2019.102270

Residential mobility is hypothesized to impact health through changes to the built environment and disruptions in social networks, and may vary by neighborhood deprivation exposure. However, there are few longitudinal investigations of residential mobility in relation to health outcomes. This study examined enrollees from the World Trade Center Health Registry, a longitudinal cohort of first responders and community members in lower Manhattan on September 11, 2001. Enrollees who completed >/=2 health surveys between 2004 and 2016 and did not have diabetes (N = 44,089) or hypertension (N = 35,065) at baseline (i.e., 2004) were included. Using geocoded annual home addresses, residential mobility was examined using two indicators: moving frequency and displacement. Moving frequency was defined as the number of times someone was recorded as living in a different neighborhood; displacement as any moving to a more disadvantaged neighborhood. We fit adjusted Cox proportional hazards models with time-dependent exposures (moving frequency and displacement) and covariates to evaluate associations with incident diabetes and hypertension. From 2004 to 2016, the majority of enrollees never moved (54.5%); 6.5% moved >/=3 times. Those who moved >/=3 times had a similar hazard of diabetes (hazard ratio (HR) = 0.78; 95% Confidence Interval (CI): 0.40, 1.53) and hypertension (HR = 0.99; 95%

CI: 0.68, 1.43) compared with those who never moved. Similarly, displacement was not associated with diabetes or hypertension. Residential mobility was not associated with diabetes or hypertension among a cohort of primarily urban-dwelling adults.

Lim S, Liu SYS, Jacobson MH, et al. 2020. Housing stability and diabetes among people living in New York city public housing. SSM Popul Health. 11:100605.

HTTPS://DOI.ORG/10.1016/J.SSMPH.2020.100605

Public housing provides affordable housing and, potentially, housing stability for low-income families. Housing stability may be associated with lower incidence or prevalence and better management of a range of health conditions through many mechanisms. We aimed to test the hypotheses that public housing residency is associated with both housing stability and reduced risk of diabetes incidence, and the relationship between public housing and diabetes risk varies by levels of housing stability. Using 2004-16 World Trade Center Health Registry data, we compared outcomes (housing stability measured by sequence analysis of addresses, self-reported diabetes diagnoses) between 730 New York City public housing residents without prevalent diabetes at baseline and 730 propensity score-matched non-public housing residents. Sequence analysis found 3 mobility patterns among all 1460 enrollees, including stable housing (65%), limited mobility (27%), and unstable housing patterns (8%). Public housing residency was associated with stable housing over 12 years. Diabetes risk was not associated with public housing residency; however, among those experiencing housing instability, a higher risk of diabetes was found among public housing versus non-public housing residents. Of those stably housed, the association remained insignificant. These findings provide important evidence for a health benefit of public housing via housing stability among people living in public housing.

Locke S, Nguyen A-M, Friedman L, et al. 2020. Change in binge drinking behavior after hurricane sandy among persons exposed to the 9/11 World Trade Center disaster. Preventive Medicine Reports. 19:101144.

HTTPS://DOI.ORG/10.1016/J.PMEDR.2020.101144

The objective of this study was to examine changes in drinking behavior after Hurricane Sandy among 3199 World Trade Center Health Registry (Registry) enrollees before (2011–12) and after Hurricane Sandy (2015–16). A composite Sandy exposure scale (none, low, medium and high) included Sandy traumatic experiences, financial and other factors. Probable Sandy-related posttraumatic stress disorder (PTSD) was defined as scoring ≥44 on PTSD Checklist, and binge drinking as consuming ≥5 alcoholic drinks for men or ≥4 for women on one occasion in the past 30 days. Some of the enrollees reported binge drinking post Sandy as new binge drinkers (4.7%) or consistent binge drinkers pre- and post-Sandy (19%). Compared with non-binge drinkers pre- and post-Sandy (66.9%), the adjusted odds ratios (aOR) for being new binge drinkers and consistent binge drinkers among high Sandy exposure enrollees were 2.1 (95%CI 1.1–4.1) and 2.5 (95%CI: 1.7–3.6), respectively. High Sandy traumatic experience alone was associated with consistent binge drinking (aOR: 1.9, 95%CI: 1.4–2.6). Among

enrollees without 9/11 PTSD, those with Sandy PTSD were more likely to become new binge drinkers (aOR: 4.4, 95%CI: 1.4–13.9), while Sandy PTSD was not associated with any binge drinking behavior changes among those with 9/11 PTSD. Sandy exposure, Sandy traumatic experience, and Sandy PTSD were all associated with higher binge drinking intensity. Future natural disaster response should plan for treatment to address alcohol use and PTSD simultaneously.

Miller-Archie SA, Izmirly PM, Berman JR, et al. 2020. Systemic autoimmune disease among adults exposed to the September 11, 2001, terrorist attack. Arthritis Rheumatol. 72 (5):849–859.

HTTPS://DOI.ORG/10.1002/ART.41175

OBJECTIVE: Autoimmune disease is an emerging condition among persons exposed to the September 11, 2001, attack on the World Trade Center (WTC). Components of the dust cloud resulting from the collapse of the WTC have been associated with systemic autoimmune diseases (SAID), as has posttraumatic stress disorder (PTSD). We sought to determine whether dust exposure and PTSD were associated with an increased risk of SAID in a 9/11-exposed cohort.

METHODS: Among 43,133 WTC Health Registry enrollees, 2,786 self-reported a post-9/11 SAID. We obtained consent to review medical records to validate SAID diagnoses for 1,041. SAIDs were confirmed by classification criteria, rheumatologist diagnosis, or having been prescribed SAID medication. Controls were enrollees who denied an autoimmune disease diagnosis (n=37,017). We used multivariable log-binomial regression to examine the association between multiple 9/11 exposures and risk of post-9/11 SAID, stratifying by responders and community members.

RESULTS: We identified 118 persons with SAID. Rheumatoid arthritis was most frequent (n=71), followed by Sjgren's syndrome (n=22), systemic lupus erythematosus (n=20), myositis (n=9), mixed connective tissue disease (n=7), and scleroderma (n=4). Among 9/11 responders, those with intense dust cloud exposure had almost twice the risk of SAID (adjusted risk ratio =1.86, 95% CI=1.02-3.40). Community members with PTSD had a nearly three-fold increased risk of SAID.

CONCLUSION: Intense dust cloud exposure among responders and PTSD among community members were associated with a statistically significant increased risk of new-onset SAID. Clinicians treating 9/11 survivors should be aware of the potential increased risk of SAID in this population.

Takemoto E, Brackbill R, Martins S, et al. 2020. Post-traumatic stress disorder and risk of prescription opioid use, over-use, and misuse among World Trade Center Health Registry enrollees, 2015-2016. Drug and Alcohol Dependence. 210:107959.

HTTPS://DOI.ORG/10.1016/J.DRUGALCDEP.2020.107959

BACKGROUND: Among veterans, post-traumatic stress disorder (PTSD) has been shown to be associated with the use and misuse of prescription opioids. Less is known about PTSD among the general population and

PTSD resulting from non-combat related trauma. We sought to determine if PTSD following exposure to the World Trade Center (WTC) disaster is associated with the recent use, over use, or misuse of prescription opioids.

METHODS: This study, conducted in 2018, examined 26,840 individuals from the WTC Health Registry. PTSD symptoms were assessed on multiple surveys (2003-2016) using the PCL Checklist-17. Three categories of post-9/11 PTSD were derived: never, past, and current. Self-reported opioid use outcomes (past year, 2015-2016) were defined as (yes/no): recent use (use of a prescription opioid), over-use (use of a prescribed opioid in a manner other than prescribed) and misuse (use of a prescription opioid prescribed to someone else).

RESULTS: Opioid use, over-use, and misuse prevalence was highest among those with current PTSD (prevalence: 12.2%-46.1%) compared to past PTSD (prevalence: 6.7%-35.8%) and never PTSD (prevalence: 3.6%-22.9%). In adjusted models, individuals with past and current PTSD had a greater risk of all opioid outcomes compared to never PTSD.

CONCLUSIONS: Past and current 9/11-related PTSD is a risk factor for opioid use and misuse among the general population, findings which may assist in improving screening and surveillance measures.

Wyka K, Friedman SM, and Jordan HT. 2020. Probable posttraumatic stress disorder and lower respiratory symptoms among rescue/recovery workers and community members after the 9/11 World Trade Center attacks-a longitudinal mediation analysis. Psychosom Med. 82 (1):115–124.

HTTPS://DOI.ORG/10.1097/PSY.0000000000000731

OBJECTIVE: Posttraumatic stress disorder (PTSD) and lower respiratory symptoms (LRS) often coexist among survivors of the September 11, 2001 (9/11) World Trade Center (WTC) attacks. Research in police and nontraditional responders suggests that PTSD mediates the relationship between 9/11 physical exposures and LRS, but not vice versa. We replicated these findings in WTC rescue/recovery workers (R/R workers), extended them to exposed community members, and explored the interplay between both physical and psychological 9/11 exposures, probable PTSD, and LRS over a 10-year follow-up.

METHODS: Participants were 12,398 R/R workers and 12,745 community members assessed in three WTC Health Registry surveys (2003-2004, 2006-2007, and 2011-2012). LRS and 9/11 exposures were self-reported. Probable PTSD was defined as a PTSD Checklist score >/=44.

RESULTS: Probable PTSD predicted LRS (R/R workers: beta = 0.88-0.98, $p < .001$; community members: beta = 0.67-0.86, $p < .001$) and LRS predicted PTSD (R/R workers: beta = 0.83-0.91, $p < .001$; community members: beta = 0.68-0.75, $p < .001$) at follow-ups, adjusting for prior symptoms and covariates. In both R/R workers and community members, probable PTSD mediated the relationship between 9/11 physical exposures (dust cloud, long duration of work) and LRS (indirect effects, p = .001-.006), and LRS mediated the physical exposure-PTSD relationship (indirect

effects, p = .001-.006). In R/R workers, probable PTSD mediated the psychological exposure (losing friends or loved ones, witnessing horrific events)-LRS relationship (indirect effect, p < .001), but LRS did not mediate the psychological exposure-PTSD relationship (indirect effect, p = .332). In community members, high 9/11 psychological exposure predicted both probable PTSD and LRS at follow-ups; probable PTSD mediated the psychological exposure-LRS relationship (indirect effect, p < .001), and LRS mediated the psychological exposure-PTSD relationship (indirect effect, p = .001).

CONCLUSIONS: Probable PTSD and LRS each mediated the other, with subtle differences between R/R workers and community members. A diagnosis of either should trigger assessment for the other; treatment should be carefully coordinated.

Year Published 2021 (19)

Alper HE, Brite J, Cone JE, et al. 2021. Comparison of prevalence and exposure-disease associations using self-report and hospitalization data among enrollees of the World Trade Center health registry. BMC Med Res Methodol. 21 (1):162.

HTTPS://DOI.ORG/10.1186/S12874-021-01358-Y

BACKGROUND: Although many studies have investigated agreement between survey and hospitalization data for disease prevalence, it is unknown whether exposure-chronic disease associations vary based on data collection method. We investigated agreement between self-report and administrative data for the following: 1) disease prevalence, and 2) the accuracy of self-reported hospitalization in the last 12 months, and 3) the association of seven chronic diseases (rheumatoid arthritis, hypertension, heart attack, stroke, asthma, diabetes, hyperlipidemia) with four measures of 9/11 exposure.

METHODS: Enrollees of the World Trade Center Health Registry who resided in New York State were included (N = 18,206). Hospitalization data for chronic diseases were obtained from the New York State Planning and Research Cooperative System (SPARCS). Prevalence for each disease and concordance measures (kappa, sensitivity, specificity, positive agreement, and negative agreement) were calculated. In addition, the associations of the seven chronic diseases with the four measures of exposure were evaluated using logistic regression.

RESULTS: Self-report disease prevalence ranged from moderately high (40.5% for hyperlipidemia) to low (3.8% for heart attack). Self-report prevalence was at least twice that obtained from administrative data for all seven chronic diseases. Kappa ranged from 0.35 (stroke) to 0.04 (rheumatoid arthritis). Self-reported hospitalizations within the last 12 months showed little overlap with actual hospitalization data. Agreement for exposure-disease associations was good over the twenty-eight exposure-disease pairs studied.

CONCLUSIONS: Agreement was good for exposure-disease associations, modest for disease prevalence, and poor for self-reported hospitalizations. Neither self-report nor administrative data can be treated as the "gold standard." Which source to use depends on the availability and context of data, and the disease under study.

Berger KI, Wohlleber M, Goldring RM, et al. 2021. Respiratory impedance measured using impulse oscillometry in a healthy urban population. ERJ Open Research. 7 (1):00560–02020.

HTTPS://DOI.ORG/10.1183/23120541.00560-2020

This study derives normative prediction equations for respiratory impedance in a healthy asymptomatic urban population using an impulse oscillation system (IOS). In addition, this study uses body mass index (BMI) in the equations to describe the effect of obesity on respiratory impedance. Data from an urban population comprising 472 healthy asymptomatic subjects that resided or worked in lower Manhattan, New York City were retrospectively analysed. This population was the control group from a previously completed case–control study of the health effects of exposure to World Trade Center dust. Since all subjects underwent spirometry and oscillometry, these previously collected data allowed a unique opportunity to derive normative prediction equations for oscillometry in an urban, lifetime non-smoking, asymptomatic population without underlying respiratory disease. Normative prediction equations for men and women were successfully developed for a broad range of respiratory oscillometry variables with narrow confidence bands. Models that used BMI as an independent predictor of oscillometry variables (in addition to age and height) demonstrated equivalent or better fit when compared with models that used weight. With increasing BMI, resistance and reactance increased compatible with lung and airway compression from mass loading.This study represents the largest cohort of healthy urban subjects assessed with an IOS device. Normative prediction equations were derived that should facilitate application of IOS in the clinical setting. In addition, the data suggest that modelling of lung function may be best performed using height and BMI as independent variables rather than the traditional approach of using height and weight.Prediction equations for respiratory impedance were derived in an urban cohort incorporating the effects of mass loading from obesity. Urban exposures had minimal effect on impedance allowing application of the equations to a broad range of populations. https://bit.ly/3a3zZvd

Brackbill RM, Kahn AR, Li J, et al. 2021. Combining three cohorts of World Trade Center rescue/recovery workers for assessing cancer incidence and mortality. International Journal of Environmental Research and Public Health. 18 (4):1386.

HTTPS://DOI.ORG/10.3390/IJERPH18041386

Three cohorts including the Fire Department of the City of New York (FDNY), the World Trade Center Health Registry (WTCHR), and the General Responder Cohort (GRC), each funded by the World Trade Center Health Program have reported associations between WTC-exposures and cancer. Results have generally been consistent with effect estimates for excess incidence for all cancers

ranging from 6 to 14% above background rates. Pooling would increase sample size and de-duplicate cases between the cohorts. However, pooling required time consuming steps: obtaining Institutional Review Board (IRB) approvals and legal agreements from entities involved; establishing an honest broker for managing the data; de-duplicating the pooled cohort files; applying to State Cancer Registries (SCRs) for matched cancer cases; and finalizing analysis data files. Obtaining SCR data use agreements ranged from 6.5 to 114.5 weeks with six states requiring >20 weeks. Records from FDNY (n = 16,221), WTCHR (n = 29,372), and GRC (n = 33,427) were combined de-duplicated resulting in 69,102 unique individuals. Overall, 7894 cancer tumors were matched to the pooled cohort, increasing the number cancers by as much as 58% compared to previous analyses. Pooling resulted in a coherent resource for future research for studies on rare cancers and mortality, with more representative of occupations and WTC- exposure. Note--This paper describes the processes involved with combining data across the three WTC-exposed cohorts and linking the pooled data with state cancer registries; and the strategies for overcoming administrative challenges. To our knowledge, studies that use pooled data do not typically provide a detailed description of their combining process. The transparency of this approach is important for a fuller understanding of the findings derived from analyses of WTC-exposure and health in our case, as well as, other endeavors that also use information combined from multiple sources.

Cone JE, Santiago-Colón A, and Lucchini R. 2021. 9/11 health update. International Journal of Environmental Research and Public Health. 18 (12):6383.

HTTPS://DOI.ORG/10.3390/IJERPH18126383

This Special Issue of the International Journal of Environmental Research and Public Health is dedicated to increasing the scientific information available about the long-term effects of exposure to the 2001 World Trade Center disaster [...].

Gargano LM, Locke SH, Alper HE, et al. 2021. Hospitalizations among World Trade Center health registry enrollees who were under 18 years of age on 9/11, 2001-2016. Int J Environ Res Public Health. 18 (14)

HTTPS://DOI.ORG/10.3390/IJERPH18147527

Much of the literature on hospitalizations post-September 11, 2001 (9/11) focuses on adults but little is known about post-9/11 hospitalizations among children. Data for World Trade Center Health Registry enrollees who were under 18-years old on 9/11 were linked to New York State hospitalization data to identify hospitalizations from enrollment (2003-2004) to December 31, 2016. Logistic regression was used to analyze factors associated with hospitalization. Of the 3151 enrollees under age 18 on 9/11, 243 (7.7%) had at least one 9/11-related physical health hospitalization and 279 (8.9%) had at least one 9/11-related mental health hospitalization. Individuals of non-White race, those living in New York City Housing Authority housing, those exposed to the dust cloud on 9/11, and those with probable 9/11-related PTSD symptoms were more likely to be hospitalized for a 9/11-related physical health condition. Older age and having probable 9/11-related PTSD symptoms at baseline were associated with

being hospitalized for a 9/11-related mental health condition. Dust cloud exposure on 9/11 and PTSD symptoms were associated with hospitalizations among those exposed to 9/11 as children. Racial minorities and children living in public housing were at greater risk of hospitalization. Continued monitoring of this population and understanding the interplay of socioeconomic factors and disaster exposure will be important to understanding the long-term effects of 9/11.

Garrey SK, Ogunyemi AA, and Gargano LM. 2021. A mixed-methods study after multiple disasters: September 11, 2001, World Trade Center terrorist attacks and hurricane sandy. Disaster Medicine and Public Health Preparedness. :1–8.

HTTPS://DOI.ORG/10.1017/DMP.2020.465

OBJECTIVE: The aim of this study was to use a mixed-method analysis to investigate the associations between qualitative themes found in written responses and quantitative reported level of stress after Hurricane Sandy.

METHODS: A survey was conducted among World Trade Center Health Registry enrollees 5-12 mo after Hurricane Sandy. This study included 1202 participants who completed the free-response section and answered the question on how stressful their experiences were with Hurricane Sandy and its aftermath. Content analysis was used to generate qualitative data. Mixed-methods analysis was performed using a 1-way analysis of variance test for bivariate comparisons of qualitative thematic codes and the quantitative outcome of mean Sandy stress scores.

RESULTS: Seven themes emerged from the qualitative analysis. The themes of lack of information, negative emotional response, and financial stress had higher quantitative mean Sandy stress scores compared with other themes. The theme of patriotism/gratitude had an overall lower quantitative Sandy stress scores than other themes.

CONCLUSIONS: Qualitative and mixed-methods research on mental health outcomes after a disaster add new depth and findings to the existing literature. Using such methodologies to identify modifiable factors, such as improving communication during a disaster, may confer better mental health outcomes after a disaster.

Giesinger I, Li J, Takemoto E, et al. 2021. Confirming mortality in a longitudinal exposure cohort: Optimizing national death index search result processing. Ann Epidemiol. 56:40–46.

HTTPS://DOI.ORG/10.1016/J.ANNEPIDEM.2020.10.010

PURPOSE: The National Death Index (NDI) is an important resource for mortality ascertainment. Methods selected to process NDI search results are rarely described in studies using linked data and can have an impact on resources and mortality ascertainment. We evaluate methods to process NDI search results among a 9/11-exposed cohort-the World Trade Center Health Registry (Registry).

METHODS: We describe three approaches to process search results (NDI-recommended cutoff points [NDIc]; National Program of

Cancer Registries [NPCR] algorithm, and modified National Institute of Occupational Safety and Health algorithm [mNIOSH]). We calculate percent agreement, positive predictive value, sensitivity, specificity, and quantify the burden of manual review to compare the approaches.

RESULTS: Of 51,158 Registry enrollees submitted for linkage, 9449 enrollee-level and 17,909 record-level matches were identified. NPCR and mNIOSH were highly concordant (97.1%); more record pairs required manual review for mNIOSH (mNIOSH: 2.7% and NPCR: 1.8%). NDIc sensitivity was 82.9%, with differences observed by race and ethnicity (Asian: 74.4% and White: 86.1%).

CONCLUSIONS: NPCR algorithm minimized false matches and reduced the manual review burden. NDIc had nonrandom distribution of missed matches and low sensitivity. NDI search processing methods have important implications for resulting linked data; measures of linkage quality should be available to data users.

Goldfarb DG, Colbeth HL, Skerker M, et al. 2021. Impact of healthcare services on thyroid cancer incidence among World Trade Center-exposed rescue and recovery workers. American Journal of Industrial Medicine. 64 (10):861–872.

HTTPS://DOI.ORG/10.1002/AJIM.23277

BACKGROUND: A recent study of World Trade Center (WTC)-exposed firefighters and emergency medical service workers demonstrated that elevated thyroid cancer incidence may be attributable to frequent medical testing, resulting in the identification of asymptomatic tumors. We expand on that study by comparing the incidence of thyroid cancer among three groups: WTC-exposed rescue/recovery workers enrolled in a New York State (NYS) WTC-medical monitoring and treatment program (MMTP); WTC-exposed rescue/recovery workers not enrolled in an MMTP (non-MMTP); and the NYS population.

METHODS: Person-time began on 9/12/2001 or at enrollment in a WTC cohort and ended at death or on 12/31/2015. Cancer data were obtained through linkages with 13 state cancer registries. We used Poisson regression to estimate rate ratios (RRs) and 95% confidence intervals (CIs) for MMTP and non-MMTP participants. NYS rates were used as the reference. To estimate potential changes over time in WTC-associated risk, change points in RRs were estimated using profile likelihood.

RESULTS: The thyroid cancer incidence rate among MMTP participants was more than twice that of NYS population rates (RR = 2.31; 95% CI = 2.00–2.68). Non-MMTP participants had a risk similar to NYS (RR = 0.96; 95% CI = 0.72–1.28). We observed no change points in the follow-up period.

CONCLUSION: Our findings support the hypothesis that no-cost screening (a benefit provided by WTC-MMTPs) is associated with elevated identification of thyroid cancer. Given the high survival rate for thyroid cancer, it is important to weigh the costs and benefits of treatment, as many of these cancers were asymptomatic and may have been detected incidentally.

Goldfarb DG, Zeig-Owens R, Kristjansson D, et al. 2021. Cancer survival among World Trade Center rescue and recovery workers: A collaborative cohort study. Am J Ind Med. 64 (10):815–826.

HTTPS://DOI.ORG/10.1002/AJIM.23278

BACKGROUND: World Trade Center (WTC)-exposed responders may be eligible to receive no-cost medical monitoring and treatment for certified conditions, including cancer. The survival of responders with cancer has not previously been investigated.

METHODS: This study compared the estimated relative survival of WTC-exposed responders who developed cancer while enrolled in two WTC medical monitoring and treatment programs in New York City (WTC-MMTP responders) and WTC-exposed responders not enrolled (WTC-non-MMTP responders) to non-responders from New York State (NYS-non-responders), all restricted to the 11-southernmost NYS counties, where most responders resided. Parametric survival models estimated cancer-specific and all-cause mortality. Follow-up ended at death or on December 31, 2016.

RESULTS: From January 1, 2005 to December 31, 2016, there were 2,037 cancer cases and 303 deaths (248 cancer-related deaths) among WTC-MMTP responders, 564 cancer cases, and 143 deaths (106 cancer-related deaths) among WTC-non-MMTP responders, and 574,075 cancer cases and 224,040 deaths (158,645 cancer-related deaths) among the NYS-non-responder population. Comparing WTC-MMTP responders with NYS-non-responders, the cancer-specific mortality hazard ratio (HR) was 0.72 (95% confidence interval [CI] = 0.64-0.82), and all-cause mortality HR was 0.64 (95% CI = 0.58-0.72). The cancer-specific HR was 0.94 (95% CI = 0.78-1.14), and all-cause mortality HR was 0.93 (95% CI = 0.79-1.10) comparing WTC-non-MMTP responders to the NYS-non-responder population.

CONCLUSIONS: WTC-MMTP responders had lower mortality compared with NYS-non-responders, after controlling for demographic factors and temporal trends. There may be survival benefits from no-out-of-pocket-cost medical care which could have important implications for healthcare policy, however, other occupational and socioeconomic factors could have contributed to some of the observed survival advantage.

Haghighi A, Cone JE, Li J, et al. 2021. Asthma-COPD overlap in World Trade Center Health Registry enrollees, 2015–2016. Journal of Asthma. 58 (11):1415–1423.

HTTPS://DOI.ORG/10.1080/02770903.2020.1817935

INTRODUCTION: Asthma-chronic obstructive pulmonary disease (COPD) overlap (ACO) is a newly redefined form of chronic airway disease and has not been well studied among 9/11-exposed populations with increased prevalence of asthma. We assessed the prevalence and risk factors associated with ACO in an exposure cohort of World Trade Center Health Registry (WTCHR) enrollees.

METHODS: This is a longitudinal study, including enrollees with complete data on 9/11/01 exposure at enrollment (2003 -2004, Wave 1), asthma and COPD diagnoses and

at least 25-years of age at the time of the 2015 - 2016 (Wave 4) WTCHR survey. Probable ACO was defined as self-reported post-9/11 physician-diagnosed asthma and either emphysema, chronic bronchitis, or COPD. We evaluated whether probable ACO was associated with World Trade Center (WTC)-related exposures, using multivariable logistic regression.

RESULTS: Of 36,864 Wave 4 participants, 29,911 were eligible for this analysis, and 1,495 (5.0%) had self-reported post-9/11 probable ACO. After adjusting for demographics and smoking status, we found 38% increased odds of having ACO in enrollees with exposure to the dust cloud, and up to 3.39 times the odds in those with ≥3 injuries sustained on 9/11. Among rescue/recovery workers, ever working on the pile, on the pile on 9/11 or 9/12/01, or working on the WTC site for >7-days showed increased odds ratios of having ACO.

CONCLUSION: Probable ACO is associated with WTC exposures. Further study of ACO is needed to understand the development of this and other environmentally or occupationally-related airway diseases, and how to prevent these in disasters like 9/11.

Ko TM, Alper HE, Brackbill RH, et al. 2021. Trajectories of psychological distress among individuals exposed to the 9/11 World Trade Center disaster. Psychological Medicine. :1–12.

HTTPS://DOI.ORG/10.1017/S0033291720004912

BACKGROUND: Individuals present in lower Manhattan during the 9/11 World Trade Center (WTC) disaster suffered from significant physical and psychological trauma. Studies of longitudinal psychological distress among those exposed to trauma have been limited to relatively short durations of follow-up among smaller samples.

METHODS: The current study longitudinally assessed heterogeneity in trajectories of psychological distress among WTC Health Registry enrollees – a prospective cohort health study of responders, students, employees, passersby, and residents in the affected area (N = 30 839) – throughout a 15-year period following the WTC disaster. Rescue/recovery status and exposure to traumatic events of 9/11, as well as sociodemographic factors and health status, were assessed as risk factors for trajectories of psychological distress.

RESULTS: Five psychological distress trajectory groups were found: none-stable, low-stable, moderate-increasing, moderate-decreasing, and high-stable. Of the study sample, 78.2% were classified as belonging to the none-stable or low-stable groups. Female sex, being younger at the time of 9/11, lower education and income were associated with a higher probability of being in a greater distress trajectory group relative to the none-stable group. Greater exposure to traumatic events of 9/11 was associated with a higher probability of a greater distress trajectory, and community members (passerby, residents, and employees) were more likely to be in greater distress trajectory groups – especially in the moderate-increasing [odds ratios (OR) 2.31 (1.97–2.72)] and high-stable groups [OR 2.37 (1.81–3.09)] – compared to the none-stable group.

CONCLUSIONS: The current study illustrated the heterogeneity in psychological distress trajectories following the 9/11 WTC disaster, and identified potential avenues for intervention in future disasters.

Lim S, Liu SY, Brite J, et al. 2021. Dynamic residential movement and depression among the World Trade Center health registry enrollees. Social Psychiatry and Psychiatric Epidemiology.

HTTPS://DOI.ORG/10.1007/S00127-021-02192-9

PURPOSE: Residential instability is associated with poor mental health, but its causal inference is challenging due to time-varying exposure and confounding, and the role of changing social environments. We tested the association between frequent residential moving and depression risk among adults exposed to the 9/11 disaster.

METHODS: We used four waves of survey data from the World Trade Center Health Registry. We measured residential movement and depression using geocoded annual address records and the Personal Health Questionnaire Depression Scale, respectively, for a prospective cohort of 38,495 adults. We used the longitudinal Targeted Maximum Likelihood

METHOD: to estimate depression risk by frequent residential moving and conducted causal mediation analysis to evaluate a mediating role of social environments.

RESULTS: Most enrollees (68%) did not move in 2007–2014, and 6% moved at least once every 4 years. The remaining 26% moved less frequently (e.g., only moving in 2007–2010). Frequent moving versus no moving was associated with risk of depression in 2015–16 (RR = 1.20, 95% CI = 1.06, 1.37). Frequent residential moving—depression pathway was mediated by high social integration (OR = 0.93, 95% CI = 0.90, 0.97).

CONCLUSION: These findings demonstrate the importance of social networks in understanding increased risk of depression associated with housing instability.

Pollari CD, Brite J, Brackbill RM, et al. 2021. World Trade Center exposure and posttraumatic growth: Assessing positive psychological change 15 years after 9/11. Int J Environ Res Public Health. 18 (1)

HTTPS://DOI.ORG/10.3390/IJERPH18010104

We evaluated the presence of posttraumatic growth (PTG) among survivors of the 9/11 terrorist attack and how indicators of psychosocial well-being, direct 9/11-related exposure, and posttraumatic stress symptoms (PTSS) relate to PTG. PTG was examined among 4934 participants using the Posttraumatic Growth Inventory (PTGI). A confirmatory factor analysis (CFA) was conducted to determine if the original factor structure of the PTGI fits our data and principal component analysis (PCA) to identify the appropriate factor structure. Multivariable linear regression models were used to examine the association between PTG and indicators of psychosocial well-being, 9/11-related exposure, and PTSS, controlling for covariates. CFA identified a two-factor structure of the PTGI as a better fit than the original five-factor model. Participants who experienced very high 9/11-related exposure level (ss = 7.72; 95% CI: 5.75-9.70), higher PTSS at waves 1 (ss = 0.13; 95% CI: 0.08-0.18) and 2 (ss = 0.09;

95% CI: 0.05-0.14), high social integration (ss = 5.71; 95% CI: 4.47, 6.96), greater social support (ss = 0.49; 95% CI: 0.37, 0.61), and higher self-efficacy (ss = 1.26; 95% CI: 1.04, 1.48) had higher PTGI scores. Our findings suggest PTG is present, 15 years following the 9/11 terrorist attack. Very high-level 9/11 exposure, PTSS, and indicators of psychosocial well-being were associated with PTG.

Seil K, Yu MS, Brackbill R, et al. 2021. Web and paper survey mode patterns and preferences, health & employment survey, World Trade Center Health Registry. Survey Practice. 14 (1):1–12.

HTTPS://DOI.ORG/10.29115/SP-2021-0006

This study described patterns of response versus nonresponse, earlier versus later response, and paper versus web response to the 2017–2018 Health & Employment Survey (HES). We predicted odds of responding to the survey based on demographic factors and examined impact of multiple email reminders on response volume. The overall completion rate was 65%. The likelihood of responding to HES was more than doubled when the web survey was an option. Most web surveys were received during the first two months of data collection compared with less than one-third of paper surveys. Multiple email reminders resulted in increased responses. To offer mode options to all, more efforts should be made on collecting valid email addresses.

Seil K, Yu S, Brackbill R, et al. 2021. Effects of 9/11-related injury on retirement patterns among World Trade Center health registry enrollees. Am J Ind Med. 64 (10):873–880.

HTTPS://DOI.ORG/10.1002/AJIM.23288

BACKGROUND: Many survivors of the 9/11/2001 terrorist attacks in New York City sustained injuries. The aim of this study was to understand how 9/11-related injuries affected retirement patterns of World Trade Center Health Registry enrollees.

METHODS: The study included enrollees who participated in the 2017 Health & Quality of Life Survey, focused on 9/11-related injuries and quality of life, and the 2017-2018 Health & Employment Survey, focused on retirement and employment (N = 3535). Using Cox proportional hazards and logistic regression modeling, we calculated the risk of retiring at earlier ages and the odds of retirees working again, controlling for relevant covariates.

RESULTS: Results showed that 9/11-related injuries did affect retirement patterns. Injured enrollees were at greater risk of retiring at younger age compared to non-injured enrollees. Compared to more severely injured retirees, non-injured and less severely injured retirees were significantly more likely to work again postretirement. Our results suggested that being injured on 9/11 was associated with retirement, meaning that if the injury had not occurred, the individual may have continued working longer.

CONCLUSIONS: The need to retire earlier than planned could be addressed with employer and societal changes. Employers should consider making accommodations for those impacted by 9/11 a priority, as it is imperative for those who were injured

on 9/11 to have the ability to work to support their physical, mental, and financial well-being.

Takemoto E, Giesinger I, Russell JS, et al. 2021. Association between post-traumatic stress disorder and alcohol-related hospitalizations among World Trade Center Health Registry enrollees. Drug and Alcohol Dependence. 221:108656.

HTTPS://DOI.ORG/10.1016/J.DRUGALCDEP.2021.108656

BACKGROUND: We examined both the impact of 9/11-related exposures and repeated assessments of post-traumatic stress disorder (PTSD) on the risk of alcohol-related hospitalizations (ARH)among individuals exposed to the World Trade Center (WTC) disaster.

METHODS: 9/11-related exposures (witnessing traumatic events, physical injuries, or both) were measured at baseline and PTSD symptoms were assessed at four time points (2003-2016) using the PTSD Checklist-17 among 53,174 enrollees in the WTC Health Registry. ICD-9-CM and the PTSD Checklist-17 among 53,174 enrollees in the WTC Health Registry. ICD-9-CM andICD-10-CM codes were used to identify ARHs (2003-2016) through linked administrative data. For the effect of 9/11-related exposures on ARH, Cox proportional-hazards regression estimated hazard ratios (HR) and 95% confidence intervals (CI); for time-varying PTSD, extended Coxproportional-hazards regression was used. Models were adjusted for a priori confounders and stratified by enrollee group (uniformed rescue and recovery worker (RRW), non-uniformed RRW, and community members). Person-time was calculated from baseline or 9/12/2001 to the earliest of ARH, withdrawal, death, or end of follow-up (12/31/2016).

RESULTS: Across all 9/11-related exposures, community members and non-uniformed RRWs were at increased risk of ARHs; uniformed RRWs were not. In adjusted models, PTSD was associated with an increased risk of hospitalization across all groups [HR, (95% CI): uniformed RRWs: 2.6, (1.9, 3.6); non-uniformed RRWs: 2.1, (1.7, 2.7); and community members: 2.6, (2.1,3.2)].

CONCLUSIONS: Among certain enrollee groups, 9/11-related exposures are associated with an increased risk of ARH and that PTSD is strongly associated with ARHs among all enrollee groups. Findings may assist the clinical audience in improving screening and treatment.

Takemoto E, Van Oss KR, Chamany S, et al. 2021. Post-traumatic stress disorder and the association with overweight, obesity, and weight change among individuals exposed to the World Trade Center disaster, 2003-2016. Psychol Med. 51 (15):2647–2656.

HTTPS://DOI.ORG/10.1017/S0033291720001208

BACKGROUND: Among Veterans, post-traumatic stress disorder (PTSD) has been shown to be associated with obesity and accelerated weight gain. Less is known among the general population. We sought to determine the impact of PTSD on body mass index (BMI) and weight change among individuals with exposure to the World Trade Center (WTC) disaster.

METHODS: We examined individuals from the WTC Health Registry. PTSD symptoms were assessed on multiple surveys (Waves 1-4) using the PTSD Checklist-Specific. Three categories of post-9/11 PTSD were derived: no, intermittent, and persistent. We examined two outcomes: (1) Wave 3 BMI (normal, overweight, and obese) and (2) weight change between Waves 3 and 4. We used multivariable logistic regression to assess the association between PTSD and BMI (N = 34 958) and generalized estimating equations to assess the impact of PTSD on weight change (N = 26 532). Sex- and age-stratified analyses were adjusted for a priori confounders.

RESULTS: At Wave 3, the observed prevalence of obesity was highest among the persistent (39.5%) and intermittent PTSD (36.6%) groups, compared to the no PTSD group (29.3%). In adjusted models, persistent and intermittent PTSD were consistently associated with a higher odds of obesity. Weight gain was similar across all groups, but those with persistent and intermittent PTSD had higher estimated group-specific mean weights across time.

CONCLUSIONS: Our findings that those with a history of PTSD post-9/11 were more likely to have obesity is consistent with existing literature. These findings reaffirm the need for an interdisciplinary focus on physical and mental health to improve health outcomes.

Yu S, Alper HE, Nguyen AM, et al. 2021. Stroke hospitalizations, posttraumatic stress disorder, and 9/11-related dust exposure: Results from the World Trade Center health registry. Am J Ind Med. 64 (10):827–836.

HTTPS://DOI.ORG/10.1002/AJIM.23271

BACKGROUND: Few studies have examined the association between disaster-related factors and stroke by subtype or number. We investigated the association between 9/11-related posttraumatic stress disorder (PTSD), dust exposure, and stroke subtype as well as recurrent strokes.

METHODS: The study included 29,012 individuals enrolled in the World Trade Center Health Registry. Stroke cases were obtained by matching Registry enrollees to the New York State Department of Health's discharge records for inpatient visits between 2000 and 2016. Cox proportional hazards regression models were performed to examine the association between 9/11-related risk factors and stroke by subtype. Multinomial logistic regression models were conducted to assess the associations between the same risk factors and the number of stroke hospitalizations.

RESULTS: Having PTSD significantly increased the risk of developing ischemic and hemorrhagic stroke, with adjusted hazards ratios (AHRs) of 1.64 (95% confidence interval [CI]: 1.28-2.10) and 1.73 (95% CI: 1.10-2.71), respectively. The point estimate for dust cloud exposure, although not significant statistically, suggested an increased risk of ischemic stroke (AHR = 1.20, 95% CI: 0.96-1.50). PTSD was significantly associated with recurrent strokes with an adjusted odds ratio of 1.79 (95% CI: 1.09-2.95).

CONCLUSIONS: PTSD is a risk factor for both ischemic and hemorrhagic stroke and is

associated with recurrent strokes. Dust exposure on 9/11 is a possible risk factor for ischemic stroke but not for hemorrhagic stroke, and was not associated with recurrent strokes. Our findings warrant additional research on stroke-morbidity and mortality associated with 9/11-related PTSD and dust exposure.

Yung J, Takemoto E, Cone J, et al. 2021. Change in 9/11-related post-traumatic stress symptoms following cancer diagnosis. Psychooncology.

HTTPS://DOI.ORG/10.1002/PON.5855

OBJECTIVE: Cancer can be a life-threatening stressor that may evoke pre-existing post-traumatic stress disorder (PTSD). We assessed change in 9/11-related PTSD symptoms following cancer diagnosis in a 9/11-exposed cohort, the World Trade Center Health Registry.

METHODS: We examined enrollees who had a first-time post-9/11 invasive cancer diagnosis and at least one pre- and two post-diagnosis 9/11-related PTSD assessments from enrolment through 2015. PTSD symptoms were measured using 17-item PTSD Checklist (PCL, range 17-85). Cancer was identified from New York State Cancer Registry and categorized as localized or advanced stage. We used piecewise spline linear mixed-effects models to examine rate of change in PCL scores from pre- to post-diagnosis periods, and whether the change differed by gender or stage, with time as fixed and random effects, adjusting for baseline age, race, and education.

RESULTS: 9/11-related PTSD symptoms were slightly increasing in the pre-diagnosis period, while this trend reversed in the post-diagnosis period (β: -0.38; 95% CI: -0.60, -0.15). This trend was driven by male rescue/recovery workers (RRW), among whom significant decrease in rate of change in PCL scores was observed for those with advanced stage (slope change difference [95% CI]: -1.81 [-2.73, -0.90]). No significant difference in rate of change was observed among non-RRW. Among females, PCL scores tended to decrease slightly, with no significant difference in rate of change between pre- and post-diagnosis periods.

CONCLUSIONS: We observed significant reduction in the rate of change in 9/11-related PTSD symptoms among male RRW. The underlying mechanism is unknown, necessitating future research.

Year Published 2022 (10)

Boffetta P, Goldfarb DG, Zeig-Owens R, et al. 2022. Temporal aspects of the association between exposure to the World Trade Center disaster and risk of skin melanoma. Journal. 2 (1):100063.

HTTPS://DOI.ORG/10.1101/2021.03.10.21253261

Rescue/recovery workers who responded to the World Trade Center (WTC) attacks on 9/11/2001 were exposed to known/suspected carcinogens. Studies have identified an increased risk of skin melanoma in this population, but the temporal aspects of the association have not been investigated. A total

of 44,540 non-Hispanic White workers from the WTC Combined Rescue/Recovery Cohort were observed between 3/12/2002 and 12/31/2015. Cancer data were obtained via linkages with 13 state registries. Poisson regression was used to estimate hazard ratios (HR) and 95% confidence intervals (CI), using the New York State population as reference; change points in the HRs were estimated using profile likelihood. We observed 247 incident cases of skin melanoma. No increase in incidence was detected between 2002 and 2004. Beginning in 2005, the HR was 1.34 (95% CI 1.18-1.52). A dose-response relationship was observed according to time worked on the WTC effort. Risk of melanoma among non-Hispanic White WTC rescue/recovery workers was elevated, beginning in 2005. While WTC-related exposure to ultraviolet radiation or other agents might have contributed to this result, exposures other than the WTC effort and enhanced medical surveillance cannot be discounted. Our results support the continued surveillance of this population for melanoma.

Boffetta P, Hall CB, Todd AC, et al. 2022. Cancer risk among World Trade Center rescue and recovery workers: A review. CA Cancer J Clin.

HTTPS://DOI.ORG/10.3322/CAAC.21723

BACKGROUND: Twenty years after the September 11th, 2001 terrorist attacks, the association between exposures present at the World Trade Center (WTC) site and the risk of several specific types of cancer has been reported among rescue and recovery workers. The authors' objective was to conduct an updated review of these data. Most studies have found elevated rates of both prostate and thyroid cancers compared with rates in the general population, and some have reported statistically significant differences for the rates of all cancers as well. Studies including a larger combined cohort of WTC-exposed rescue and recovery workers from 3 main cohorts have since replicated findings for these cancers, with additional years of follow-up. Among this combined cohort, although a lower-than-expected standardized incidence ratio for all cancers was observed, WTC exposure was also related to an increased risk of cutaneous melanoma and tonsil cancer. Importantly, another study found that WTC-exposed rescue and recovery workers who are enrolled in the federally funded medical monitoring and treatment program experienced improved survival post-cancer diagnosis compared with New York state patients with cancer. On the basis of these combined cohort studies, the full effect of WTC exposure on cancer risk is becoming clearer. Consequently, the authors believe that surveillance of those with WTC exposure should be continued, and in-depth analysis of epidemiologic, molecular, and clinical aspects of specific cancers in these workers should be pursued.

Clouston SAP, Hall CB, Kritikos M, et al. 2022. Cognitive impairment and world trade centre-related exposures. Nat Rev Neurol. 18 (2):103–116.

HTTPS://DOI.ORG/10.1038/S41582-021-00576-8

BACKGROUND: On 11 September 2001 the World Trade Center (WTC) in New York was attacked by terrorists, causing the collapse of multiple buildings including the iconic 110-story 'Twin Towers'. Thousands of peo-

ple died that day from the collapse of the buildings, fires, falling from the buildings, falling debris, or other related accidents. Survivors of the attacks, those who worked in search and rescue during and after the buildings collapsed, and those working in recovery and clean-up operations were exposed to severe psychological stressors. Concurrently, these 'WTC-affected' individuals breathed and ingested a mixture of organic and particulate neurotoxins and pro-inflammogens generated as a result of the attack and building collapse. Twenty years later, researchers have documented neurocognitive and motor dysfunctions that resemble the typical features of neurodegenerative disease in some WTC responders at midlife. Cortical atrophy, which usually manifests later in life, has also been observed in this population. Evidence indicates that neurocognitive symptoms and corresponding brain atrophy are associated with both physical exposures at the WTC and chronic post-traumatic stress disorder, including regularly re-experiencing traumatic memories of the events while awake or during sleep. Despite these findings, little is understood about the long-term effects of these physical and mental exposures on the brain health of WTC-affected individuals, and the potential for neurocognitive disorders. Here, we review the existing evidence concerning neurological outcomes in WTC-affected individuals, with the aim of contextualizing this research for policymakers, researchers and clinicians and educating WTC-affected individuals and their friends and families. We conclude by providing a rationale and recommendations for monitoring the neurological health of WTC-affected individuals.

Huber KA, Frazier PA, Alper HE, et al. 2022. Trajectories of posttraumatic stress symptoms following the september 11, 2001, terrorist attacks: A comparison of two modeling approaches. J Trauma Stress.

HTTPS://DOI.ORG/10.1002/JTS.22763

BACKGROUND: Several studies have analyzed longitudinal data on posttraumatic stress symptoms (PTSS) from individuals who were proximal to the September 11, 2001, terrorist attacks (9/11) in an attempt to identify different trajectories of mental health in the years following mass trauma. The results of these studies have been heterogeneous, with researchers who used latent growth mixture modeling (LGMM) tending to identify four trajectories and those who used group-based trajectory modeling (GBTM) identifying five to seven trajectories. Given that no study has applied both GBTM and LGMM to their data, it remains unknown which modeling approach and what number of trajectories best fit post-9/11 PTSS data. The present study aimed to address that question by applying both LGMM and GBTM to data from the largest sample of survivors to date, comprising 37,545 New York City community members. When analyzing four waves of PTSS, reflecting participants' mental health up to 15 years post-9/11, LGMM fit the data better than GBTM. Our optimal solution consisted of four trajectories: low-stable (72.2% of the sample), decreasing (12.8%), increasing (9.5%), and high-stable (5.5%) symptoms. Covariate analyses indicated that economic factors (i.e., having a household income less than $25,000 and experiencing job loss due to 9/11) increased the odds of

belonging to the high-stable symptom trajectory group to the greatest degree, ORs = 4.93-6.08. The results suggest that providing financial support, including affordable mental health care, could be an important intervention in the wake of future mass traumatic events.

Li J, Yung J, Qiao B, et al. 2022. Cancer incidence in World Trade Center rescue and recovery workers: 14 years of follow-up. J Natl Cancer Inst. 114 (2):210–219.

HTTPS://DOI.ORG/10.1093/JNCI/DJAB165

BACKGROUND: Statistically significantly increased cancer incidence has been reported from 3 cohorts of World Trade Center (WTC) disaster rescue and recovery workers. We pooled data across these cohorts to address ongoing public concerns regarding cancer risk 14 years after WTC exposure.

METHODS: From a combined deduplicated cohort of 69 102 WTC rescue and recovery workers, a sample of 57 402 workers enrolled before 2009 and followed through 2015 was studied. Invasive cancers diagnosed in 2002-2015 were identified from 13 state cancer registries. Standardized incidence ratios (SIRs) were used to assess cancer incidence. Adjusted hazard ratios (aHRs) were estimated from Cox regression to examine associations between WTC exposures and cancer risk.

RESULTS: Of the 3611 incident cancers identified, 3236 were reported as first-time primary (FP) cancers, with an accumulated 649 724 and 624 620 person-years of follow-up, respectively. Incidence for combined FP cancers was below expectation (SIR = 0.96, 95% confidence interval [CI] = 0.93 to 0.99). Statistically significantly elevated SIRs were observed for melanoma-skin (SIR = 1.43, 95% CI = 1.24 to 1.64), prostate (SIR = 1.19, 95% CI = 1.11 to 1.26), thyroid (SIR = 1.81, 95% CI = 1.57 to 2.09), and tonsil (SIR = 1.40, 95% CI = 1.00 to 1.91) cancer. Those arriving on September 11 had statistically significantly higher aHRs than those arriving after September 17, 2001, for prostate (aHR = 1.61, 95% CI = 1.33 to 1.95) and thyroid (aHR = 1.77, 95% CI = 1.11 to 2.81) cancers, with a statistically significant exposure-response trend for both.

CONCLUSIONS: In the largest cohort of 9/11 rescue and recovery workers ever studied, overall cancer incidence was lower than expected, and intensity of WTC exposure was associated with increased risk for specific cancer sites, demonstrating the value of long-term follow-up studies after environmental disasters.

Lin NW and Maier LA. 2022. Occupational exposures and sarcoidosis: Current understanding and knowledge gaps. Curr Opin Pulm Med. 28 (2):144–151.

HTTPS://DOI.ORG/10.1097/MCP.0000000000000835

PURPOSE OF REVIEW: Sarcoidosis is an idiopathic granulomatous disease that primarily affects the lungs. Several lines of evidence suggest that occupational exposures are associated with disease risk. This review critically evaluates studies using the Bradford Hill criteria for causation to determine if a causal relationship can be established between occupational exposure and sarcoidosis.

RECENT FINDINGS: Large epidemiological studies have proposed multiple occupation-

al exposures associated with sarcoidosis but lack consistency of results. Many convincing studies demonstrate an association between World Trade Center (WTC) dust and sarcoidosis, which illustrates a causal relationship based on the fulfillment of the Bradford Hill criteria. Studies describing an association between silica/metals and sarcoidosis are intriguing but fulfill a limited number of the Bradford Hill criteria and warrant further investigation before a causal relationship can be determined. Finally, we also discuss preliminary studies associating sarcoidosis phenotypes with specific occupational exposures.

SUMMARY: Using the Bradford Hill criteria for causation, we demonstrate that WTC dust has a causative relationship with sarcoidosis, which reinforces the theory that sarcoidosis is an exposure-related disease. More research is needed to determine other specific occupational exposures causing disease.

Liu SY, Li J, Leon LF, et al. 2022. The bidirectional relationship between posttraumatic stress symptoms and social support in a 9/11-exposed cohort: A longitudinal cross-lagged analysis. Int J Environ Res Public Health. 19 (5)

HTTPS://DOI.ORG/10.3390/IJERPH19052604

BACKGROUND: Research on the longitudinal relationship between posttraumatic stress disorder (PTSD) and social support among survivors of large-scale trauma is limited. This study assessed bidirectional relationships between PTSD and perceived social support in a large sample of the 9/11-exposed cohort over a 14-year follow-up. We used data from 23,165 World Trade Center Health Registry (WTCHR) enrollees who were exposed to the 9/11 attacks and participated in the first four WTCHR surveys (Wave 1 (2003-2004) to Wave 4 (2015-2016)). PTSD symptoms were measured using the 17-item PTSD Checklist. Perceived social support was measured using the five-item version of the Modified Social Support Survey. We used a cross-lagged panel analysis and found an inverse relationship between PTSD symptoms and social support. PTSD at Wave 2 (W2) predicted less social support at Wave 3 (W3) ($\beta = -0.10$, $p < 0.01$), and PTSD at W3 predicted less social support at W4 ($\beta = -0.05$, $p < 0.01$). Conversely, social support at W3 buffered PTSD symptoms at W4 ($\beta = -0.03$, $p < 0.05$). Sub-analyses by types of perceived social support suggest greater effects of PTSD on emotional support than tangible support and in community members than rescue/recovery workers. Our findings suggest a bidirectional effect between PTSD symptoms and social support in a longitudinal study of 9/11-exposed populations.

Seil K, Takemoto E, Farfel MR, et al. 2022. Exploratory case study of suicide among a sample of 9/11 survivors. International Journal of Environmental Research and Public Health. 19 (1)

HTTPS://DOI.ORG/10.3390/IJERPH19010057

BACKGROUND: Previous research has found higher than expected suicide mortality among rescue/recovery workers (RRWs) enrolled in the World Trade Center Health Registry (WTCHR). Whether any enrollee suicides are related to the decedents' experiences on 9/11 is unknown. We abstracted medical examiner

file data to learn more about 9/11-related circumstances of suicides among WTCHR enrollees. Methods: We identified 35 enrollee suicide cases that occurred in New York City using linked vital records data. We reviewed medical examiner files on each case, abstracting demographic and circumstantial data. We also reviewed survey data collected from each case at WTCHR enrollment (2003–2004) and available subsequent surveys to calculate descriptive statistics.

RESULTS: Cases were mostly non-Hispanic White (66%), male (83%), and middle-aged (median 58 years). Nineteen decedents (54%) were RRWs, and 32% of them worked at the WTC site for >90 days compared to 18% of the RRW group overall. In the medical examiner files of two cases, accounts from family mentioned 9/11-related circumstances, unprompted. All deaths occurred during 2004–2018, ranging from one to four cases per year. Leading mechanisms were hanging/suffocation (26%), firearm (23%), and jump from height (23%). Sixty percent of the cases had depression mentioned in the files, but none mentioned posttraumatic stress disorder.

CONCLUSIONS: RRWs may be at particular risk for suicide, as those who worked at the WTC site for long periods appeared to be more likely to die by suicide than other RRWs. Mental health screening and treatment must continue to be prioritized for the 9/11-exposed population. More in-depth investigations of suicides can elucidate the ongoing impacts of 9/11.

Takemoto E, Locke S, Goin DE, et al. 2022. Exposure to the World Trade Center disaster and test performance among New York city public school students over time, 1998–2003. SSM - Mental Health. 2:100096.

HTTPS://DOI.ORG/10.1016/J.SSMMH.2022.100096

BACKGROUND: The World Trade Center (WTC) disaster exposed children to environmental toxins and emotional traumas. WTC exposure health effects have been well-documented; impacts on education outcomes, which have been associated with health over the life course, have not. We examined the WTC disaster's impact on math and English language arts (ELA) exams among New York City (NYC) public school students.

METHODS: Student-level data for 3rd graders in 1998–99 were obtained for five consecutive school years, three pre-9/11 and two post-9/11 from the NYC Department of Education. Piecewise linear mixed models with two slopes representing two time periods—pre-and post-9/11—were used to examine the WTC impact on exam scores among 393 students in exposed Ground Zero area schools (WTC site: 0–1.5 miles) versus 39,047 students in unexposed NYC schools (WTC site: >6 miles).

RESULTS: On math exams, students in Ground Zero area schools were improving their scores in both the pre-9/11 period and post-9/11 period – with a slightly greater magnitude of improvement post-9/11 (change in slope post-9/11 from pre-9/11: 0.5, 95% CI: 3.1, 5.2). Students in unexposed schools experienced a slight decrease in the rate of improvement on math scores

in the post-9/11 period (change in slope post-9/11 from pre-9/11: 0.6, 95% CI: 1.2, −0.0). On ELA exams, both students in Ground zero area schools and unexposed schools were positively increasing their test scores in both the pre-9/11 and post-9/11 period; both groups experienced a faster rate of improvement in the post-9/11 period (change in slope post-9/11 from pre-9/11 [95% CI]: Ground zero: 1.2 [-2-2, 4.5], unexposed: 3.0 [2.6, 3.4].

CONCLUSIONS: Compared to the pre-9/11 time-period, students in Ground Zero area schools experienced modest improvements in test scores in the post-9/11 time-period. Futures studies should evaluate long-term impacts on education, as outcomes may differ compared to the short-term effects.

Yu H, Tuminello S, Alpert N, et al. 2022. Global DNA methylation of WTC prostate cancer tissues show signature differences compared to non-exposed cases. Carcinogenesis.

HTTPS://DOI.ORG/10.1093/CARCIN/BGAC025

BACKGROUND: There is increased incidence of prostate cancer (PC) among World Trade Center (WTC)-exposed responders and community members, with preliminary evidence suggestive of more aggressive disease. While previous research is supportive of differences in DNA methylation and gene expression as a consequence of WTC exposure, as measured in blood of healthy individuals, the epigenetics of WTC PC tissues has yet to be explored. Patients were recruited from the World Trade Center Health Program. Non-WTC PC samples were frequency matched on age, race/ethnicity and Gleason score. Bisulfite-treated DNA was extracted from tumor tissue blocks and used to assess global DNA methylation with the MethylationEPIC BeadChip. Differential and pathway enrichment analysis were conducted. RNA from the same tumor blocks was used for gene expression analysis to further support DNA methylation findings. Methylation data were generated for 28 samples (13 WTC and 15 non-WTC). Statistically significant differences in methylation were observed for 3,586 genes; on average WTC samples were statistically significantly more hypermethylated (p=0.04131). Pathway enrichment analysis revealed hypermethylation in epithelial mesenchymal transition (EMT), hypoxia, mitotic spindle, TNFA signaling via NFKB, WNT signaling, and TGF beta signaling pathways in WTC compared to non-WTC samples. The androgen response, G2M and MYC target pathways were hypomethylated. These results correlated well with RNA gene expression. In conclusion, long-term epigenic changes associated with WTC dust exposure were observed in PC tissues. These occurred in genes of critical pathways, likely increasing prostate tumorigenesis potential. This warrants analysis of larger WTC groups and other cancer types.

Appendix 2, Section 3

WTC FDNY Responders Data Center • Research Publications

Year Published 2002 (4)

Baunach G, McLaughlin M, Hirschorn R, et al. 2002. Injuries and illnesses among New York City Fire Department rescue workers after responding to the World Trade Center attacks. Morbidity and Mortality Weekly. 51 (Spec. No.):1–5.

HTTPS://WWW.NCBI.NLM.NIH.GOV/PUBMED/12238534

Within minutes of the terrorist attacks on September 11, 2001, the Fire Department of New York City (FDNY) operated a continuous rescue/recovery effort at the WTC site. Medical officers of FDNY Bureau of Health Services (FDNY-BHS) responded to provide emergency medical services (see box). The collapse of the WTC towers and several adjacent structures resulted in a vast, physically dangerous disaster zone. The height of the WTC towers produced extraordinary forces during their collapse, pulverizing considerable portions of the buildings' structural components and exposing first responders and civilians to substantial amounts of airborne particulate matter. Fires burned continuously under the debris until mid-December 2001. Because of ongoing fire activity and the large numbers of civilians and rescue workers who were killed during the attacks, approximately 11,000 FDNY firefighters and many emergency medical service (EMS) personnel worked on or directly adjacent to the rubble and incurred substantial exposures. This report describes morbidity and mortality in FDNY rescue workers during the 11-month period after the WTC attacks and documents a substantial increase in respiratory and stress-related illness compared with the time period before the WTC attacks. These findings demonstrate the need to provide acute and long-term medical monitoring, treatment, and counseling to FDNY rescue workers exposed to this disaster and to solve supply, compliance, and supervision problems so that respiratory protection can be rapidly provided at future disasters.

Prezant D, Kelly K, Jackson B, et al. 2002. Use of respiratory protection among responders at the World Trade Center site--New York City, September 2001 Morbidity and Mortality Weekly. 51 (Spec. No.):6–8.

HTTPS://WWW.NCBI.NLM.NIH.GOV/PUBMED/12238539

The terrorist attacks on the WTC on September 11, 2001, created an occupational health and safety challenge for New York City (NYC) firefighters and rescue workers responding to the disaster. Immediate respiratory hazards included explosions, fire, falling debris, and dust clouds containing particulate matter comprised of pulverized building materials. Ongoing risks included lingering particulate matter in the air and intermittent combustion products from initial and persistent fires beneath the rubble pile. Because the nature and extent of exposures in

disaster situations are complex and difficult to characterize, the use of adequate personal protective equipment (PPE), including respiratory protection, is essential in protecting the health of firefighters and other rescue workers. During the weeks after September 11, the NYC Fire Department's Bureau of Health Services (FDNY-BHS) and CDC's National Institute for Occupational Safety and Health (NIOSH) organized a collaborative study to evaluate occupational hazards and exposures for these workers, including their use of respiratory protection. This report summarizes the results of that study, which indicate that the majority of firefighters did not use adequate respiratory protection during the first week of the rescue/recovery operation.

Prezant D, Weiden M, Banauch G, et al. 2002. Cough and bronchial responsiveness in firefighters at the World Trade Center site. New England Journal of Medicine. 347(11):806–815.

HTTPS://DOI.ORG/10.1056/NEJMOA021300

BACKGROUND: Workers from the Fire Department of New York City were exposed to a variety of inhaled materials during and after the collapse of the WTC. We evaluated clinical features in a series of 332 firefighters in whom severe cough developed after exposure and the prevalence and severity of bronchial hyperreactivity in firefighters without severe cough classified according to the level of exposure.

METHODS: "WTC cough" was defined as a persistent cough that developed after exposure to the site and was accompanied by respiratory symptoms severe enough to require medical leave for at least four weeks. Evaluation of exposed firefighters included completion of a standard questionnaire, spirometry, airway-responsiveness testing, and chest imaging.

RESULTS: In the first six months after September 11, 2001, WTC cough occurred in 128 of 1636 firefighters with a high level of exposure (8%), 187 of 6958 with a moderate level of exposure (3%), and 17 of 1320 with a low level of exposure (1%). In addition, 95% had symptoms of dyspnea, 87% had gastroesophageal reflux disease, and 54% had nasal congestion. Of those tested before treatment of WTC cough, 63%of firefighters (149 of 237) had a response to a bronchodilator and 24% (9 of 37) had bronchial hyperreactivity. Chest radiographs were unchanged from precollapse findings in 319 of the 332 with WTC cough. Among the cohort without severe cough, bronchial hyperreactivity was present in 77 firefighters with a high level of exposure (23%) and 26 with a moderate level of exposure (8%).

CONCLUSIONS: Intense, short-term exposure to materials generated during the collapse of the WTC was associated with bronchial responsiveness and the development of cough. Clinical and physiological severity was related to the intensity of exposure.

Rom W, Weiden M, Garcia R, et al. 2002. Acute eosinophilic pneumonia in a New York City fire-

fighter exposed to World Trade Center dust. American Journal of Respiratory and Critical Care Medicine. 166(6):797–800.

HTTPS://DOI.ORG/10.1164/RCCM.200206-576OC

BACKGROUND: We report a sentinel case of acute eosinophilic pneumonia in a firefighter exposed to high concentrations of WTC dust during the rescue effort from September 11 to 24. The firefighter presented with a Pa(O2) of 53 mm Hg and responded to oxygen and corticosteroids. Computed tomography scan showed patchy ground glass density, thickened bronchial walls, and bilateral pleural effusions. Bronchoalveolar lavage recovered 70% eosinophils, with only 1% eosinophils in peripheral blood. Eosinophils were not degranulated and increased levels of interleukin-5 were measured in bronchoalveolar lavage and serum. Mineralogic analysis counted 305 commercial asbestos fibers/10(6) macrophages including those with high aspect ratios, and significant quantities of fly ash and degraded fibrous glass. Acute eosinophilic pneumonia is a rare consequence of acute high dust exposure. WTC dust consists of large particle-size silicates, but fly ash and asbestos fibers may be found in bronchoalveolar lavage cells.

Year Published 2003 (2)

Banauch G, Alleyne D, Sanchez R, et al. 2003. Persistent hyperreactivity and reactive airway dysfunction in firefighters at the World Trade Center. American Journal of Respiratory and Critical Care Medicine. 168(1):54–62.

HTTPS://DOI.ORG/10.1164/RCCM.200211-1329OC

BACKGROUND: New York City Fire Department rescue workers experienced massive exposure to airborne particulates at the WTC site. Aims of this longitudinal study were to (1) determine if bronchial hyperreactivity was present, persistent, and independently associated with exposure intensity, (2) identify objective measures shortly after the collapse that would predict persistent hyperreactivity and a diagnosis of reactive airways dysfunction 6 months post-collapse. A representative sample of 179 rescue workers stratified by exposure intensity (high, moderate, and control) without current smoking or prior respiratory disease was enrolled. Highly exposed workers arrived within 2 hours of collapse, moderately exposed workers arrived later on Days 1–2; control subjects were not exposed. Hyperreactivity at 1, 3, and 6 months post-collapse was associated with exposure intensity, independent of ex-smoking and airflow obstruction. Six months post-collapse, highly exposed workers were 6.8 times more likely than moderately exposed workers and control subjects to be hyperreactive (95% confidence interval, 1.8–25.2; p=0.004), and hyperreactivity persisted in 55% of those hyperreactive

at1 and/or 3 months. In highly exposed subjects, hyperreactivity 1 or 3 months post-collapse was the sole predictor for reactive airways dysfunction (p=0.021). In conclusion, development and persistence of hyperreactivity and reactive airways dysfunction were strongly and independently associated with exposure intensity. Hyperreactivity shortly post-collapse predicted reactive airways dysfunction at 6 months in highly exposed workers; this has important implications for disaster management.

Edelman P, Osterloh J, Pirkle J, et al. 2003. Biomonitoring of chemical exposure among New York City firefighters responding to the World Trade Center fire and collapse. Environmental Health Perspectives. 111(16):1906–1911.

HTTPS://WWW.NCBI.NLM.NIH.GOV/PMC/ARTICLES/PMC1241765/

BACKGROUND: The collapse of the WTC on September 11, 2001, exposed New York City firefighters to smoke and dust of unprecedented magnitude and duration. The chemicals and the concentrations produced from any fire are difficult to predict, but estimates of internal dose exposures can be assessed by the biological monitoring of blood and urine. We analyzed blood and urine specimens obtained from 321 firefighters responding to the WTC fires and collapse for 110 potentially fire-related chemicals. Controls consisted of 47 firefighters not present at the WTC. Sampling occurred 3 weeks after 11 September, while fires were still burning. When reference or background ranges were available, most chemical concentrations were found to be generally low and not outside these ranges. Compared with controls, the exposed firefighters showed significant differences in adjusted geometric means for six of the chemicals and significantly greater detection rates for an additional three. Arrival time was a significant predictor variable for four chemicals. Special Operations Command firefighters (n=95), compared with other responding WTC firefighters (n=226), had differences in concentrations or detection rate for 14 of the chemicals. Values for the Special Operations Command firefighters were also significantly different from the control group values for these same chemicals and for two additional chemicals. Generally, the chemical concentrations in the other firefighter group were not different from those of controls. Biomonitoring was used to characterize firefighter exposure at the WTC disaster. Although some of the chemicals analyzed showed statistically significant differences, these differences were generally small.

Year Published 2004 (3)

Feldman D, Baron S, Bernard B, et al. 2004. Symptoms, respirator use, and pulmonary function changes among New York City firefighters responding to the World Trade Center disaster. Chest.

125(4):1256–1264.

HTTPS://DOI.ORG/10.1378/CHEST.125.4.1256

HTTPS://WWW.SCIENCEDIRECT.COM/SCIENCE/ARTICLE/PII/S0012369215320833?VIA%3DIHUB

CONTEXT: New York City firefighters responding to the WTC disaster on September 11, 2001, were exposed to numerous hazards. A medical screening program was conducted 3 weeks after the disaster on a sample of firefighters.

OBJECTIVES: To determine whether arrival time at the WTC and other exposure variables (including respirator use) were associated with symptoms and changes in pulmonary function (after exposure before exposure).

DESIGN: A cross-sectional comparison of firefighters representing the following groups: (1)firefighters who arrived before/during the WTC collapse, (2) firefighters who arrived 1 to 2 days after the collapse, (1) Firefighters who arrived 3 to 7 days after the collapse, and (4) unexposed firefighters.

SETTING: Fire Department of New York City (FDNY) Bureau of Health Services on October 1 to 5, 2001.

POPULATION: A stratified random sample of 362 of 398 recruited working firefighters (91%). Of these, 149 firefighters (41%) were present at the WTC collapse, 142 firefighters (39%) arrived after the collapse but within 48 h, 28 firefighters (8%) arrived 3 to 7 days after the collapse, and 43 firefighters (12%) were unexposed.

MAIN OUTCOME MEASURES: New/worsening symptoms involving the eyes, skin, respiratory system, and nose and throat (NT), and changes in spirometry from before to after exposure.

RESULTS: During the first 2 weeks at the WTC site, 19% of study firefighters reported not using a respirator; 50% reported using a respirator but only rarely. Prevalence ratios (PRs) for skin, eye, respiratory, and NT symptoms showed a dose-response pattern between exposure groups based on time of arrival at the WTC site, with PRs between 2.6 and 11.4 with 95% confidence intervals (CIs) excluding 1.0 for all but skin symptoms. For those spending > 7 days at the site, the PR for respiratory symptoms was 1.32 (95% CI, 1.13 to 1.55), compared with those who were exposed for < 7 days. Mean spirometry results before and after exposure were within normal limits. The change in spirometry findings (after exposure before exposure) showed near-equal reductions for FVC and FEV(1). These reductions were greater than the annual reductions measured in a referent population of incumbent FDNY firefighters prior to September 11 ($p <or= 0.05$). There was a 60% increased risk of a decline of >or= 450 mL in FEV(1) in those arriving during the first 48 h compared to the referent ($p <or= 0.05$).

CONCLUSIONS: The symptoms and pulmonary function changes following exposure at the WTC demonstrate the need for improvements in respirators and

their use, as well as long-term medical monitoring of rescue workers.

Fireman E, Lerman Y, Ganor E, et al. 2004. Induced Sputum Assessment in New York City firefighters Exposed to World Trade Center Dust. Environmental Health Perspectives. 112(15):1564–1569.

HTTPS://WWW.NCBI.NLM.NIH.GOV/PMC/ARTICLES/PMC1247622/

CONTEXT: New York City Firefighters (FDNY-FFs) were exposed to particulate matter and combustion/pyrolysis products during and after the World Trade Center (WTC) collapse. Ten months after the collapse, induced sputum (IS) samples were obtained from 39 highly exposed FDNY-FFs (caught in the dust cloud during the collapse on 11 September 2001) and compared to controls to determine whether a unique pattern of inflammation and particulate matter deposition, compatible with WTC dust, was present. Control subjects were 12 Tel-Aviv, Israel, firefighters (TA-FFs) and 8 Israeli healthcare workers who were not exposed to WTC dust. All controls volunteered for this study, had never smoked, and did not have respiratory illness. IS was processed by conventional methods. Retrieved cells were differentially counted, and metalloproteinase-9 (MMP-9), particle size distribution (PSD), and mineral composition were measured. Differential cell counts of FDNY-FF IS differed from those of health care worker controls ($p < 0.05$) but not from those of TA-FFs. Percentages of neutrophils and eosinophils increased with greater intensity of WTC exposure (< 10 workdays or greater than or equal to 10 workdays; neutrophils p=0.046; eosinophils p=0.038). MMP-9 levels positively correlated to neutrophil counts (p=0.002; r=0.449). Particles were larger and more irregularly shaped in FDNY-FFs (1–50 microm; zinc, mercury, gold, tin, silver) than in TA-FFs (1–10 microm; silica, clays). PSD was similar to that of WTC dust samples.

IN CONCLUSION:, IS from highly exposed FDNY-FFs demonstrated inflammation, PSD, and particle composition that was different from non-exposed controls and consistent with WTC dust exposure.
Truncale T, Brooks S, Prezant D, et al. 2004. World Trade Center dust and airway reactivity. American Journal of Respiratory and Critical Care Medicine. 169(7):883–884; author reply 884–885. [no abstract]

HTTPS://DOI.ORG/10.1164/AJRCCM.169.7.954

BACKGROUND: Banauch and coworkers (1) reported that a subgroup of New York City's firefighters exposed to airborne particulates during and after the World Trade Center (WTC) collapse suffered from persistent bronchial hyperreactivity and reactive airway dysfunction syndrome (RADS). Nemery (2), commenting on the article, argued that "RADS does not require a clinically severe inhalation injury necessitating medical care, let alone hospitalization."We disagree with both of these contentions and suggest that the pulmonary condition associated with the WTC not be considered as RADS. This disagreement is especially valid because the WTC pulmonary con-

dition does not fulfill the clinical criteria of RADS, an acute asthma syndrome that develops after a single high-level exposure to an irritant gas, fume, or vapor (3). The asthma symptoms develop acutely and always within 24 hours. The exposure is of such magnitude that there is almost always a need for acute medical attention. Furthermore, a dust exposure (e.g., pulverized cement, gypsum, concrete aggregate, ceiling tiles, and wall board or high concentrations of particulate matter) has not been previously reported to cause RADS. Much of the WTC debris was of a particle size too large to be inhaled into the lungs. Perhaps a better term to describe the WTC pulmonary condition is "nonallergic asthma." This general term also could encompass conditions such as RADS, irritant-induced asthma, and perhaps even noneosinophilic asthma (4). An interesting observation is the high alkalinity of the dust. Perhaps there is a more effective human response to an acid inhalation challenge (e.g., from acid air pollutants). The human defense against an alkaline inhalation challenge may not be as efficient and perhaps more detrimental. A better understanding of the airway responses to acid and alkaline challenges seems to be an appropriate area for future research.We are still left with the consideration that the exposure to the dust and debris from the WTC collapse caused asthma symptoms in only a susceptible subgroup of individuals. Although preexisting asthma in remission and asymptomatic airway hyperresponsiveness may explain some cases, there may be other factors characterizing greater host susceptibility (5, 6). The role of host susceptibility in nonallergic asthma syndromes is another area of necessary research.

Year Published 2005 (2)

Banauch G, Dhala A, Alleyne D, et al. 2005. Bronchial hyperreactivity and other inhalation lung injuries in rescue/recovery workers after the World Trade Center collapse. Critical Care Medicine. 33(S1):S102–S106.

HTTPS:DOI.ORG/10.1097/01.CCM.0000151138.10586.3A

BACKGROUND: The collapse of the WTC on September 11, 2001 created a large-scale disaster site in a dense urban environment. In the days and months thereafter, thousands of rescue/recovery workers, volunteers, and residents were exposed to a complex mixture of airborne pollutants.

METHODS: We review current knowledge of aerodigestive inhalation lung injuries resulting from this complex exposure and present new data on the persistence of nonspecific bronchial hyperreactivity (methacholine PC20 < or=8 mg/mL) in a representative sample of 179 Fire Department of the City of New York (FDNY) rescue workers stratified by exposure intensity (according to arrival time) who underwent challenge testing at 1, 3, 6, and 12 months post-collapse.

RESULTS: Aerodigestive tract inflammatory injuries, such as declines in pulmonary function, reactive airways dysfunction syndrome (RADS), asthma, reactive upper airways dysfunction syndrome (RUDS), gastroesophageal reflux disease (GERD), and rare cases of inflammatory pulmonary parenchymal diseases, have been documented in WTC rescue/recovery workers and volunteers. In FDNY rescue workers, we found persistent hyperreactivity associated with exposure intensity, independent of airflow obstruction. One year post-collapse, 23% of highly exposed subjects were hyperreactive as compared with only 11% of moderately exposed and 4% of controls. At 1 yr, 16% met the criteria for RADS.

CONCLUSIONS: While it is too early to ascertain all of the long-term effects of WTC exposures, continued medical monitoring and treatment is needed to help those exposed and to improve our prevention, diagnosis, and treatment protocols for future disasters.

Banauch G, Dhala A, Prezant D. 2005. Pulmonary disease in rescue workers at the World Trade Center site. Current Opinion in Pulmonary Medicine. 11(2):160–168.

HTTP://DOI.ORG/10.1097/01.MCP.0000151 716.96241.0A

PURPOSE OF REVIEW: The catastrophic collapse of the WTC towers on September 11, 2001 created a large-scale disaster site in a densely populated urban environment. Over the ensuing months, tens of thousands of rescue, recovery and cleanup workers, volunteers, and residents of the adjacent community were exposed to a complex mixture of airborne pollutants. This review focuses on currently described respiratory syndromes, symptoms, and physiologic derangements in WTC rescue, recovery, and cleanup workers, discusses potential long- term effects on respiratory health, and draws parallels to community findings.

RECENT FINDINGS: Detailed qualitative and quantitative analyses of airborne pollutants with their changing composition during initial rescue/recovery and subsequent cleanup have been published. Major concerns include persistent aerodigetive tract inflammatory syndromes, such as reactive airways dysfunction syndrome (RADS), reactive upper airways dysfunction syndrome (RUDS), gastroesophageal reflux disease (GERD), and inflammatory pulmonary parenchymal syndromes, as well as respiratory tract and nonrespiratory malignancies. Aerodigestive tract inflammatory syndromes have now been documented in WTC exposed occupational groups, and syndrome incidence has been linked to WTC airborne pollutant exposure intensity. Community based investigations have yielded similar findings.

SUMMARY: While it is too early to ascertain long-term effects of WTC dust exposure, current studies already demonstrate a definite link between exposure to WTC-derived airborne pollutants and respiratory disease, both in the occupational and the community setting. A better understanding of causes and effects

of this exposure will help in developing appropriate preventative tools for rescue workers in future disasters.

Year Published 2006 (3)

Banauch G, Hall C, Weiden M, et al. 2006. Pulmonary function after exposure to the World Trade Center collapse in the New York City Fire Department. American Journal of Respiratory and Critical Care Medicine. 174(3):312–319.

HTTPS://DOI.ORG/10.1164/RCCM.200511-17360C

RATIONALE: On September 11, 2001, the WTC collapse created an enormous urban disaster site with high levels of airborne pollutants. First responders, rescue and recovery workers, and residents have since reported respiratory symptoms and developed pulmonary function abnormalities.

OBJECTIVES: To quantify respiratory health effects of WTC exposure in the New York City Fire Department.

MEASUREMENTS: Longitudinal study of pulmonary function in 12,079 New York City Fire Department rescue workers employed on or before 09/11/2001. Between 01/01/1997 and 09/11/2002, 31,994 spirometries were obtained and the FEV(1) and FVC were analyzed for differences according to estimated WTC exposure intensity. Adjusted average FEV(1) during the first year after 09/11/2001 was compared with the 5 yr before 09/11/2001. Median time between 09/11/2001 and a worker's first spirometry afterwards was 3 mo; 90% were assessed within 5 mo.

MAIN RESULTS: WTC exposed worker-experienced a substantial reduction in adjusted average FEV(1) during the year after 09/11/2001 (372 ml; 95% confidence interval, 364–381 ml; $p < 0.001$) This exposure-related FEV(1) decrement equaled 12 yr of aging-related FEV(1) decline. Moreover, exposure intensity assessed by initial arrival time at the WTC site correlated linearly with FEV(1) reduction in an exposure intensity-response gradient ($p=0.048$). Respiratory symptoms also predicted a further FEV(1) decrease ($p< 0.001$). Similar findings were observed for adjusted average FVC.

CONCLUSIONS: WTC exposure produced a substantial reduction in pulmonary function in New York City Fire Department rescue workers during the first year after 09/11/2001.

Bars M, Banauch G, Appel D, et al. 2006. Tobacco Free With FDNY: the New York City Fire Department World Trade Center tobacco cessation study. Chest. 129(4):979–987.

HTTPS://DOI.ORG/10.1378/CHEST.129.4.979

CONTEXT: After the WTC collapse, 15% (1,767) of rescue workers from the Fire

Department of the City of New York (FDNY) considered themselves to be current cigarette smokers. Post-WTC collapse, 98% reported acute respiratory symptoms, and 81% reported health concerns. Nonetheless, 29% of current smokers increased tobacco use, and 23% of ex-smokers resumed cigarette smoking.

OBJECTIVE: To determine the effect of a comprehensive tobacco-cessation program using combination tobacco-dependency treatment medications adjusted to the individual's daily tobacco use.

DESIGN: FDNY cigarette smokers enrolled in "Tobacco Free With FDNY," a no-cost quit-smoking program providing counseling, support, and medications. At the end of the 3-month treatment phase and at the 6-month and 12-month follow-up visits, abstinence rates were confirmed by expired carbon monoxide levels or by the verification of a household member.

SETTING: FDNY Bureau of Health Services between August 1, 2002 and October 30, 2002.

PARTICIPANTS: A total of 220 current cigarette smokers from the FDNY.

RESULTS: At study enrollment, the mean (+/ SD) tobacco use was 20 +/7 cigarettes per day, and the mean tobacco dependency, as assessed by a modified Fagerstrom test score, was 6.7+/2.5 (maximum score, 10). Based on tobacco use, 20% of enrollees used three types of nicotine medications, 64% used two types, 14% used one type, and 3% used no medications. Additionally, 14% of enrollees used bupropion sustained release. The confirmed continuous abstinence rates were 47%, 36%, and 37%, respectively, after 3 months of treatment and at the 6-month and 12-month follow- up. Abstinence rates did not correlate with the history of tobacco use but correlated inversely with tobacco dependency. Adverse events and maximal nicotine medication use were unrelated, and no one experienced a serious adverse event.

CONCLUSION: Tobacco dependency treatment using combination nicotine medications is effective and safe. Future studies should consider the following: (1) both history of tobacco use and withdrawal symptoms to determine the number and dose of nicotine medications; and (2) continuing combination treatment for > 3 months.

Lioy P, Pellizari E, Prezant D. 2006. The World Trade Center aftermath and its effects on health: understanding and learning through human-exposure science. Environmental Science & Technology. 40(22):6876–6885. PMID: 17153990. [no abstract]

HTTPS://WWW.NCBI.NLM.NIH.GOV/PUBMED/17153990?DOPT=ABSTRACTPLUS

NO ABSTRACT

Year Published 2007 (3)

Alvarez J, Rosen C, Davis K, et al. 2007. Stay connected: psychological services for retired firefighters after 11 September 2001. Prehospital and Disaster Medicine. 22(1):49–54. PMID: 17484363.

HTTPS://WWW.NCBI.NLM.NIH.GOV/PUBMED/17484363

HTTPS://WWW.CAMBRIDGE.ORG/CORE/SERVICES/AOP-CAMBRIDGE-CORE/CONTENT/VIEW/C2F3EE2B69ED30B10AFB35C690BD7C21/S1049023X00004337A.PDF/DIV-CLASS-TITLE-STAY-CONNECTED-PSYCHOLOGICAL-SERVICES-FOR-RETIRED-FIREFIGHTERS-AFTER-11-SEPTEMBER-2001-DIV.PDF

INTRODUCTION: A large number of firefighters retired after 11 September 2001. These retirees were confronted with multiple challenges, including grief, trauma-related physical injuries and psychological distress, difficulties related to the transition of their roles, and deterioration of social support.

OBJECTIVE: The Fire Department of New York (FDNY) Counseling Service Unit's "Stay Connected" Program designed and implemented after 11 September 2001 is described in this report. This unique program was designed to use a combination of peer outreach and professional counseling to address the mental health needs of retiring firefighters and their families.

METHODS: Descriptive information about the intervention program was gathered through semi- structured interviews with Counseling Service Unit staff. Client satisfaction surveys were collected during three six-week periods.

RESULTS: Quantitative data indicate that clients rated their overall satisfaction with the clerical and counseling staff a perfect 4 out of 4. The report of their overall satisfaction with the services also was nearly at ceiling (3.99 out 4). The perceived helpfulness of the services in resolving the problems experienced by the clients increased significantly over time. Qualitative data indicate that peer involvement and intensive community outreach, i.e., social events, wellness activities, and classes, were integral to the success of the intervention.

CONCLUSIONS: This project provided valuable lessons about how to develop and implement a "culturally competent" intervention program for public safety workers retiring after a disaster. Creative, proactive, non-traditional outreach efforts and leveraging peers for credibility and support were particularly important.

Izbicki G, Chavko R, Banauch G, et al. 2007. World Trade Center "sarcoid-like" granulomatous pulmonary disease in New York City Fire Department rescue workers. Chest. 131(5):1414–1423.

HTTPS://DOI.ORG/10.1378/CHEST.06-2114

BACKGROUND: Previous reports suggest that sarcoidosis occurs with abnormally high frequency in firefighters. We sought to determine whether exposure to WTC "dust" during the collapse and rescue/recovery effort increased the incidence of sarcoidosis or "sarcoid-like" granulomatous pulmonary disease (SLGPD).

METHODS: During the 5 years after themWTC disaster, enrollees in the Fire Department of New York (FDNY) WTC monitoring and treatment programs who had chest radiograph findings suggestive of sarcoidosis underwent evaluation, including the following: chest CT imaging, pulmonary function, provocative challenge, and biopsy. Annual incidence rates were compared to the 15 years before the WTC disaster.

RESULTS: After WTC dust exposure, pathologic evidence consistent with new-onset sarcoidosis was found in 26 patients: all 26 patients had intrathoracic adenopathy, and 6 patients (23%) had extrathoracic disease. Thirteen patients were identified during the first year after WTC dust exposure (incidence rate, 86/100,000), and 13 patients were identified during the next 4 years (average annual incidence rate, 22/100,000; as compared to 15/100,000 during the 15 years before the WTC disaster). Eighteen of 26 patients (69%) had findings consistent with asthma. Eight of 21 patients (38%) agreeing to challenge testing had airway hyperreactivity (AHR), findings not seen in FDNY sarcoidosis patients before the WTC disaster.

CONCLUSION: After the WTC disaster, the incidence of sarcoidosis or SLGPD was increased among FDNY rescue workers. This new information about the early onset of WTC-SLGPD and its association with asthma/AHR has important public health consequences for disease prevention, early detection, and treatment following environmental/occupational exposures.

Fire Department of NY. 2007. World Trade Center health impacts on FDNY rescue workers : a six-year assessment, September 2001-September 2007. Brooklyn, New York, Fire Department, City of New York.

HTTP://WWW.NYC.GOV/HTML/OM/PDF/2007/WTC_HEALTH_IMPACTS_ON_FDNY_RESCUE_WORKERS_SEPT_2007.PDF

Year Published 2008 (4)

Banauch G, Izbicki G, Christodoulou V, et al. 2008. Trial of prophylactic inhaled steroids to prevent or reduce pulmonary function decline, pulmonary symptoms, and airway hyperreactivity in firefighters

at the World Trade Center site. Disaster Medicine and Public Health Preparedness. 2(1):33–39.

HTTPS://DOI.ORG/10.1097/DMP.0B013E318164EE0C

BACKGROUND: Inhaled corticosteroids (ICS) are the most effective anti- inflammatory treatment for asthmatics. This trial evaluated the effects of prophylactic ICS in firefighters exposed to the WTC disaster.

METHODS: Inhaled budesonide via a dry powder inhaler (Pulmicort Turbuhaler, AstraZeneca, and Wilmington, DE) was offered on-site to New York City firefighters between September 18 and 25, 2001. One to 2 years later, firefighters (n=64) who completed 4 weeks of daily ICS treatment were evaluated and compared with an age and exposure-matched comparison group (n=72) who did not use ICS.

RESULTS: When spirometry results at the final visit were compared with those from the weeks following the 9/11 disaster, the treatment group had a greater increase in forced vital capacity (P=.009) and possibly a slower decline in forced expiratory volume at 1 second (P=.11), as well as a greater improvement in perceived well-being as assessed by the St George's Respiratory Questionnaire (P < .01). There was no difference in airway hyperreactivity and no evidence of adverse effects from ICS.

CONCLUSIONS: Because the potential for hazardous exposures is great at many disasters, disease prevention programs based on environmental controls and respiratory protection are warranted immediately. Our results suggest that, pending further study with a larger sample, prophylactic ICS should be considered, along with respiratory protection, to minimize possible lung insult.

Friedman S, Cone J, Eros-Sarnyai M, et al. 2008. Clinical guidelines for adults exposed to the World Trade Center disaster. City Health Information. 27(6):41–54. [Online Publication]

HTTPS://WWW1.NYC.GOV/ASSETS/DOH/DOWNLOADS/PDF/CHI/CHI27-6.PDF

The World Trade Center (WTC) terrorist attack and its aftermath exposed hundreds of thousands of people to debris, dust, smoke, and fumes. Studies conducted after September 11, 2001, among rescue and clean-up workers, office workers, building evacuees, and residents of lower Manhattan showed an increase in respiratory and other physical and mental health problems, including post-traumatic stress disorder. Many New Yorkers have health problems that could be associated with - or made worse by - exposure to the attack and its aftermath. Primary care physicians need to know how to identify, evaluate, treat, and if necessary, refer these individuals to expert care. This publication suggests how clinicians can take a brief exposure history and describes common health problems that could be caused or exacerbated by exposure to the disaster. It offers algorithms to evaluate and care for exposed individuals, and provides brief tools to assess and treat physical and mental health disorders. Resources are also fea-

tured, including information about free (or need-based) treatment programs that may benefit WTC-exposed individuals (Resources). While these recommendations are targeted to adults, some principles and diagnostic methods may be applicable to children and adolescents. Consult appropriate resources such as the American Academy of Pediatrics for general (non-WTC-specific) pediatric guidelines.

Prezant D. 2008. World Trade Center Cough Syndrome and its treatment. Lung. 186(S1):S94–S102.

HTTPS://DOI.ORG/10.1007/S00408-007-9051-9

To date, the main respiratory health consequence from the collapse of the WTC on September 11, 2001 has been the "WTC Cough Syndrome" (chronic rhinosinusitis, asthma, and/ or bronchitis, often complicated by gastroesophageal reflux dysfunction). Syndrome incidence and severity have been linked to WTC dust exposure intensity. While it is too early to ascertain long-term effects of WTC dust exposure, effective treatment guidelines have been designed through a collaborative effort by the three established centers of excellence for WTC medical monitoring and treatment and the WTC Registry. These treatment recommendations are described here.

Prezant D, Levin S, Kelly K, et al. 2008. Upper and lower respiratory diseases after occupational and environmental disasters. Mount Sinai Journal of Medicine. 75(2):89–100.

HTTPS://DOI.ORG/10.1002/MSJ.20028

Respiratory consequences from occupational and environmental disasters are the result of inhalation exposures to chemicals, particulate matter (dusts and fibers) and/or the incomplete products of combustion that are often liberated during disasters such as fires, building collapses, explosions and volcanoes. Unfortunately, experience has shown that environmental controls and effective respiratory protection are often unavailable during the first days to week after a large-scale disaster. The English literature was reviewed using the key words-disaster and any of the following: respiratory disease, pulmonary, asthma, bronchitis, sinusitis, pulmonary fibrosis, or sarcoidosis. Respiratory health consequences after aerosolized exposures to high- concentrations of particulates and chemicals can be grouped into 4 major categories: 1) upper respiratory disease (chronic rhinosinusitis and reactive upper airways dysfunction syndrome), 2) lower respiratory diseases (reactive [lower] airways dysfunction syndrome, irritant- induced asthma, and chronic obstructive airways diseases), 3)parenchymal or interstitial lung diseases (sarcoidosis, pulmonary fibrosis, and bronchiolitis obliterans, and 4) cancers of the lung and pleura. This review describes several respiratory consequences of occupational and environmental disasters and uses the WTC disaster to illustrate in detail the consequences of chronic upper and lower respiratory inflammation.

Year Published 2009 (2)

Corrigan M, et al. 2009. A computerized, self-administered questionnaire to evaluate posttraumatic stress among firefighters after the World Trade Center collapse. American Journal of Public Health. 99(S):S702–S709.

HTTPS://DOI.ORG/10.2105/AJPH.2008.151605

OBJECTIVES: We sought to determine the frequency of psychological symptoms and elevated PTSD risk among New York City firefighters after the WTC attack and whether these measures were associated with Counseling Services Unit (CSU) use or mental health-related medical leave over the first 2.5 years after the attack.

METHODS: Shortly after the WTC attack, a computerized, binary-response screening questionnaire was administered. Exposure assessment included WTC arrival time and "loss of a co-worker while working at the collapse." We determined elevated PTSD risk using thresholds derived from Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition, Text Revision, and a sensitivity-specificity analysis.

RESULTS: Of 8487 participants, 76% reported at least 1 symptom, 1016 (12%) met criteria for elevated PTSD risk, and 2389 (28%) self-referred to the CSU, a 5–fold increase from before the attack. Higher scores were associated with CSU use, functional job impairment, and mental health-related medical leave. Exposure- response gradients were significant for all outcomes.

CONCLUSIONS: This screening tool effectively identified elevated PTSD risk, higher CSU use, and functional impairment among firefighters and therefore may be useful in allocating scarce postdisaster mental health resources.

Webber M, Gustave J, Lee R, et al. 2009. Trends in respiratory symptoms of firefighters exposed to the World Trade Center disaster: 2001–2005. Environmental Health Perspectives. 117(6):975–980.

HTTPS://DOI.ORG/10.1289/EHP.0800291

BACKGROUND: Respiratory symptoms, either newly reported after the WTC disaster on 11 September 2001 (9/11) or increased in severity, have been well documented in WTC-exposed workers and New York City residents. However, considerable uncertainty exists over the persistence of symptoms.

OBJECTIVES: In this study, our goals were to describe trends in post-9/11 respiratory and gastro-esophageal reflux disease (GERD) symptoms in WTC-exposed firefighters and to examine symptom progression in the cohort that completed both year 1 and year 4 questionnaires.

METHODS: We analyzed questionnaire responses from 10,378 firefighters in yearly intervals, from 2 October 2001 to 11 September 2005, defining exposure based on arrival time at the WTC site. For the cohort of 3,722 firefighters who completed the two questionnaires, we also calculated exposure duration summing

months of work at the site.

RESULTS: In cross- sectional analyses, the prevalence of dyspnea, wheeze, rhinosinusitis, and GERD remained relatively stable, whereas cough and sore throat declined, especially between 1 and 2 years post-9/11. We found a dose- response relationship between arrival time and symptoms in all years ($p < 0.01$). Logistic models of symptoms at year 4 in the cohort demonstrated independent effects of earlier arrival and longer work duration: each additional month of work increased the odds of symptoms 8% to 11%.

CONCLUSIONS: Protracted work exposures increased the odds of respiratory and GERD symptoms 4 years later. In most large disasters, exposures may be unavoidable during the rescue phase, but our data strongly suggest the need to minimize additional exposures during recovery and cleanup phases.

Year Published 2010 (8)

Aldrich T, Gustave J, Hall C, et al. 2010. Lung function in rescue workers at the World Trade Center after 7 years. New England Journal of Medicine. 362(14):1263–1272.

HTTPS://DOI.ORG/10.1056/NEJMOA0910087

BACKGROUND: The terrorist attacks on the WTC on September 11, 2001, exposed thousands of Fire Department of New York City (FDNY) rescue workers to dust, leading to substantial declines in lung function in the first year. We sought to determine the longer-term effects of exposure.

METHODS: Using linear mixed models, we analyzed the forced expiratory volume in 1 second (FEV(1)) of both active and retired FDNY rescue workers on the basis of spirometry routinely performed at intervals of 12 to 18 months from March 12, 2000, to September 11, 2008.

RESULTS: Of the 13,954 FDNY workers who were present at the WTC between September 11, 2001, and September 24, 2001, a total of 12,781 (91.6%) participated in this study, contributing 61,746 quality-screened spirometric measurements. The median follow-up was 6.1 years for firefighters and 6.4 years for emergency-medical-services (EMS) workers. In the first year, the mean FEV(1) decreased significantly for all workers, more for firefighters who had never smoked (a reduction of 439 ml; 95% confidence interval [CI], 408 to 471) than for EMS workers who had never smoked (a reduction of 267 ml; 95% CI, 263 to 271) ($P<0.001$ for both comparisons). There was little or no recovery in FEV(1) during the subsequent 6 years, with a mean annualized reduction in FEV(1) of 25 ml per year for firefighters and 40 ml per year for EMS workers. The proportion of workers who had never smoked and who had an FEV(1) below the lower limit

of the normal range increased during the first year, from 3% to 18% for firefighters and from 12% to 22% for EMS workers, stabilizing at about 13% for firefighters and 22% for EMS workers during the subsequent 6 years.

CONCLUSIONS: Exposure to WTC dust led to large declines in FEV(1) for FDNY rescue workers during the first year. Overall, these declines were persistent, without recovery over the next 6 years, leaving a substantial proportion of workers with abnormal lung function.

Banauch G, Brantly M, Izbicki G, et al. 2010. Accelerated spirometric decline in New York City firefighters with alpha(1)- antitrypsin deficiency. Chest. 138:1116–1124.

HTTPS://DOI.ORG/10.1378/CHEST.10-0187

BACKGROUND: On September 11, 2001, the WTC collapse caused massive air pollution, producing variable amounts of lung function reduction in the New York City Fire Department (FDNY) rescue workforce. alpha(1)-Antitrypsin (AAT) deficiency is a risk factor for obstructive airway disease.

METHODS: This prospective, longitudinal cohort study of the first 4 years post-September 11, 2001, investigated the influence of AAT deficiency on adjusted longitudinal spirometric change (FEV(1)) in 90 FDNY rescue workers with WTC exposure. Workers with protease inhibitor (Pi) Z heterozygosity were considered moderately AAT deficient. PiS homozygosity or PiS heterozygosity without concomitant PiZ heterozygosity was considered mild deficiency, and PiM homozygosity was considered normal. Alternately, workers had low AAT levels if serum AAT was </= 20 mumol/L.

RESULTS: In addition to normal aging-related decline (37 mL/y), significant FEV(1) decline accelerations developed with increasing AAT deficiency severity (110 mL/y for moderate and 32 mL/y for mild) or with low AAT serum levels (49 mL/y). Spirometric rates pre-September 11, 2001, did not show accelerations with AAT deficiency. Among workers with low AAT levels, cough persisted in a significant number of participants at 4 years post- September 11, 2001.

CONCLUSIONS: FDNY rescue workers with AAT deficiency had significant spirometric decline accelerations and persistent airway symptoms during the first 4 years after WTC exposure, representing a novel gene- by-environment interaction. Clinically meaningful decline acceleration occurred even with the mild serum AAT level reductions associated with PiS heterozygosity (without concomitant PiZ heterozygosity).

Berninger A, Webber M, Cohen H, et al. 2010. Trends of elevated PTSD risk in firefighters exposed to the World Trade Center disaster: 2001–2005. Public Health Reports. 125(4):556–566.

HTTPS://DOI.ORG/10.1177/003335 491012500411

OBJECTIVES: We identified trends in the prevalence of elevated PTSD risk as determined by the Fire Department of the City of New York (FDNY)-modified PCL

in WTC-exposed firefighters. We also examined trends in relation to WTC exposure, social support, change in recreational activities, and functional health.

METHODS: We analyzed 16,826 questionnaires from 10,074 firefighters in yearly intervals, from September 12, 2001, to September 11, 2005.

RESULTS: The prevalence of elevated PTSD risk increased over time, from 9.8% in year 1 to 10.6% in year 4 ($p < 0.0001$). Earliest arrival at the WTC site (odds ratio [OR]=6.0; 95% confidence interval [CI] 4.4, 8.3), prolonged work at the site (OR=2.0; 95% CI 1.8, 2.3), providing supervision without previous supervisory experience (OR=4.1; 95% CI 2.8, 6.1), and retirement due to a WTC-related disability (OR=1.3; 95% CI 1.1, 1.5) were associated with ever having elevated PTSD risk. Difficulty functioning at home was strongly associated with elevated PTSD risk (ORs ranged from 17.0 [95% CI 14.5, 20.0] in year 1 to 26.7 [95% CI 20.3, 35.2] in year 3), as was difficulty functioning at work (ORs ranged from 12.1 [95% CI 10.2, 14.2] in year 1 to 23.0 [95% CI 14.6, 36.3] in year 2).

CONCLUSIONS: Elevated PTSD risk was associated with exposure to the WTC site as well as functional impairment, and remained largely unabated during the first four years of the study. Screening for elevated PTSD risk may be useful in identifying those who could benefit from interventions during long-term follow-up, as well as in the immediate aftermath of disasters.

Berninger A, Webber M, Niles J, et al. 2010. Longitudinal study of probable post-traumatic stress disorder in firefighters exposed to the World Trade Center disaster. American Journal of Industrial Medicine. 53(12):1177–1185.

HTTPS://DOI.ORG/10.1002/AJIM.20894

BACKGROUND: Symptoms of PTSD have been reported even years after the terrorist attacks of September 11, 2001 (9/11).

METHODS: We used screening tools to assess the prevalence of probable PTSD in 9/11- exposed firefighters at two time points, within 6 months of 9/11 (baseline) and 3–4 years post-disaster (follow-up).

RESULTS: Five thousand six hundred fifty-six individuals completed assessments at both times. 15.5% reported probable PTSD post- 9/11, 8.6% at baseline and 11.1% at follow- up, on average 2.9 (SD 0.5) years later. Analyses revealed that nearly half of all probable PTSD occurred as delayed onset (absent baseline, present follow-up). Compared with the resilient group (no probable PTSD at either time), probable PTSD at baseline, and delayed onset at follow-up were each associated with concomitant functional impairment (OR 19.5 and 18.9), respectively.

CONCLUSION: Similar percentages of firefighters met criteria for baseline and delayed onset probable PTSD at follow-up, years later. Both were associated with substantial functional impairment. Early risk identification could provide opportunities for mental health interventions before symptoms compromise work and social relationships.

Berninger A, Webber M, Weakley J, et al. 2010. Quality of life in relation to upper and lower respiratory conditions among retired 9/11-exposed firefighters with pulmonary disability. Quality of Life Research. 19(10):1467–1476.

HTTPS://DOI.ORG/10.1007/S11136-010-9710-9

PURPOSE: To examine health-related quality of life (HRQoL) and WTC cough syndrome conditions in male firefighters who retired due to a 9/11-related pulmonary disability.

METHODS: From 3/1/2008 to 1/31/2009, we contacted 275 disability- retired firefighters and compared their HRQoL and current aerodigestive conditions to those from WTC-exposed non-disabled retired and active firefighters. Relationships between HRQoL and explanatory variable(s) were examined using multivariable linear regression models.

RESULTS: Mean physical component summary (PCS) scores were lowest in disabled retirees compared with non-disabled retirees and actives: 36.4 (9.6), 49.4 (8.7), and 53.1 (5.1), respectively ($P < 0.0001$). Mean mental component summary (MCS) scores were closer: 44.5 (11.9), 48.1 (8.5), and 48.7 (7.4), respectively ($P < 0.0001$). In multivariable models, after adjustment for many factors, PCS scores were not associated with early WTC arrival, but were inversely associated with disability retirement and all WTC cough syndrome conditions. MCS scores were inversely associated with early WTC arrival and most WTC cough syndrome conditions, but were not associated with disability retirement.

CONCLUSION: WTC cough syndrome conditions predict lower HRQoL scores even 8 years after exposure, independent of retirement status. These data suggest that monitoring physical conditions of individuals with occupational exposures might help identify those at risk for impaired HRQoL.

Chiu S, Webber M, Zeig-Owens R, et al. 2010. Validation of the Center for Epidemiologic Studies depression scale in screening for major depressive disorder among retired firefighters exposed to the World Trade Center disaster. Journal of Affective Disorders. 121(3):212–219.

HTTPS://DOI.ORG/10.1016/J.JAD.2009.05.028

BACKGROUND: We evaluated the performance of a modified Center of Epidemiologic Studies Depression Scale (CES-D-m), which captured symptoms in the past month, in

comparison to the Diagnostic Interview Schedule (DIS) in identification of major depressive disorder (MDD) in WTC-exposed retired Fire Department, City of New York (FDNY) firefighters.

METHODS: From 12/2005 to 7/2007, FDNY enrolled retired firefighters in its Medical Monitoring and Treatment Program. All participants completed the CES-D-m and the DIS on the same day. Sensitivity, specificity, receiver operating characteristic (ROC) curves, and Youden's index were used to assess properties of the CES-D-m. Multivariate logistic regression analyses were also used.

RESULTS: 7% of 1915 retired male firefighters were diagnosed with MDD using the DIS. Using the most common CES-Dcutoff score of 16, the prevalence of elevated risk was 36%, which declined to 23% using a cutoff score of 22, as determined by Youden's index. At 22, CESD-m sensitivity was 0.84, specificity was 0.82, and the area under the ROC curve was 0.89 relative to DIS MDD diagnosis.

LIMITATIONS: Participants were more likely than non- participants to live in the New York City area.

CONCLUSIONS: This is the first study of WTC rescue/recovery workers to assess the performance of a one-month version of the CES-D. The CES-D-m performed well in identifying those at elevated risk. Since diagnostic follow-up is time consuming and costly, it is important to correctly distinguish those at elevated risk using a screening tool that has been validated in the population under study.

Rom W, Reibman J, Rogers L, et al. 2010. Emerging exposures and respiratory health: World Trade Center dust. Proceedings of the American Thoracic Society. 7(2):142–145.

HTTPS://DOI.ORG/10.1513/PATS.200908-092RM

The attack on the WTC on 9/11/2001 produced a massive dust cloud with acute exposure, and the rubble pile burning over 3 months exposed more than 300,000 residents, rescue workers, and clean-up workers. Firefighters in the New York City Fire Department had significant respiratory symptoms characterized by cough, dyspnea, gastroesophageal reflux, and nasal stuffiness with a significant 1–year decline in FVC and FEV(1). Bronchial hyperreactivity measured by methacholine challenge correlated with bronchi al wall thickening on CT scans. Compared with the NHANES III data for FVC and FEV (1), 32% of 2,000 WTC dust-exposed residents and clean-up workers were below the lower 5th percentile. The most common abnormality was a low FVC pattern, a finding similar to that also described for individuals in rescue and recovery activities. Among those complaining of respiratory symptoms and normal spirometry, almost half had abnormalities detected with impedance oscillometry consistent with distal airways' disease. Follow-up with the WTCHR and the WTC Environmental Health Center will help discern whether treatment with anti-inflammatory medications or

bronchodilators in those with respiratory symptoms may prevent the development of chronic obstructive pulmonary disease.

Weiden M, Ferrier N, Nolan A, et al. 2010. Obstructive airways disease with air trapping among firefighters exposed to World Trade Center dust. Chest. 137(3):566–574.

HTTPS://DOI.ORG/10.1378/CHEST.09-1580

BACKGROUND: The WTC collapse produced a massive exposure to respirable particulates in New York City Fire Department (FDNY) rescue workers. This group had spirometry examinations pre-September 11, 2001, and Post-September 11, 2001, demonstrating declines in lung function with parallel declines in FEV (1) and FVC. To date, the underlying pathophysiologic cause for this has been open to question.

METHODS: Of 13,234 participants in the FDNY-WTC Monitoring Program, 1,720 (13%) were referred for pulmonary subspecialty evaluation at a single institution. Evaluation included 919 full pulmonary function tests, 1,219 methacholine challenge tests, and 982 high-resolution chest CT scans.

RESULTS: At pulmonary evaluation (median 34 months post- September 11, 2001), median values were FEV(1) 93% predicted (interquartile range [IQR], 83%-101%), FVC 98% predicted (IQR, 89%-106%), and FEV(1)/FVC 0.78(IQR, 0.72–0.82). The residual volume (RV) was 123% predicted (IQR, 106%147%) with nearly all participants having normal total lung capacity, functional residual capacity, and diffusing capacity of carbon monoxide. Also, 1,051/1,720 (59%) had obstructive airways disease based on at least one of the following: FEV(1)/FVC, bronchodilator responsiveness, hyperreactivity, or elevated RV. After adjusting for age, gender, race, height and weight, and tobacco use, the decline in FEV(1) post-September 11, 2001, was significantly correlated with increased RV percent predicted ($P < .0001$), increased bronchodilator responsiveness ($P < .0001$), and increased hyperreactivity ($P = .0056$). CT scans demonstrated bronchial wall thickening that was significantly associated with the decline in FEV (1) post-September 11, 2001 ($P = .024$), increases in hyperreactivity ($P < .0001$), and increases in RV ($P < .0001$). Few had evidence for interstitial disease.

CONCLUSIONS: Airways obstruction was the predominant physiologic finding underlying the reduction in lung function post-September 11, 2001, in FDNY WTC rescue workers presenting for pulmonary evaluation.

Year Published 2011 (11)

Chiu S, Niles J, Webber M, et al. 2011. Evaluating risk factors and possible mediation effects in posttraumatic depression and posttraumatic stress disorder comorbidity. Public Health Reports. 126(2):201–209.

HTTPS://DOI.ORG/10.1177/003335491112600211

OBJECTIVES: On September 11, 2001 (9/11), attacks on the WTC killed 341 Fire Department of the City of New York (FDNY) firefighters and injured hundreds more. Previous WTC-related studies reported high rates of comorbid depression and PTSD, identifying disability retirement, alcohol use, and early arrival at the WTC site as correlates. However, those studies did not evaluate risk factors that could have mediated the observed comorbidity. We identified unique risk factors for each condition in an effort to better understand comorbidity.

METHODS: We screened retired WTC-exposed firefighters using self- administered questionnaires including the Center for Epidemiologic Studies Depression Scale, the Post Traumatic Stress Disorder Checklist, and the Alcohol Use Disorders Identification Test. We performed regression analyses to compare independent predictors of elevated depression and PTSD risk, and also tested a mediation hypothesis.

RESULTS: From December 2005 to July 2007, 23% and 22% of 1,915 retirees screened positive for elevated depression and PTSD risk, respectively, with comorbidity > 70%. Controlling for comorbidity, we identified unique risk factors for (1) depression: problem alcohol use and (2) PTSD: early arrival at the WTC site.

CONCLUSIONS: Our data support the premise that PTSD and depression are different responses to trauma with unique risk factors. The data also suggest a hypothesis that PTSD mediates the relationship between early WTC arrival and depression, while depression mediates the relationship between alcohol use and PTSD, a more complex relationship than shown in previous studies. Clinicians should consider these factors when evaluating patients for depression and PTSD.

Chiu S, Webber M, Zeig-Owens R, et al. 2011. Performance characteristics of the PTSD Checklist in retired firefighters exposed to the World Trade Center disaster. Annals of Clinical Psychiatry. 23(3):95–104. PMID: 21547269.

HTTPS://WWW.NCBI.NLM.NIH.GOV/PUBMED/21547269

BACKGROUND: Since the WTC attacks on September 11, 2001, the Fire Department, City of New York Monitoring Program has provided physical and mental health screening services to rescue/recovery workers. This study evaluated performance of the self-report PCL as a screening tool for risk of PTSD in firefighters who worked at Ground Zero, compared

with the interviewer-administered Diagnostic Interview Schedule (DIS).

METHODS: From December 2005 to July 2007, all retired firefighter enrollees completed the PCL and DIS on the same day. Sensitivity, specificity, receiver operating characteristic (ROC) curves, and Youden index (J) were used to assess properties of the PCL and to identify an optimum cutoff score.

RESULTS: Six percent of 1,915 retired male firefighters were diagnosed with PTSD using the DIS to assess DSM-IV criteria. Depending on the PCL cutoff, the prevalence of elevated risk relative to DSM- IV criteria varied from 16% to 22%. Youden index identified an optimal cutoff score of 39, in contrast with the frequently recommended cutoff of 44. At 39, PCL sensitivity was 0.85, specificity was 0.82, and the area under the ROC curve was 0.91 relative to DIS PTSD diagnosis.

CONCLUSIONS: This is the first study to validate the PCL in retired firefighters and determine the optimal cutoff score to maximize opportunities for PTSD diagnosis and treatment.

Guidotti L, Prezant D, de la Hoz R, et al. 2011. The evolving spectrum of pulmonary disease in responders to the World Trade Center tragedy. American Journal of Industrial Medicine. 54(9):646–660. PMID: 23236631.

HTTPS://WWW.NCBI.NLM.NIH.GOV/PUBMED/23236631

BACKGROUND: On September 11, 2001, events at the WTC exposed residents of New York City to WTC dust and products of combustion and pyrolysis. The majority of WTC-exposed fire department rescue workers experienced a substantial decline in airflow over the first 12 months post-9/11, in addition to the normal age-related decline that affected all responders, followed by a persistent plateau in pulmonary function in the 6 years thereafter. The spectrum of the resulting pulmonary diseases consists of chronic inflammation, characterized by airflow obstruction, and expressing itself indifferent ways in large and small airways. These conditions include irritant- induced asthma, non-specific chronic bronchitis, aggravated preexisting obstructive lung disease (asthma or COPD), and bronchiolitis. Conditions concomitant with airways obstruction, particularly chronic rhinosinusitis and upper airway disease,and gastroesophageal reflux, have been prominent in this population. Less common have been reports of sarcoidosis or interstitial pulmonary fibrosis. Pulmonary fibrosis and bronchiolitis are generally characterized by long latency, relatively slow progression, and a silent period with respect to pulmonary function during its evolution. For these reasons, the incidence of these outcomes may be underestimated and may increase overtime. The spectrum of chronic obstructive airways disease is broad in this population and may importantly include involvement at the bronchiolar level, manifested as small airways disease. Protocols that go beyond conventional screening pulmonary function testing and imaging may be necessary to identify these diseases

in order to understand the underlying pathologic processes so that treatment can be most effective.

Jordan H, Stellman S, Prezant D, et al. 2011. Sarcoidosis diagnosed after September 11, 2001, among adults exposed to the World Trade Center disaster. Journal of Occupational and Environmental Medicine. 53:966–974.

HTTPS://DOI.ORG/10.1097/JOM.0B013E31822A3596

OBJECTIVE: Explore relationships between WTC exposures and sarcoidosis.

METHODS: Sarcoidosis has been reported after exposure to the WTC disaster. We ascertained biopsy-proven post-9/11 sarcoidosis among WTCHR enrollees. Cases diagnosed after Registry enrollment were included in a nested case- control study. Controls were matched to cases on age, sex, race or ethnicity, and eligibility group (e.g., rescue or recovery worker).

RESULTS: We identified 43 cases of post-9/11 sarcoidosis. Twenty-eight incident cases and 109 controls were included in the case-control analysis. Working on the WTC debris pile was associated with sarcoidosis (odds ratio 9.1, 95% confidence interval 1.1 to 74.0), but WTC dust cloud exposure was not (odds ratio 1.0, 95% confidence interval 0.4 to 2.8).

CONCLUSIONS: Working on the WTC debris pile was associated with an elevated risk of post-9/11 sarcoidosis. Occupationally exposed workers may be at increased risk.

Niles J, Webber M, Gustave J, et al. 2011. Comorbid trends in World Trade Center cough syndrome and probable posttraumatic stress disorder in firefighters. Chest. 140(5):1146–1154.

HTTPS://DOI.ORG/10.1378/CHEST.10-2066

BACKGROUND: We describe the relationship between WTC cough syndrome symptoms, pulmonary function, and symptoms consistent with probable PTSD in WTC-exposed firefighters in the first year post-September 11, 2001 (baseline), and 3 to 4 years later (follow-up).

METHODS: Five thousand three hundred sixty-three firefighters completed pulmonary function tests (PFTs) and questionnaires at both times. Relationships among WTC cough syndrome, probable PTSD, and PFTs were analyzed using simple and multivariable models. We also examined the effects of cofactors, including WTC exposure.

RESULTS: WTC cough syndrome was found in 1,561 firefighters (29.1%) at baseline and 1,186 (22.1%) at follow-up, including 559 with delayed onset (present only at follow-up). Probable PTSD was found in 458 firefighters (8.5%)at baseline and 548 (10.2%) at follow-up, including 343 with delayed onset. Baseline PTSD symptom counts and probable PTSD were associated with WTC cough syndrome at baseline, at follow-up, and in those with delayed-onset WTC cough syndrome. Similarly, WTC cough syndrome symptom counts and WTC cough syndrome

at baseline were associated with probable PTSD at baseline, at follow-up, and in those with delayed-onset probable PTSD. WTC arrival time and work duration were cofactors of both outcomes. A small but consistent association existed between pulmonary function and WTC cough syndrome, but none with PTSD.

CONCLUSIONS: The study showed a moderate association between WTC cough syndrome and probable PTSD. The presence of one contributed to the likelihood of the other, even after adjustment for shared cofactors such as WTC exposure.

Niles J, Webber M, Gustave J, et al. 2011. The impact of the World Trade Center attack on FDNY firefighter retirement, disabilities, and pension benefits. American Journal of Industrial Medicine. 54(9):672–680.

HTTPS://DOI.ORG/10.1002/AJIM.20965

BACKGROUND: Our goal was to examine the effect of the WTC attack and subsequent New York City Fire Department (FDNY) rescue/recovery activities on firefighter retirements. We also analyzed the financial impact associated with the increased number and proportion of service-connected "accidental" disability retirements on the FDNY pension system.

METHODS: A total of 7,763 firefighters retired between 9/11/1994 and 9/10/2008. We compared the total number of retirements and the number and proportion of accidental disability retirements 7 years before and 7 years after the WTC attack. We categorized WTC-related accidental disability retirements by medical cause and worked with the New York City Office of the Actuary to approximate the financial impact by cause.

RESULTS: In the 7 years before 9/11 there were 3,261 retirements, 48% (1,571) of which were accidental disability retirements. In the 7 years after 9/11, there were 4,502 retirements, 66% (2,970) were accidental disability retirements, of which 47% (1,402) were associated with WTC-related injuries or illnesses. After 9/11, the increase in accidental disability retirements was, for the most part, due to respiratory-related illnesses. Additional increases were attributed to psychological-related illnesses and musculoskeletal injuries incurred at the WTC site. Pension benefits associated with WTC-related accidental disability retirements have produced an increased financial burden of over $826 million on the FDNY pension system.

CONCLUSIONS: The WTC attacks affected the health of the FDNY workforce resulting in more post-9/11 retirements than expected, and a larger proportion of these retirees with accidental disability pensions.

Soo J, Webber M, Gustave J, et al. 2011. Trends in probable PTSD in firefighters exposed to the World Trade Center disaster, 2001–2010. Disaster Medicine and Public Health Preparedness. 5(S1):S197–S203.

HTTPS://DOI.ORG/10.1001/DMP.2011.48

OBJECTIVE: We present the longest follow-up, to date, of probable PTSD after the 2001 terrorist attacks on the WTC in

FDNY Responders

New York City firefighters who participated in the rescue/recovery effort.

METHODS: We examined data from 11,006 WTC- exposed firefighters who completed 40,672 questionnaires and reported estimates of probable PTSD by year from serial cross- sectional analyses. In longitudinal analyses, we used separate Cox models with data beginning from October 2, 2001, to identify variables associated with recovery from or delayed onset of probable PTSD.

RESULTS: The prevalence of probable PTSD was 7.4% by September 11, 2010, and continued to be associated with early arrival at the WTC towers during every year of analysis. An increasing number of aerodigestive symptoms (hazard ratio [HR] 0.89 per symptom, 95% confidence interval [CI] 0.86–.93) and reporting a decrease in exercise, whether the result of health (HR 0.56 vs no change in exercise, 95% CI 0.41–.78) or other reasons (HR 0.76 vs no change in exercise, 95% CI 0.63–.92), were associated with a lower likelihood of recovery from probable PTSD. Arriving early at the WTC (HR 1.38 vs later WTC arrival, 95% CI 1.12–1.70), an increasing number of aerodigestive symptoms (HR 1.45 per symptom, 95% CI 1.40–1.51), and reporting an increase in alcohol intake since September 11, 2001 (HR 3.43 vs no increase in alcohol intake, 95% CI 2.67–4.43) were associated with delayed onset of probable PTSD.

CONCLUSIONS: Probable PTSD continues to be associated with early WTC arrival even 9 years after the terrorist attacks. Concurrent conditions and behaviors, such as respiratory symptoms, exercise, and alcohol use also play important roles in contributing to PTSD symptoms.

Weakley J, Webber M, Gustave J, et al. 2011. Trends in respiratory diagnoses and symptoms of firefighters exposed to the World Trade Center disaster: 2005–2010. Preventive Medicine. 53(6):364–369.

HTTPS://DOI.ORG/10.1016/J.YPMED.2011.09.001

OBJECTIVES: To compare the prevalence of self-reported respiratory diagnoses in WTC-exposed Fire Department of New York City firefighters to the prevalence in demographically similar National Health Interview Survey participants by year; and, 2) to describe the prevalence of WTC- related symptoms up to 9 years post-9/11.

METHODS: We analyzed 45,988 questionnaires completed by 10,999 firefighters from 10/2/2001 to 9/11/2010. For comparison of diagnosis rates, we calculated 95% confidence intervals around yearly firefighter prevalence estimates and generated odds ratios and confidence intervals to compare the odds of diagnoses in firefighters to the National Health Interview Survey prevalence, by smoking status.

RESULTS: Overall, WTC- exposed firefighters had higher respiratory diagnosis rates than the National Health Interview Survey; Fire Department of New York City rates also varied less by smoking status. In 2009, bronchitis rates in firefighters aged 45–65 were 13.3 in smokers versus 13.1

in never-smokers while in the National Health Interview Survey, bronchitis rates were doubled for smokers: 4.3 vs. 2.1. In serial cross- sectional analyses, the prevalence of most symptoms stabilized by 2005, at ~10% for cough to ~48% for sinus.

CONCLUSIONS: We found generally higher rates of respiratory diagnoses in WTC-exposed firefighters compared to US males, regardless of smoking status. This underscores the impact of WTC exposure and the need for continued monitoring and treatment of this population.

Webber M, Glaser M, Weakley J, et al. 2011. Physician-diagnosed respiratory conditions and mental health symptoms 7–9 years following the World Trade Center disaster. American Journal of Industrial Medicine. 54(9):661–671.

HTTPS://DOI.ORG/10.1002/AJIM.20993

BACKGROUND: This study examines the prevalence of physician-diagnosed respiratory conditions and mental health symptoms in firefighters and emergency medical service workers up to 9 years after rescue/recovery efforts at the WTC.

METHODS: We analyzed Fire Department of New York (FDNY) physician and self-reported diagnoses by WTC exposure and quintiles of pulmonary function (FEV1% predicted). We used screening instruments to assess probable PTSD and probable depression.

RESULTS: FDNY physicians most commonly diagnosed asthma (8.8%) and sinusitis (9.7%). The highest prevalence of physician-diagnosed obstructive airway disease (OAD) was in the lowest FEV1% predicted quintile. Participants who arrived earliest on 9/11 were more likely to have physician- diagnosed asthma (OR=1.4). Seven percent had probable PTSD. 19.4% had probable depression.

CONCLUSIONS: Self-reported and physician-diagnosed respiratory conditions remain common, especially among those who arrived earliest at the WTC site. OAD was associated with the lowest pulmonary function. Since respiratory and mental health conditions remain prevalent, ongoing monitoring and treatment is important.

Webber M, Lee R, Soo J, et al. 2011. Prevalence and incidence of high risk for obstructive sleep apnea in World Trade Center-exposed rescue/recovery workers. Sleep & Breathing. 15(3):283–294.

HTTPS://DOI.ORG/10.1007/S11325-010-0379-7

PURPOSE: WTC-exposed rescue/recovery workers continue to have high rates of gastroesophageal reflux disease (GERD), chronic rhinosinusitis, and PTSD symptoms. This study examines the relationship between these WTC-related conditions and being at high risk for obstructive sleep apnea (OSA).

MATERIALS AND METHODS: The Fire Department of the City of New York (FDNY) performs periodic health evaluations on FDNY members every 12 to 18 months. Evaluations consist of physician exam-

inations and self-administered health questionnaires, which, since 2005, have incorporated questions about sleep problems that were adapted from the Berlin Questionnaire. The study population consisted of 11,701 male firefighters and emergency medical service personnel. Incidence analyses were limited to a cohort (n=4,576) who did not meet the criterion for being at high risk for OSA at baseline (between September 12, 2005 and September 8, 2006) and had at least one follow-up assessment, on average, 1.4 (+/- 0.5) years later.

RESULTS: The baseline prevalence of high risk for OSA was 36.5%. By follow-up, 16.9% of those not at high risk initially became at high risk for OSA. In multivariable logistic regression models predicting incident high risk for OSA, independent predictors included: earlier time of arrival at the WTC site, GERD, chronic rhinosinusitis, PTSD symptoms, self-assessed fair/poor health, low body mass index (BMI < 18.5 kg/m(2)), and, as expected, BMI > 30 kg/m(2) and weight gain of >/=10 lb (4.5 kg).

CONCLUSIONS: We found significant associations between being at high risk for OSA and common WTC-related conditions, although the responsible causative mechanisms remain unknown. Since the etiology of OSA is likely multifactorial, improvement may require successful treatment of both OSA and its comorbid conditions.

Zeig-Owens R, Webber M, Hall C, et al. 2011. Early assessment of cancer outcomes in New York City firefighters after the 9/11 attacks: an observational cohort study. Lancet.378(9794):898–905.

HTTPS://DOI.ORG/10.1016/S0140-6736(11)60989-6

BACKGROUND: The attacks on the WTC on September 11, 2001, created the potential for occupational exposure to known and suspected carcinogens. We examined cancer incidence and its potential association with exposure in the first seven years after 9/11 in firefighters with health information, before 9/11, and minimal loss to follow-up.

METHODS: We assessed 9,853 men who were employed as firefighters on Jan 1, 1996. On and after 9/11, person-time for 8927 firefighters was classified as WTC- exposed; all person-time before 9/11, and person-time after 9/11 for 926 non-WTC-exposed firefighters, was classified as non- WTC-exposed. Cancer cases were confirmed by matches with state tumor registries or through appropriate documentation. We estimated the ratio of incidence rates in WTC-exposed firefighters to non-exposed firefighters, adjusted for age, race and ethnic origin, and secular trends, with the US National Cancer Institute Surveillance Epidemiology and End Results (SEER) reference population. CIs were estimated with over-dispersed Poisson models. Additional analyses included corrections for potential surveillance bias and modified cohort inclusion criteria.

FINDINGS: Compared with the general male population in the USA with a similar demographic mix, the standardized

incidence ratios (SIRs) of the cancer incidence in WTC-exposed firefighters was 1.10 (95% CI 0.98–1.25). When compared with non-exposed firefighters, the SIR of cancer incidence in WTC-exposed firefighters was 1.19 (95% CI 0.96–1.47) corrected for possible surveillance bias and 1.32 (1.07–1.62) without correction for surveillance bias. Secondary analyses showed similar effect sizes.

INTERPRETATION: We reported a modest excess of cancer cases in the WTC- exposed cohort. We remain cautious in our interpretation of this finding because the time since 9/11 is short for cancer outcomes, and the reported excess of cancers is not limited to specific organ types. As in any observational study, we cannot rule out the possibility that effects in the exposed group might be due to unidentified confounders. Continued follow-up will be important and should include cancer screening and prevention strategies.

FUNDING: NIOSH.

Year Published 2012 (4)

Naveed B, Weiden M, Kwon S, et al. 2012. Metabolic syndrome biomarkers predict lung function impairment: a nested case-control study. American Journal of Respiratory and Critical Care Medicine. 185(4):392–399.

HTTPS://DOI.ORG/10.1164/RCCM.201109-1672OC

RATIONALE: Cross-sectional studies demonstrate an association between metabolic syndrome and impaired lung function.

OBJECTIVES: To de fine if metabolic syndrome biomarkers are risk factors for loss of lung function after irritant exposure.

METHODS: A nested case- control study of Fire Department of New York personnel with normal pre-September 11th FEV(1) and who presented for subspecialty pulmonary evaluation before March 10, 2008. We correlated metabolic syndrome biomarkers obtained within 6 months of WTC dust exposure with subsequent FEV(1). FEV(1) at subspecialty pulmonary evaluation within 6.5 years defined disease status; cases had FEV(1) less than lower limit of normal, whereas control subjects had FEV(1) greater than or equal to lower limit of normal.

MEASUREMENTS AND MAIN RESULTS: Clinical data and serum sampled at the first monitoring examination within 6 months of September 11, 2001, assessed body mass index, heart rate, serum glucose, triglycerides and high-density lipoprotein (HDL), leptin, pancreatic polypeptide, and amylin. Cases and control subjects had significant differences in HDL less than 40 mg/dl with triglycerides greater than or equal to 150 mg/dl, heart rate greater than or equal to 66 bpm, and leptin greater than or equal to 10,300 pg/

ml. Each increased the odds of abnormal FEV(1) at pulmonary evaluation by more than twofold, whereas amylin greater than or equal to 116 pg/ml decreased the odds by 84%, in a multibiomarker model adjusting for age, race, body mass index, and WTC arrival time. This model had a sensitivity of 41%, a specificity of 86%, and a receiver operating characteristic area under the curve of 0.77.

CONCLUSIONS: Abnormal triglycerides and HDL and elevated heart rate and leptin are independent risk factors of greater susceptibility to lung function impairment after September 11, 2001, whereas elevated amylin is protective. Metabolic biomarkers are predictors of lung disease, and may be useful for assessing risk of impaired lung function in response to particulate inhalation.

Nolan A, Naveed B, Comfort A, et al. 2012. Inflammatory biomarkers predict airflow obstruction after exposure to World Trade Center dust. Chest. 142:412–418.

HTTPS://DOI.ORG/10.1378/CHEST.11-1202

BACKGROUND: The WTC collapse on September 11, 2001, produced airflow obstruction in a majority of firefighters receiving subspecialty pulmonary evaluation (SPE) within 6.5 years post- September 11, 2001.

METHODS: In a cohort of 801 never smokers with normal pre-September 11, 2001, FEV1, we correlated inflammatory biomarkers and CBC counts at monitoring entry within 6 months of September 11, 2001, with a median FEV(1) at SPE (34 months; interquartile range, 25–57). Cases of airflow obstruction had FEV(1) less than the lower limit of normal (LLN) (100 of 801; 70 of 100 had serum), whereas control subjects had FEV(1) greater than or equal to LLN (153 of 801; 124 of 153 had serum).

RESULTS: From monitoring entry to SPE years later, FEV(1) declined 12% in cases and increased 3% in control subjects. Case subjects had elevated serum macrophage derived chemokine (MDC), granulocyte-macrophage colony-stimulating factor (GM-CSF), granulocyte colony-stimulating factor, and interferon inducible protein-10 levels. Elevated GM- CSF and MDC increased the risk for subsequent FEV(1) less than LLN by 2.5–fold (95% CI, 1.2–5.3) and 3.0–fold (95% CI, 1.4–6.1) in a logistic model adjusted for exposure, BMI, age on September 11, 2001, and polymorphonuclear neutrophils. The model had sensitivity of 38% (95% CI, 27–51) and specificity of 88% (95% CI, 80–93).

CONCLUSIONS: Inflammatory biomarkers can be risk factors for airflow obstruction following dust and smoke exposure. Elevated serum GM-CSF and MDC levels soon after WTC exposure were associated with increased risk of airflow obstruction in subsequent years. Biomarkers of inflammation may help identify pathways producing obstruction after irritant exposure.

Soo J, Webber M, Hall C, et al. 2012. Pulmonary function predicting confirmed recovery from lower-

respiratory symptoms in World Trade Center-exposed firefighters, 2001 to 2010. Chest. 142(5):1244–1250.

HTTPS://DOI.ORG/10.1378/CHEST.11-2210

BACKGROUND: We examined the relationship between pulmonary function (FEV 1) and confirmed recovery from three lower-respiratory symptoms (LRSs) (cough, dyspnea, and wheeze) up to 9 years after symptom onset.

METHODS: The study included white and black male WTC- exposed firefighters who reported at least one LRS on a medical monitoring examination during the first year after September 11, 2001. Confirmed recovery was defined as reporting no LRSs on two consecutive and all subsequent examinations. FEV 1 was assessed at the first post-September 11, 2001, examination and at each examination where symptom information was ascertained. We used stratified Cox regression models to analyze FEV 1, WTC exposure, and other variables in relation to confirmed symptom recovery.

RESULTS: A total of 4,368 firefighters met inclusion criteria and were symptomatic at year 1, of whom1,592 (36.4%) experienced confirmed recovery. In univariable models, first post-September 11,2001, concurrent, and difference between first post- September 11, 2001, and concurrent FEV 1 values were all significantly associated with confirmed recovery. In adjusted analyses, both first post-September 11, 2001, FEV 1 (hazard ratio [HR], 1.07 per 355–mL difference; 95% CI, 1.04–1.10) and FEV 1% predicted (HR, 1.08 per 10% predicted difference; 95% CI, 1.041.12) predicted confirmed recovery. WTC exposure had an inverse association with confirmed recovery in the model with FEV 1 , with the earliest arrival group less likely to recover than the latest arrival group (HR, 0.73;95% CI, 0.58–0.92).

CONCLUSIONS: Higher FEV 1 and improvement in FEV 1 after September 11, 2001, predicted confirmed LRS recovery, supporting a physiologic basis for recovery and highlighting consideration of spirometry as part of any post exposure respiratory health assessment.

Weiden M, Naveed B, Kwon S, et al. 2012. Comparison of WTC dust size on macrophage inflammatory cytokine release in vivo and in vitro. PLoS One. 7(7):e40016.

HTTPS://DOI.ORG/10.1371/JOURNAL.PONE.0040016

BACKGROUND: The WTC collapse exposed over 300,000 people to high concentrations of WTCPM; particulates up to approximately 50 mm were recovered from rescue workers' lungs. Elevated MDC and GM-CSF independently predicted subsequent lung injury in WTC-PM-exposed workers. Our hypotheses are that components of WTC dust strongly induce GM-CSF and MDC in AM; and that these two risk factors are in separate inflammatory pathways.

METHODOLOGY/PRINCIPAL FINDINGS: Normal adherent AM from 15 subjects without WTC-exposure were incubated in media alone, LPS 40 ng/mL, or suspen-

sions of WTC-PM(10–53) or WTC- PM(2.5) at concentrations of 10, 50 or 100 microg/mL for 24 hours; supernatants assayed for 39 chemokines/cytokines. In addition, sera from WTC-exposed subjects who developed lung injury were assayed for the same cytokines. In the in vitro studies, cytokines formed two clusters with GMCSF and MDC as a result of PM(10–53) and PM(2.5). GM-CSF clustered with IL-6 and IL-12(p70) at baseline, after exposure to WTC-PM(10–53) and in sera of WTC dust- exposed subjects (n=70) with WTC lung injury. Similarly, MDC clustered with GRO and MCP-1. WTC-PM(10–53) consistently induced more cytokine release than WTC- PM(2.5) at 100 microg/mL. Individual baseline expression correlated with WTC- PM-induced GM-CSF and MDC.

CONCLUSIONS: WTC-PM(10–53) induced a stronger inflammatory response by human AM than WTC-PM(2.5). This large particle exposure may have contributed to the high incidence of lung injury in those exposed to particles at the WTC site. GM- CSF and MDC consistently cluster separately, suggesting a role for differential cytokine release in WTC-PM injury. Subject-specific response to WTC- PM may underlie individual susceptibility to lung injury after irritant dust exposure.

Year Published 2013 (6)

Aldrich T, Ye F, Hall C, et al. 2013. Longitudinal pulmonary function in newly hired, non- World Trade Center-exposed fire department City of New York firefighters: the first 5 years. Chest. 143(3):791–797.

HTTPS://DOI.ORG/10.1378/CHEST.12-0675

BACKGROUND: Few longitudinal studies characterize firefighters' pulmonary function. We sought to determine whether firefighters have excessive FEV (1) decline rates compared with control subjects.

METHODS: We examined serial measurements of FEV(1) from about 6 months pre hire to approximately 5 years post hire in newly hired male, never smoking, non-Hispanic black and white firefighters, hired between 2003 and 2006, without prior respiratory disease or WTC exposure. Similarly defined Emergency Medical Service (EMS) workers served as control subjects.

RESULTS: Through June 30, 2011, 940 firefighters (82%) and 97 EMS workers (72%) who met study criteria had four or more acceptable post hire spirometries. Pre hire FEV(1) averaged higher for firefighters than EMS workers (99% vs 95%), reflecting more stringent job entry criteria. FEV(1) (adjusted for baseline age and height) declined by an average of 45 mL/y both for firefighters and EMS workers, with Fire 2 EMS decline rate differences averaging 0.2 mL/y (CI, 2

9.2 to 9.6). Four percent of each group had FEV(1) less than the lower limit of normal before hire, increasing to 7% for firefighters and 17.5% for EMS workers, but similar percentages of both groups had adjusted FEV(1) decline rates 10%. Mixed effects modeling showed a significant influence of weight gain but not baseline weight: FEV(1) declined by about 8 mL/kg gained for both groups. Adjusting for weight change, FEV(1) decline averaged 38 mL/y for firefighters and 34 mL/y for EMS workers.

CONCLUSIONS: During the first 5 years of duty, firefighters do not show greater longitudinal FEV(1) decline than EMS control subjects, and fewer of them develop abnormal lung function. Weight gain is associated with a small loss of lung function, of questionable clinical relevance in this fit and active population.

Cho S, Nolan A, Echevarria G, et al. 2013. Chitotriosidase is a biomarker for the resistance to World Trade Center lung injury in New York City firefighters. Journal of Clinical Immunology. 33(6):1134–1142.

HTTPS://DOI.ORG/10.1007/S10875-013-9913-2

PURPOSE: WTC exposure caused airflow obstruction years after exposure. Chitinases and IgE are innate and humoral mediators of obstructive airway disease. We investigated if serum expression of chitinases and IgE early after WTC exposure predicts subsequent obstruction.

METHODS: With a nested case-control design, 251 FDNY personnel had chitotriosidase, YKL-40 and IgE measured in serum drawn within months of 9/11/2001. The main outcome was subsequent Forced Expiratory Volume after 1 second/Forced Vital Capacity (FEV1/FVC) less than the lower limit of normal (LLN). Cases (N=125) had abnormal FEV1/FVC whereas controls had normal FEV1/FVC (N= 126). In a secondary analysis, resistant cases (N=66) had FEV1 (>/=107%) one standard deviation above the mean. Logistic regression adjusted for age, BMI, exposure intensity and post-exposure FEV1/FVC modeled the association between early biomarkers and later lung function.

RESULTS: Cases and Controls initially lost lung function. Controls recovered to pre-9/11 FEV1 and FVC while cases continue to decline. Cases expressed lower serum chitotriosidase and higher IgE levels. Increase in IgE increased the odds of airflow obstruction and decreased the odds of above average FEV1. Alternately, increasing chitotriosidase decreased the odds of abnormal FEV1/ FVC and increased the odds of FEV1 >/=107%. Serum YKL-40 was not associated with FEV1/FVC or FEV1 in this cohort.

CONCLUSIONS: Increased serum chitotriosidase reduces the odds of developing obstruction after WTC- particulate matter exposure and is associated with recovery of lung function. Alternately, elevated IgE is a risk factor for airflow obstruction and progressive lung function decline.

Kwon S, Weiden M, Echevarria G, et al. 2013. Early elevation of serum MMP-3 and MMP-12 predicts protection from World Trade Center-lung injury

in New York City firefighters: A nested case-control study. PLoS One. 8(10):e76099.

HTTPS://DOI.ORG/10.1371/JOURNAL.PONE.00 76099

OBJECTIVE: After 9/11/2001, some Fire Department of New York (FDNY) workers had excessive lung function decline. We hypothesized that early serum matrix metalloproteinases (MMP) expression predicts World Trade Center-Lung Injury (WTC-LI) years later.

METHODS: This is a nested case-control analysis of never- smoking male firefighters with normal pre-exposure Forced Expiratory Volume in one second (FEV1) who had serum drawn up to 155 days post 9/11/2001. Serum MMP1, 2,3,7,8, 9, 12 and 13 were measured. Cases of WTC-LI (N=70) were defined as having an FEV1 one standard deviation below the mean (FEV1 </= 77%) at subspecialty pulmonary evaluation (SPE) which was performed 32 months (IQR 21–53) post9/11. Controls (N=123) were randomly selected. We modeled MMP's ability as a predictor of cases status with logistic regression adjusted for time to blood draw, exposure intensity, weight gain and pre-9/11 FEV1.

RESULTS: Each log-increase in MMP-3 and MMP-12 showed reduced odds of developing WTC- LI by 73% and 54% respectively. MMP-3 and MMP-12 consistently clustered together in cases, controls, and the cohort. Increasing time to blood draw significantly and independently increased the risk of WTC-LI.

CONCLUSIONS: Elevated serum levels of MMP-3 and MMP-12 reduce the risk of developing WTC-LI. At any level of MMP-3 or 12, increased time to blood draw is associated with a diminished protective effect.

Niles J, Webber M, Cohen H, et al. 2013. The respiratory pyramid: From symptoms to disease in World Trade Center exposed firefighters. American Journal of Industrial Medicine. 56(8):870–880.

HTTPS://DOI.ORG/10.1002/AJIM.22171

BACKGROUND: This study utilizes a four-level pyramid framework to understand the relationship between symptom reports and/or abnormal pulmonary function and diagnoses of airway diseases (AD), including asthma, recurrent bronchitis and COPD/emphysema in WTC-exposed firefighters. We compare the distribution of pyramid levels at two time-points: by 9/11/2005 and by 9/11/2010.

METHODS: We studied 6,931 WTC-exposed FDNY firefighters who completed a monitoring exam during the early period and at least two additional follow-up exams 9/11/2005–9/11/2010.

RESULTS: By 9/11/2005 the pyramid structure was as follows: 4,039 (58.3%) in Level 1, no respiratory evaluation or treatment; 1,608 (23.2%) in Level 2, evaluation or treatment without AD diagnosis; 1,005 (14.5%) in Level 3, a single AD diagnosis (asthma, emphysema/COPD, or recurrent bronchitis); 279 (4.0%) in Level 4, asthma

and another AD. By 9/11/2010, the pyramid distribution changed considerably, with Level 1 decreasing to 2,612 (37.7% of the cohort), and Levels 3 (N=1,530) and 4 (N=796) increasing to 22.1% and 11.5% of the cohort, respectively. Symptoms, spirometry measurements and healthcare utilization were associated with higher pyramid levels.

CONCLUSIONS: Respiratory diagnoses, even four years after a major inhalation event, are not the only drivers of future healthcare utilization. Symptoms and abnormal FEV-1 values must also be considered if clinicians and healthcare administrators are to accurately anticipate future treatment needs, years after initial exposure.

Weakley J, Webber M, Ye F, et al. 2013. Agreement between obstructive airways disease diagnoses from self-report questionnaires and medical records. Preventive Medicine. 57(1):38–42.

HTTPS://DOI.ORG/10.1016/J.YPMED.2013.04. 001

OBJECTIVE: To evaluate agreement between self-reported obstructive airways disease (OAD) diagnoses of asthma, bronchitis, and chronic obstructive pulmonary disease (COPD)/emphysema obtained from the New York City Fire Department (FDNY) monitoring questionnaires with physician diagnoses from FDNY medical records.

METHOD: We measured sensitivity, specificity, and agreement between self-report and physician OAD diagnoses in FDNY members enrolled in the WTC monitoring program who completed a questionnaire between 8/2005–1/2012. Using logistic models, we identified characteristics of those who self-report a physician diagnosis that is also reported by FDNY physicians.

RESULTS: 20.3% of the study population (N=14,615) self-reported OAD, while 15.1% received FDNY physician OAD diagnoses. Self-reported asthma had the highest sensitivity (68.7%) and overall agreement (91.9%) between sources. Non-asthma OAD had the lowest sensitivity (32.1%). Multivariate analyses showed that among those with an OAD diagnosis from FDNY medical records, inhaler use (OR=4.90,95% CI=3.84–6.26) and respiratory symptoms (OR=1.55 [95% CI=1.25–1.92]-1.77 [95% CI=1.37–2.27]) were associated with self- reported OAD diagnoses.

CONCLUSION: Among participants in the WTC monitoring program, sensitivity for self-reported OAD diagnoses ranges from good to poor and improves by considering inhaler use. These findings highlight the need for improved patient communication and education, especially for bronchitis or COPD/emphysema.

Weiden M, Naveed B, Kwon S, et al. 2013. Cardiovascular biomarkers predict susceptibility to lung injury in World Trade Center dust-exposed firefighters. The European Respiratory Journal. 2013:41:1023–1030.

HTTPS://DOI.ORG/10.1183/09031936.00077012

Pulmonary vascular loss is an early feature of chronic obstructive pulmonary

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disease. Biomarkers of inflammation and of metabolic syndrome predict loss of lung function in WTC lung injury (LI). We investigated if other cardiovascular disease (CVD) biomarkers also predicted WTC-LI. This nested case-cohort study used 801 never-smoker, WTC-exposed firefighters with normal pre-9/11 lung function presenting for subspecialty pulmonary evaluation (SPE) before March 2008. A representative subcohort of 124 out of 801 subjects with serum drawn within 6 months of 9/11 defined CVD biomarker distribution. Post-9/11 forced expiratory volume in 1 s (FEV1) at defined cases were as follows: susceptible WTC-LI cases with FEV1 </=77% predicted (66 out of 801) and resistant WTC-LI cases with FEV1 >/=107% predicted (68 out of 801). All models were adjusted for WTC exposure intensity, body mass index at SPE, age on 9/11 and pre-9/11 FEV1. Susceptible WTC-LI cases had higher levels of apolipoprotein-AII, C-reactive protein and macrophage inflammatory protein-4 with significant relative risks (RRs) of 3. 85 , 3.93 and 0.26, respectively, with an area under the curve (AUC) of 0.858. Resistant WTC-LI cases had significantly higher soluble vascular cell adhesion molecule and lower myeloperoxidase, with RRs of 2.24 and 2.89, respectively (AUC 0.830). Biomarkers of CVD in serum 6 months post-9/11 predicted either susceptibility or resistance to WTC-LI. These biomarkers may define pathways either producing or protecting subjects from pulmonary vascular disease and associated loss of lung function after an irritant exposure.

Year Published 2014 (8)

Cho S, Echevarria G, Kwon S, et al. 2014.
One airway: Biomarkers of protection from upper and lower airway injury after World Trade Center exposure. Respiratory Medicine. 108(1):162–170.

HTTPS://DOI.ORG/10.1016/J.RMED.2013.11.002

BACKGROUND: Firefighters exposed to WTC dust have developed chronic rhinosinusitis (CRS) and abnormal forced expiratory volume in 1 s (FEV1). Overlapping but distinct immune responses may be responsible for the clinical manifestations of upper and lower airway injury. We investigated whether a panel of inflammatory cytokines, either associated or not associated with WTC-LI, can predict future chronic rhinosinusitis disease and its severity.

METHODS: Serum obtained within six months of 9/11/2001 from 179 WTC exposed firefighters presenting for subspecialty evaluation prior to 3/2008 was assayed for 39 cytokines. The main outcomes were medically managed CRS (N= 62) and more severe CRS cases requiring sinus surgery (N=14). We tested biomarker-CRS severity association using ordinal logistic regression analysis.

RESULTS: Increasing serum IL-6, IL-8, GRO

and neutrophil concentration reduced the risk of CRS progression. Conversely, increasing TNF-alpha increased the risk of progression. In a multivariable model adjusted for exposure intensity, increasing IL-6, TNF-alpha and neutrophil concentration remained significant predictors of progression. Elevated IL-6 levels and neutrophil counts also reduced the risk of abnormal FEV1 but in contrast to CRS, increased TNF-alpha did not increase the risk of abnormal FEV1.

CONCLUSIONS: Our study demonstrates both independent and overlapping biomarker associations with upper and lower respiratory injury, and suggests that the innate immune response may play a protective role against CRS and abnormal lung function in those with WTC exposure.Cho S, Echevarria G, Lee Y, et al. 2014. YKL-40 is a protective biomarker for fatty liver in World Trade Center particulate matter-exposed firefighters. Journal of Molecular Biomarkers & Diagnosis. 5:174.

HTTPS://DOI.ORG/10.4172/2155-9929.1000174

BACKGROUND: Serum biomarkers of metabolic syndrome predict abnormal lung function in World Trade Center particulate matter (WTC-PM)-exposed Fire Department of New York (FDNY) rescue workers. In animal models, exposure to ambient PM induces non-alcoholic fatty liver disease (NAFLD), a well-known comorbidity of metabolic syndrome. YKL-40 is an inflammatory biomarker for both liver and lung disease. We tested if YKL40 is a biomarker for NAFLD in this dust- exposed cohort.

METHODS: Using a nested case-control design, we studied 131 FDNY personnel who had Computer Tomography performed within 5 years post 9/11. NAFLD was defined by a liver/spleen attenuation ratio of </=1. Serum biomarkers, lipid panel and liver function were measured in serum that had been drawn within 6 months of September 11, 2001. YKL-40 and chitotriosidase were assayed by ELISA. We tested biomarker and NAFLD association using logistic regression adjusted for age, BMI, and post-911 lung function.

RESULTS: NAFLD was present in 29/131 (22%) of the cohort. In a multivariable model increasing YKL-40 was protective while increasing triglyceride and alkaline phosphatase were risk factors for NAFLD.

CONCLUSIONS: Increased YKL-40 is a protective biomarker in non-alcoholic fatty liver disease. Further studies may reveal a link between PM-induced lung and liver diseases.Glaser M, Shah N, Webber M, et al. 2014. Obstructive sleep apnea and World Trade Center exposure. Journal of Occupational and Environmental Medicine. 56 Suppl 10: S30-34.

HTTPS://DOI.ORG/10.1097/JOM.0000000000000283

OBJECTIVES: To describe the proportion of at risk WTC-exposed rescue/recovery workers with polysomnogram-confirmed obstructive sleep apnea (OSA) and examine the relationship between WTC exposures, physician-diagnosed gastroesophageal reflux disease (GERD), and

rhinosinusitis and OSA.

METHODS: A total of 636 male participants completed polysomnography from September 24, 2010, to September 23, 2012. Obstructive sleep apnea was classified as mild, moderate, or severe. Associations were tested using nominal polytomous logistic regression.

RESULTS: Eighty-one percent of workers were diagnosed with OSA. Using logistic regression models, severe OSA was associated with WTC exposure on September 11, 2001 (odds ratio, 1.91; 95% confidence interval, 1.15 to 3.17), GERD (odds ratio, 2.75; 95% confidence interval, 1.33 to 5.70), and comorbid GERD/rhinosinusitis (odds ratio, 2.31; 95% confidence interval, 1.22 to 4.40).

CONCLUSIONS: We found significant associations between severe OSA and WTC exposure, and with diseases prevalent in this population. Accordingly, we recommend clinical evaluation, including polysomnography, for patients with high WTC exposure, other OSA risk factors, and a physician diagnosis of GERD or comorbid GERD and rhinosinusitis.

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Niles J, Webber M, Liu X, et al. 2014. The upper respiratory pyramid: early factors and later treatment utilization in World Trade Center exposed firefighters. American Journal of Industrial Medicine. 57(8):857–865.

HTTPS://DOI.ORG/10.1002/AJIM.22326

BACKGROUND: We investigated early post 9/11 factors that could predict rhinosinusitis healthcare utilization costs up to 11 years later in 8,079 WTC-exposed rescue/recovery workers.

METHODS: We used bivariate and multivariate analytic techniques to investigate utilization outcomes; we also used a pyramid framework to describe rhinosinusitis healthcare groups at early (by 9/11/2005) and late (by 9/11/2012) time points.

RESULTS: Multivariate models showed that pre9/11/2005 chronic rhinosinusitis diagnoses and nasal symptoms predicted final year healthcare utilization outcomes more than a decade after WTC exposure. The relative proportion of workers on each pyramid level changed significantly during the study period.

CONCLUSIONS: Diagnoses of chronic rhinosinusitis within 4 years of a major inhalation event only partially explain future healthcare utilization. Exposure intensity, early symptoms and other factors must also be considered when anticipating future healthcare needs.

Nolan A, Kwon S, Cho S, et al. 2014. MMP-2 and TIMP-1 predict healing of WTC-lung injury in New York City firefighters. Respiratory Research. 15(1): 5.

HTTPS://DOI.ORG/10.1186/1465-9921-15-5

RATIONALE: After 9/11/2001, most FDNY workers had persistent lung function decline but some exposed workers recovered. We hypothesized that the protease/anti-protease balance in serum soon after exposure predicts subsequent recovery.

METHODS: We performed a nested case-control study measuring biomarkers in serum drawn before 3/2002 and subsequent forced expiratory volume at one second (FEV1) on repeat spirometry before 3/2008. Serum was assayed for matrix metalloproteinases (MMP-1,2,3,7,8,9,12 and 13) and tissue inhibitors of metalloproteinases (TIMP-1,2,3,4). The representative sub-cohort defined analyte distribution and a concentration above 75th percentile defined elevated biomarker expression. AnFEV1 one standard deviation above the mean defined resistance to airway injury. Logistic regression was adjusted for pre-9/11 FEV1, BMI, age and exposure intensity modeled the association between elevated biomarker expression and above average FEV1.

RESULTS: FEV1 in cases and controls declined 10% of after 9/11/2001. Cases subsequently returned to 99% of their pre-exposure FEV1 while decline persisted in controls. Elevated TIMP-1 and MMP-2 increased the odds of resistance by 5.4 and 4.2 fold while elevated MMP-1 decreased it by 0.27 fold.

CONCLUSIONS: Resistant cases displayed healing, returning to 99% of pre-exposure values. High TIMP-1 and MMP-2 predict healing. MMP/TIMP balance reflects independent pathways to airway injury and repair after WTC exposure.

Schenck E, Echevarria G, Girvin F, et al. 2014. Enlarged pulmonary artery is predicted by vascular injury biomarkers and is associated with WTC-Lung Injury in exposed fire fighters: a case-control study. BMJ Open. 4(9):e005575.

HTTPS://DOI.ORG/10.1136/BMJOPEN-2014-005575

OBJECTIVES: We hypothesise that there is an association between an elevated pulmonary artery/aorta (PA/A) and World Trade Center-Lung Injury (WTC-LI). We assessed if serum vascular disease biomarkers were predictive of an elevated PA/A.

DESIGN: Retrospective case-cohort analysis of thoracic CT scans of WTC- exposed firefighters who were symptomatic between 9/12/2001 and 3/10/2008. Quantification of vascular- associated biomarkers from serum collected within 200 days of exposure.

SETTING: Urban tertiary care centre and occupational healthcare centre.

PARTICIPANTS: Male never-smoking firefighters with accurate pre-9/11 forced expiratory volume in 1 s (FEV1)>/=75%, serum sampled </=200 days of exposure was the baseline cohort (n=801). A subcohort (n=97) with available CT scans and serum biomarkers was identified. WTC-LI was defined as FEV1</=77% at the subspecialty pulmonary evaluation (n=34) and compared with controls (n=63) to determine the associated PA/A ratio. The subcohort was restratified based on PA/A>/=0.92 (n=38) and PA/A<0.92(n=59) to determine serum vascular biomarkers that were predictive of this vasculopathy.

OUTCOME MEASURES: The primary outcome of this study was to identify a PA/A ratio in a cohort of individuals exposed to WTC dust that was associated with WTC-LI. The secondary outcome was to identify serum biomarkers predictive of the PA/A ratio using logistic regression.

RESULTS: PA/ A>/=0.92 was associated with WTC-LI, OR of 4.02 (95% CI 1.21 to 13.41; p=0.023) when adjusted for exposure, body mass index and age at CT. Elevated macrophage derived chemokine and soluble endothelial selectin were predictive of PA/A>/=0.92, (OR, 95% CI 2.08, 1.05 to 4.11, p=0.036; 1.33, 1.06 to 1.68, p=0.016, respectively), while the increased total plasminogen activator inhibitor 1 was predictive of not having PA/A>/=0.92 (OR 0.88,0.79 to 0.98; p=0.024).

CONCLUSIONS: Elevated PA/A was associated with WTC- LI. Development of an elevated PA/A was predicted by biomarkers of vascular disease found in serum drawn within 6 months of WTC exposure. Increased PA/A is a potentially useful non-invasive biomarker of WTC-LI and warrants further study.

Tsukiji J, Cho S, Echevarria G, et al. 2014. Lysophosphatidic acid and apolipoprotein A1 predict increased risk of developing World Trade Center-lung injury: a nested case-control study. Biomarkers. 19(2):159–165.

HTTPS://DOI.ORG/10.3109/1354750X.2014.891047

RATIONALE: Metabolic syndrome, inflammatory and vascular injury markers measured in serum after WTC exposures predict abnormal FEV1. We hypothesized that elevated LPA levels predict FEV(1) < LLN.

METHODS: Nested case-control study of WTC-exposed firefighters. Cases had FEV(1) < LLN. Controls derived from the baseline cohort. Demographics, pulmonary function, serum lipids, LPA and ApoA1 were measured.

RESULTS: LPA and ApoA1 levels were higher in cases than controls and predictive of case status. LPA increased the odds by 13% while ApoA1 increased the odds by 29% of an FEV(1) < LLN in a multivariable model.

CONCLUSIONS: Elevated LPA and ApoA1 are predictive of a significantly increased risk of developing an FEV(1) < LLN.

Weakley J, Webber M, Ye F, et al. 2014. Agreement between upper respiratory diagnoses from self- report questionnaires and medical records in an occupational health setting. American Journal of Industrial Medicine. 57(10):1181–1187.

HTTPS://DOI.ORG/10.1002/AJIM.22353

BACKGROUND: The FDNY-WTC Health Program monitors and treats WTC-related illnesses through regular physical exams, self- administered health questionnaires and treatment visits, as indicated.

METHODS: We measured PPVs and NPVs of self- reported diagnoses of GERD and rhinosinusitis from the health question-

naires in relation to FDNY physician diagnoses from the medical record.

RESULTS: Self-reported GERD had PPV and NPV of 54.0% and 95.7%, respectively; for rhinosinusitis, the PPV and NPV were 48.2% and 91.9%. These characteristics improved considerably (PPV 78.0% GERD and PPV 76.5% rhinosinusitis) in a subpopulation receiving medications from the FDNY-WTC Health Program.

CONCLUSION: The PPV of self-reported diagnoses demonstrates only modest value in predicting physician diagnoses, although high NPVs suggest benefit in ruling out disease. In subgroups selected for their higher disease prevalence, self-reported diagnoses may be considerably more useful.

Year Published 2015 (2)

Loupasakis K, Berman J, Jaber N, et al. 2015. Refractory sarcoid arthritis in World Trade Center-exposed New York City firefighters: A case series. Journal of Clinical Rheumatology: Practical Reports on Rheumatic & Musculoskeletal Diseases. 21(1):19–23.

HTTPS://DOI.ORG/10.1097/RHU.00000000000 00185

OBJECTIVE: The objective of this study was to describe cases of sarcoid arthritis in firefighters from the FDNY who worked at the WTC site.

METHODS: All WTC- exposed FDNY firefighters with sarcoidosis and related chronic inflammatory arthritis (n=11) are followed jointly by the FDNY-WTC Health Program and the Rheumatology Division at the Hospital for Special Surgery. Diagnoses of sarcoidosis were based on clinical, radiographic, and pathological criteria. Patient characteristics, WTC exposure information, smoking status, date of diagnosis, and pulmonary findings were obtained from FDNY-WTC database. Joint manifestations (symptoms and duration, distribution of joints involved), radiographic findings, and treatment responses were obtained from chart review.

RESULTS: Nine of sixty FDNY firefighters who developed sarcoidosis since September 11, 2001, presented with polyarticular arthritis. Two others diagnosed pre-September 11, 2001, developed sarcoid arthritis after WTC exposure. All 11 were never cigarette smokers, and all performed rescue/recovery at the WTC site within three days of the attacks. All had biopsy- proven pulmonary sarcoidosis, and all required additional disease-modifying antirheumatic drugs for adequate control (stepwise progression from hydroxychloroquine to methotrexateto anti- tumor necrosis factor alpha agents) of their joint manifestations.

CONCLUSIONS: Chronic inflammatory polyarthritis appears to be an important manifestation of sarcoidosis in FDNY firefighters with sarcoidosis and WTC

exposure. Their arthritis is chronic and, unlike arthritis in non-WTC-exposed sarcoid patients, inadequately responsive to conventional oral disease-modifying antirheumatic drugs, often requiring anti-tumor necrosis factor alpha agents. Further studies are needed to determine the generalizability of these findings to other groups with varying levels of WTC exposure or with other occupational/environmental exposures.Webber M, Moir W, Zeig-Owens R, et al. 2015. Nested case-control study of selected systemic autoimmune diseases in World Trade Center rescue/recovery workers. Arthritis & Rheumatology. 67(5):1369–76.

HTTPS://DOI.ORG/10.1002/ART.39059

OBJECTIVE: To test the a priori hypothesis that acute and chronic work exposures to the WTC site on or after September 11, 2001, were associated with risk of new-onset systemic autoimmune diseases.

METHODS: A nested case- control study was performed in WTC rescue/ recovery workers who had received a rheumatologist-confirmed systemic autoimmune disease diagnosis between September 12, 2001, and September 11, 2013 (n=59), each of whom was individually matched to four randomly selected controls (n=236) on the basis of year of hire (+/-1 year), sex, race, and work assignment (firefighter or emergency medical service). Acute exposure was defined according to the earliest time of arrival (morning of 9/11 versus later) at the WTC site, and chronic exposure was defined as duration (number of months) of WTC site-related work. Rheumatologists were blinded with regard to each subject's exposure status. The conditional odds ratios (CORs) with 95% confidence intervals (95% CIs) for incident autoimmune disease were derived from exact conditional logistic regression models.

RESULTS: Rheumatoid arthritis was the most common autoimmune diagnosis (37% of subjects), followed by spondyloarthritis (22%), inflammatory myositis (14%), systemic lupus erythematosus (12%), systemic sclerosis (5%), Sjogren's syndrome (5%), antiphospholipid syndrome (3%), and granulomatosis with polyangiitis (Wegener's) (2%). The COR for incident autoimmune disease increased by 13% (COR 1.13, 95% CI 1.02–1.26) for each additional month worked at the WTC site. These odds were independent of the association between high acute exposure (working during the morning of 9/11) and disease outcome, which conveyed an elevated, but not statistically significant, risk (COR 1.85, 95% CI 0.86–3.89).

CONCLUSION: Prolonged work at the WTC site, independent of acute exposure, was an important predictor of post-9/11 systemic autoimmune diseases. The WTC Health Program should expand surveillance efforts for those with extended exposures as early detection can facilitate early treatment, which has been shown to minimize organ damage and improve quality of life.

Year Published 2016 (15)

Aldrich T, Vossbrinck M, Zeig-Owens R, et al. 2016. Lung function trajectories in WTC-exposed NYC firefighters over 13 years: the roles of smoking and smoking cessation." Chest. 149(6):1419–27.

HTTPS://DOI.ORG/10.1016/J.CHEST.2015.10.067

BACKGROUND: WTC-exposed Fire Department of the City of New York (FDNY) firefighters lost, on average, 10% of lung function after 9/11, and >10% developed new obstructive airways disease. There was little recovery (on average) over the first 6 years. Follow-up into the next decade allowed us to determine the longer-term exposure effects and the roles of cigarette-smoking and cessation on lung function trajectories.

METHODS: We examined serial measurements of FEV1 from 3/11/2000 to 9/10/2014 among 10,641 WTC-exposed FDNY firefighters with known smoking and body weight histories.

RESULTS: The median number of FEV1's during follow-up was 9; 15% arrived at the WTC during the morning of 9/11/2001; and 65% never smoked. Firefighters arriving the morning of 9/11/2001 averaged lower lung function than did lesser-exposed firefighters; this difference remained significant during most of follow-up (P<0.05). Never-smokers had significantly better lung function than current-smokers; former-smokers fell in- between, depending upon their cessation date. Those arriving the morning of 9/11/2001 were more likely to have an FEV1<LLN compared with those arriving between 9/13/2001–9/24/2001 (odds ratio [OR] =1.70, P<0.01). Current-smokers were more likely to have an FEV1<LLN compared with: never- smokers (OR=2.06, P<0.01), former- smokers who quit before 9/11/2001 (OR=1.96, P<0.01); or, those who quit between 9/11/2001–3/10/2008 (OR=1.49, P<0.01).

CONCLUSIONS: 13 years after 9/11/2001, most firefighters continued to show a lack of lung function recovery, with the trajectory of decline differing by WTC-exposure and smoking-status. Unlike the immutable effect of WTC exposure, we demonstrated the benefit on lung function of smoking cessation in this unique occupational/environmental cohort.

Aldrich T, Weakley J, Dhar S, et al. 2016. Bronchial reactivity and lung function after World Trade Center exposure. Chest. 150(6):1333–1340.

HTTPS://DOI.ORG/10.1016/J.CHEST.2016.07.005

BACKGROUND: WTC-exposed rescue/recovery workers endured massive respiratory insult from inhalation of particulate matter and gases, resulting in respiratory symptoms, loss of lung function, and, for many, bronchial hyperreactivity (BHR). The persistence of respiratory symptoms and lung function abnormalities has been well-documented,

while persistence of BHR has not been investigated.

METHODS: 173 WTC- exposed firefighters with bronchial reactivity measured within two years after 9/11/2001 (9/11), (baseline methacholine challenge test [MCT]), were re-evaluated in 2013–2014 (follow-up-MCT). FEV1 measurements were obtained from the late pre-9/11, early post-9/11 and late post-9/11 periods. Respiratory symptoms and corticosteroid treatment were recorded.

RESULTS: Bronchial reactivity remained stable (within one doubling dilution) for most (n=101, 58%). 16 of 28 (57%) with BHR (PC20<8mg/ml) at baseline had BHR at follow up, and an additional 27 of the 145 (19%) without BHR at baseline had BHR at follow-up. In multivariable models, we found that BHR baseline was strongly associated with BHR follow-up (OR=6.46) and that BHR at follow-up was associated with an estimated 15.4 ml/year greater FEV1 decline than experienced by those without BHR at follow-up. Annual FEV1 decline was moderated by corticosteroid use.

CONCLUSIONS: Persistent BHR and its deleterious influence on lung function suggest a role for airway inflammation in perpetuation of WTC-associated airway disease. In future massive occupational exposure to inorganic dust/gases, we recommend early and serial pulmonary function testing, including measurements of bronchial reactivity, when possible, and inhaled corticosteroid therapy for those with symptoms or pulmonary function tests consistent with airway disease.

Boffetta P, Zeig-Owens R, Wallenstein S, et al. 2015. Cancer in World Trade Center responders: Findings from multiple cohorts and options for future study. American Journal of Industrial Medicine. 59(2):96–105.

HTTPS://DOI.ORG/10.1002/AJIM.22555

BACKGROUND: Three longitudinal studies of cancer incidence in varied populations of WTC responders have been conducted.

METHODS: We compared the design and results of the three studies.

RESULTS: Separate analyses of these cohorts revealed excess cancer incidence in responders for all cancers combined and for cancers of the thyroid and prostate. Methodological dissimilarities included recruitment strategies, source of cohort members, demographic characteristics, overlap between cohorts, assessment of WTC and other occupational exposures and confounders, methods and duration of follow-up, approaches for statistical analysis, and latency analyses.

CONCLUSIONS: The presence of three cohorts strengthens the effort of identifying and quantifying the cancer risk; the heterogeneity in design might increase sensitivity to the identification of cancers potentially associated with exposure. The presence and magnitude of an increased cancer risk remains to be fully elucidated. Continued long-term follow

up with minimal longitudinal dropout is crucial to achieve this goal.

Girvin F, Zeig-Owens R, Gupta D, et al. 2016. Radiologic features of World Trade Center-related sarcoidosis in exposed NYC Fire Department rescue workers. Journal of Thoracic Imaging. 31(5):296–303.

HTTPS://DOI.ORG/10.1097/RTI.0000000000000230

PURPOSE: An increased incidence of sarcoidosis has been demonstrated in firefighters, supporting the concern that occupational/environmental exposure may pose an etiologic risk factor. This incidence increased further after September 11, 2001 following exposure to WTC dust and gases. We review computed tomography (CT) features in this population, comparing the range of findings and physiological correlates with those typically reported in unexposed individuals with pulmonary sarcoidosis. MATERIALS AND METHODS: With C T imaging we retrospectively identified 46 patients with WTC-related sarcoidosis, between March 18, 2002 and April 5, 2014. Scans were independently reviewed by 2 dedicated thoracic radiologists and assessed for disease patterns and correlation with pulmonary functions.

RESULTS: The majority (37/46; 80%) had symmetric mediastinal and hilar lymphadenopathy. Similarly, most (38/46; 83%) had perilymphatic nodules. Foci of ill-defined ground glass attenuation were present in 6 (13%). Coalescent nodularity was present in 15 (33%). Only 3 (7%) had parenchymal reticulation. A mixed pattern of lung findings was present in 21 (46%). When all forms of parenchymal disease were scored by zonal distribution, 21 (46%) had parenchymal disease predominantly involving mid and upper lungs; 11/46 (24%) had a random distribution without zonal predominance; 6/46 (13%) demonstrated atypical lower zone predominance. Whereas 15/46 (33%) had obstructive airways disease on pulmonary function tests, there were no CT findings that were predictive of obstructive airways disease.

CONCLUSIONS: The majority of cases of WTC-related sarcoidosis demonstrated typical radiographic appearances of sarcoidosis, with symmetric hilar and mediastinal lymphadenopathy and mid to upper lung perilymphatic nodules; these findings were consistent with other previously reported cases of sarcoid-like granulomatous disease in association with various alternate underlying etiologies. There was no correlation between disease patterns or extent on CT and pulmonary function testing, likely at least in part due to the overall mild extent of disease in this population.

Hall C, Liu X, Zeig-Owens R, et al. 2016 May. The duration of an exposure response gradient between incident obstructive airways disease and work at the World Trade Center site: 2001–2011. PLoS Currents.20:7.

HTTPS://DOI.ORG/10.1371/CURRENTS.DIS.8A93E7682624698558A76A1FA8C5893F

BACKGROUND: Adverse respiratory effects of World Trade Center (WTC) exposure have been widely documented, but

the length of time that exposure remains associated with disease is uncertain. We estimate the incidence of new cases of physician-diagnosed obstructive airway disease (OAD) as a function of time since 9/11/2001 in WTC-exposed firefighters.

METHODS: Exposure was categorized by first WTC arrival time: high (9/11/2001 AM); moderate (9/11/2001 PM or 9/12/2001); or low (9/13–24/2001). We modeled relative rates (RR) and 95% confidence intervals (CI) of OAD incidence by exposure over the first 10 years post- 9/11/2001, estimating the time(s) of change in the RR with change point models. We further examined the relationship between self-reported lower respiratory symptoms and physician diagnoses.

RESULTS: Change points were observed at 15 and 84 months post-9/11/2001, with relative incidence rates for the high versus low exposure group of 4.02 (95% CI 2.62–6.16)prior to 15 months, 1.90 (95% CI 1.49–2.44)from months 16 to 84, and 1.20 (95% CI 0.92–1.56) thereafter. Incidence in all exposure groups increased after the WTC health program began to offer free coverage of OAD medications in month 63. Self- reported lower respiratory symptoms in the first 15 months had 80.6% sensitivity, but only 35.9% specificity, for eventual OAD diagnoses.

CONCLUSIONS: New OAD diagnoses are associated with WTC exposure for at least seven years. Some portion of the extended duration of that association may be due to delayed diagnoses. Nevertheless, our results support recognizing OAD among rescue workers as WTC-related even when diagnosed years after exposure.

Kwon S, Putman B, Weakley J, et al. 2016. Blood eosinophils and World Trade Center exposure predict surgery in chronic rhinosinusitis. A 13.5–year longitudinal study. Annals of the American Thoracic Society. 13(8):1253–61.

HTTPS://DOI.ORG/10.1513/ANNALSATS.201511-742OC

RATIONALE: The WTC collapse generated caustic airborne particulates that caused chronic rhinosinusitis in exposed FDNY firefighters. Surgery was performed when symptoms remained uncontrolled despite medical management.

OBJECTIVES: To identify predictors of surgical intervention for chronic rhinosinusitis in firefighters exposed to airborne irritants at the WTC collapse site.

METHODS: We assessed in 8227 firefighters with WTC exposure between September 11, 2001 (9/11), and September 25, 2001, including WTC-site arrival time, months of rescue and recovery work, and eosinophil concentration measured between September 11, 2001,and March 10, 2003. We assessed the association of serum cytokines and immunoglobulins with eosinophil concentration and surgery for rhinosinusitis in 112 surgical cases and 376 control subjects with serum available from the first 6 months after exposure to the WTC collapse site.

MEASUREMENTS AND MAIN RESULTS:

Between September 11, 2001, and March 10, 2015, the surgery rate was 0.47 cases per 100 person-years. In the first 18 months post-9/11, surgical patients had higher mean blood eosinophil levels than study cohort patients (219 +/155 vs. 191 +/134; P < 0.0001). Increased surgery risk was associated with increasing blood eosinophil counts (hazard ratio [HR], 1.12 per 100 cells/mul; 95% confidence interval [CI], 1.07–1.17; P < 0.001); arriving at the WTC site on September 11, 2001, or September 12, 2001 (HR, 1.43; 95% CI, 1.04–1.99; P=0.03); and working six months or longer at the WTC site (HR, 1.48; 95% CI, 1.14–1.93; P < 0.01). Median blood eosinophil levels for surgical patients were above levels for the cohort in all 18-month intervals March 11, 2000, through March 10, 2015, using 51,163 measurements representing 97,733 person-years of observation. Increasing age, increasing IL- 17A, and low IgA in serum from 2001 to 2002 predicted blood eosinophil concentration in surgical patients but not in control subjects (R(2)=0.26, P < 0.0001; vs. R(2)=0.008, P=0.56).

CONCLUSIONS: Increasing blood eosinophil concentration predicts surgical intervention for chronic rhinosinusitis, particularly in those with intense acute and prolonged exposure to airborne irritants. WTC-exposed FDNY firefighters who underwent irritant-associated sinus surgery are immunologically different from the cohort. Surgical patients have a higher blood eosinophil levels that is associated with mediators of mucosal immunity.

Mohr L. 2016. Longitudinal lung function decrements in firefighters who responded to the World Trade Center disaster: Important insights for the preservation of lung function in future disasters. Chest. 149(6):1362–1364.

HTTPS://DOI.ORG/10.1016/J.CHEST.2016.03.056

BACKGROUND: World Trade Center (WTC)-exposed Fire Department of the City of New York firefighters lost, on average, 10% of lung function after September 11, 2011, and >10% developed new obstructive airways disease. There was little recovery (on average) over the first 6 years. Follow-up into the next decade allowed us to determine the longer-term exposure effects and the roles of cigarette smoking and cessation on lung function trajectories.

METHODS: We examined serial measurements of FEV1 from March 11, 2000, to September 10, 2014, among 10,641 WTC-exposed Fire Department of the City of New York firefighters with known smoking and body weight histories.

RESULTS: Themedian number of FEV1 measurements during follow-up was 9; 15%of firefighters arrived at the WTC during the morning of September 11, 2001; and 65% never smoked. Firefighters arriving the morning of September 11, 2001 averaged lower lung function than did lesser exposed firefighters; this difference remained significant during most of follow-up (P < .05). Never smokers had significantly better lung function than current smokers; former smokers fell in between, depending upon their cessation date. Those arriving the

morning of September 11, 2001 were more likely to have an FEV1 < lower limits of normal compared with those arriving between September 13, 2001, and September 24, 2001 (OR ¼ 1.70, P < .01). Current smokers were more likely to have an FEV1 < lower limits of normal compared with never smokers (OR ¼ 2.06, P < .01), former smokers who quit before September 11, 2001 (OR ¼ 1.96, P < .01), or those who quit between September 11, 2001 and March 10, 2008 (OR ¼ 1.49, P < .01).

CONCLUSIONS: Thirteen years after September 11, 2001, most firefighters continued to show a lack of lung function recovery, with the trajectory of decline differing by WTC exposure and smoking status. Unlike the immutable effect of WTC exposure, we demonstrated the benefit on lung function of smoking cessation in this unique occupational/environmental cohort.

Moir W, Zeig-Owens R, Daniels R, et al. 2016. Post-9/11 cancer incidence in World Trade Center-exposed New York City firefighters as compared to a pooled cohort of firefighters from San Francisco, Chicago and Philadelphia (9/11/2001–2009). American Journal of Industrial Medicine. 59(9):722–30.

HTTPS://DOI.ORG/10.1002/AJIM.22635

BACKGROUND: We previously reported a modest excess of cancer in WTC-exposed firefighters versus the general population. This study aimed to separate the potential carcinogenic effects of firefighting and WTC exposure by comparing to a cohort of non-WTC-exposed firefighters.

METHODS: Relative rates (RRs) for all cancers combined and individual cancer subtypes from 9/11/2001 to 12/31/2009 were modeled using Poisson regression comparing 11,457 WTC-exposed firefighters to 8,220 urban non-WTC-exposed firefighters.

RESULTS: Compared with non-WTC-exposed firefighters, there was no difference in the RR of all cancers combined for WTC-exposed firefighters (RR=0.96, 95%CI: 0.83–1.12). Thyroid cancer was significantly elevated (RR=3.82, 95%CI: 1.0720.81) from 2001 to 2009; this was attenuated (RR=3.43, 95%CI: 0.94–18.94) and non- significant when controlling for possible surveillance bias. Prostate cancer was elevated during the latter half (2005–2009; RR=1.38, 95%CI: 1.01–1.88).

CONCLUSIONS: Further follow-up is needed to assess the relationship between WTC exposure and cancers with longer latency periods. Am. J. Ind. Med. 59:722–730, 2016. (c) 2016 Wiley Periodicals, Inc.

Weakley J, Hall C, Liu X, et al. 2016. The effect of World Trade Center exposure on the latency of chronic rhinosinusitis diagnoses in New York City firefighters: 2001–2011. Occupational and Environmental Medicine. 73(4):280–3.

HTTPS://DOI.ORG/10.1136/OEMED-2015 -103094

OBJECTIVE: To assess how the effect of WTC exposure on physician-diagnosed chronic rhinosinusitis (CRS) in firefighters

changed during the decade following the attack on 9/11 (11 September 2001 to 10 September 2011).

METHODS: We examined temporal effects on the relation between WTC exposure and the incidence of physician diagnosed CRS in firefighters changed during the decade following the attack on 9/11 (11 September 2001 to 10 September 2011). Exposure was grouped by time of arrival at the WTC site as follows: (high) morning 11 September 2001 (n=1623); (moderate) afternoon 11 September 2001 or 12 September 2001 (n=7025); or (low) 13–24 September 2001 (n=1200). Piecewise exponential survival models were used to estimate incidences by exposure group, with change points in the relative incidences estimated by maximum likelihood.

RESULTS: Incidences dramatically increased after 2007 due to a programmatic change that provided free medical treatment, but increases were similar in all exposure groups. For this reason, we observed no change point during the study period, meaning the relative incidence by exposure group (high vs moderate vs low) of CRS disease did not significantly change over the study period. The relative rate of developing CRS was 1.99 (95% CI=1.64 to 2.41) for high versus low exposure, and 1.52 (95% CI=1.28 to 1.80) for moderate versus low exposure during the 10 year follow up period.

CONCLUSIONS: The risk of CRS in FDNY firefighters appears increased with WTC-exposure, and has not diminished by time since exposure.

Weiden M, Kwon S, Caraher E, et al. 2016. Biomarkers of World Trade Center particulate matter exposure: Physiology of distal airway and blood biomarkers that predict FEV(1) decline. Seminars in Respiratory and Critical Care Medicine. 36(3):323–333.

HTTPS://DX.DOI.ORG/10.1055%2FS-00 35-1547349

BACKGROUND: Biomarkers can be important predictors of disease severity and progression. The intense exposure to particulates and other toxins from the destruction of the WTC overwhelmed the lung's normal protective barriers. The Fire Department of New York (FDNY) cohort not only had baseline pre-exposure lung function measures but also had serum samples banked soon after their WTC exposure. This well-phenotyped group of highly exposed first responders is an ideal cohort for biomarker discovery and eventual validation. Disease progression was heterogeneous in this group in that some individuals subsequently developed abnormal lung function while others recovered. Airflow obstruction predominated in WTC- exposed patients who were symptomatic. Multiple independent disease pathways may cause this abnormal FEV1 after irritant exposure. WTC exposure activates one or more of these pathways causing abnormal FEV1 in an individual. Our hypothesis was that serum biomarkers expressed within 6 months after WTC exposure reflect active disease pathways and predict subsequent development or protection from

abnormal FEV1 below the lower limit of normal known as WTC- Lung Injury (WTC-LI). We utilized a nested case-cohort control design of previously healthy never smokers who sought subspecialty pulmonary evaluation to explore predictive biomarkers of WTC- LI. We have identified biomarkers of inflammation, metabolic derangement, protease/antiprotease balance, and vascular injury expressed in serum within 6 months of WTC exposure that were predictive of their FEV1 up to 7 years after their WTC exposure. Predicting future risk of airway injury after particulate exposures can focus monitoring and early treatment on a subset of patients in greatest need of these services.

RESULTS: FDNY research studies have consistently found that early arrival to work and/ or prolonged work at the WTC- site increased the risks for adverse physical and mental health outcomes. To date, a substantial proportion has been diagnosed with obstructive airways disease, chronic rhinosinusitis, and gastroesophageal reflux disease; a quarter has two or more of these conditions.

CONCLUSIONS: While much has been learned, the entire spectrum and trajectory of WTC-related disorders and their mechanisms of onset and persistence remain to be fully described. Am. J. Ind. Med. 59:695–708, 2016. (c) 2016 Wiley Periodicals, Inc.

Yip J, Webber M, Zeig-Owens R, et al. 2016. FDNY and 9/11:Clinical services and health outcomes in World Trade Center-exposed firefighters and EMS workers from 2001 to 2016. American Journal of Industrial Medicine. 59(9):695–708.

HTTPS://DOI.ORG/10.1002/AJIM.22631

BACKGROUND: After the WTC attacks on September 11, 2001, the Fire Department of the City of New York (FDNY) instituted a WTC medical monitoring and treatment program and established a data center to document health outcomes in the WTC-exposed workforce of approximately 16,000 firefighters and EMS workers.

METHODS: FDNY schedules routine monitoring exams every 12–18 months and physical and mental health treatment appointments, as required.

Yip J, Zeig-Owens R, Hall C, et al. 2016. Health conditions as mediators of the association between World Trade Center exposure and health-related quality of life in firefighters and EMS workers. Journal of Occupational and Environmental Medicine. 58(2):200–206.

HTTPS://DOI.ORG/10.1097/JOM.00000000000 00597

OBJECTIVE: Studies have reported reduced health-related quality of life (HrQoL) in rescue/recovery workers for years post disaster. Few have examined specific post disaster physical and mental health conditions as mediators of the association between exposure to disaster and HrQoL.

METHODS: We used the Short Form-12 to measure HrQoL in 7190 male WTC-exposed first responders. Potential me-

FDNY Responders

diators included physician diagnoses obtained from medical records and mental health conditions obtained from questionnaires.

RESULTS: Among moderately and highly WTC-exposed workers, health conditions fully mediated the observed relationship between WTC-exposure and physical health functioning of HrQoL, and substantially mediated the association between WTC exposure and mental health functioning.

CONCLUSIONS: Because WTC-related health conditions explain the relationship between WTC-exposure and HrQoL, medical monitoring with treatment of affected populations is necessary to mitigate the adverse effects of WTC-exposure on HrQoL.

Yip J, Zeig-Owens R, Webber M, et al. 2016. World Trade Center-related physical and mental health burden among New York City Fire Department emergency medical service workers. Occupational and Environmental Medicine. 73(1):13–20.

HTTPS://DOI.ORG/10.1136/OEMED-2014 -102601

OBJECTIVES: To describe the health burden among Fire Department of the City of New York (FDNY) emergency medical service (EMS) workers and examine its association with work at the WTC disaster site.

METHODS: In this observational cohort study, we used FDNY physician diagnoses to estimate the cumulative incidence of physical health conditions including rhinosinusitis, gastroesophageal reflux disease (GERD), obstructive airways disease (OAD) and cancer among EMS workers and demographically similar firefighters who were active on 11 September 2001 (9/11). Validated screening instruments were used to estimate the prevalence of probable PTSD, probable depression and probable harmful alcohol use. We also analyzed the association between health conditions and WTC- exposure.

RESULTS: Among 2281 EMS workers, the 12–year post-9/11 cumulative incidence (11 September 2001 to 31 December 2013) of rhinosinusitis was 10.6%; GERD 12.1%; OAD 11.8%; cancer 3.1%. The prevalence of probable PTSD up to 12 years after exposure was 7%; probable depression 16.7%; and probable harmful alcohol use 3%. Compared with unexposed, EMS workers who arrived earliest at the site had higher adjusted relative risks (aRR) for most conditions, including rhinosinusitis (aRR=3.7; 95% CI 2.2 to 6.0); GERD (aRR=3.8; 95% CI 2.4 to 6.1); OAD (aRR=2.4:95% CI 1.7 to 3.6); probable PTSD (aRR=7.0; 95% CI 3.6 to 13.5); and, probable depression (aRR=2.3; 95% CI 1.6 to 3.1).

CONCLUSIONS: In this 12–year study, we documented a high burden of health conditions associated with WTC-exposure among FDNY EMS workers. These findings underscore the importance of continued monitoring and treatment of this workforce.

Zeig-Owens R, Kablanian A, Webber M, et al. 2016. Agreement between self-reported and confirmed cancer diagnoses in New York City firefighters and EMS workers, 2001–2011. Public Health Reports. 131(1):153–9.

HTTPS://DOI.ORG/10.1177/003335491613100122

OBJECTIVES: Because of the delay in availability of cancer diagnoses from state cancer registries, self-reported diagnoses may be valuable in assessing the current cancer burden in many populations. We evaluated agreement between self-reported cancer diagnoses and state cancer registry- confirmed diagnoses among 21,437 firefighters and emergency medical service workers from the Fire Department of the City of New York. We also investigated the association between WTC exposure and other characteristics in relation to accurate reporting of cancer diagnoses.

METHODS: Participants self-reported cancer status in questionnaires from October 2, 2001, to December 31, 2011. We obtained data on confirmed cancer diagnoses from nine state cancer registries, which we used as our gold standard. We calculated sensitivity, specificity, PPV, and NPV, comparing self- reported cancer diagnoses with confirmed cancer diagnoses. We used multivariable logistic regression models to assess the association between WTC exposure and correct self-report of cancer status, false- positive cancer reports, and false-negative cancer reports.

RESULTS: Sensitivity and specificity for all cancers combined were 90.3% and 98.7%, respectively. Specificities and NPVs remained high in different cancer types, while sensitivities and PPVs varied considerably. WTC exposure was not associated with accurate reporting.

CONCLUSION: We found high specificities, NPVs, and general concordance between self-reported cancer diagnoses and registry- confirmed diagnoses. Given the low population prevalence of cancer, self- reported cancer diagnoses may be useful for determining non-cancer cases. Because of the low sensitivities and PPVs for some individual cancers, however, case confirmation with state cancer registries or medical records remains critically important.

Zeig-Owens R, Nolan A, Putman B, et al. 2016. Biomarkers of patient intrinsic risk for upper and lower airway injury after exposure to the World Trade Center atrocity. American Journal of Industrial Medicine. 59(9):788–894. [Review]

HTTPS://DOI.ORG/10.1002/AJIM.22643

BACKGROUND: High rates of upper and lower airways disease have occurred in Fire Department of the City of New York (FDNY) workers exposed to the WTC disaster site. Most experienced acute declines in pulmonary function, and some continued to experience decline over 14 years of follow- up. Similarly, some with rhinosinusitis had symptoms requiring sinus surgery.

AIM: To increase generalizability of biomarker investigation, we describe bio-

markers of risk for upper and lower airway injury that do not require stored serum.

METHODS: We review WTC biomarker literature.

RESULTS: Cytokines expressed in stored serum from the first 6 months post-9/11 can identify individuals at higher risk for future abnormal pulmonary function.

CONCLUSION: This research will help identify individuals at high risk of lung and sinus disease that develop after these, or future, irritant exposures for intensive monitoring and treatment. It may also identify targets for effective therapeutic interventions. Am. J. Ind. Med. 59:788–794, 2016. (c) 2016 Wiley Periodicals, Inc.

Year Published 2017 (5)

Caraher, EJ, Kwon S, Haider SH, et al. 2017. Receptor for advanced glycation end-products and World Trade Center particulate induced lung function loss: A case-cohort study and murine model of acute particulate exposure. PLoS One 12(9):e0184331.

HTTP://DOI.ORG/10.1371/JOURNAL.PONE.0184331

BACKGROUND: World Trade Center-particulate matter(WTC-PM) exposure and metabolic-risk are associated with WTC-Lung Injury (WTC-LI). The receptor for advanced glycation end-products (RAGE) is most highly expressed in the lung, mediates metabolic risk, and single-nucleotide polymorphisms at the AGER-locus predict forced expiratory volume (FEV). Our objectives were to test the hypotheses that RAGE is a biomarker of WTC-LI in the FDNY-cohort and that loss of RAGE in a murine model would protect against acute PM-induced lung disease. We know from previous work that early intense exposure at the time of the WTC collapse was most predictive of WTC-LI therefore we utilized a murine model of intense acute PM-exposure to determine if loss of RAGE is protective and to identify signaling/cytokine intermediates. This study builds on a continuing effort to identify serum biomarkers that predict the development of WTC-LI. A case-cohort design was used to analyze a focused cohort of male never-smokers with normal pre-9/11 lung function. Odds of developing WTC-LI increased by 1.2, 1.8 and 1.0 in firefighters with soluble RAGE (sRAGE)≥97pg/mL, CRP≥2.4mg/L, and MMP-9≤397ng/mL, respectively, assessed in a multivariate logistic regression model (ROCAUC of 0.72). Wild type (WT) and RAGE-deficient(Ager-/-) mice were exposed to PM or PBS-control by oropharyngeal aspiration. Lung function, airway hyperreactivity, bronchoalveolar lavage, histology, transcription factors and plasma/BAL cytokines were quantified. WT-PM mice had decreased FEV and compliance, and increased airway resistance and methacholine reactivity after 24-hours. Decreased IFN-γ and increased LPA were observed in WT-PM mice; similar findings have been reported

for firefighters who eventually develop WTC-LI. In the murine model, lack of RAGE was protective from loss of lung function and airway hyperreactivity and was associated with modulation of MAP kinases. We conclude that in a multivariate adjusted model increased sRAGE is associated with WTC-LI. In our murine model, absence of RAGE mitigated acute deleterious effects of PM and may be a biologically plausible mediator of PM-related lung disease.

Cleven K, Webber M, Zeig-Owens R, et al. 2017. Airway disease in rescue/recovery workers: Recent findings from the World Trade Center collapse. Current Allergy and Asthma Reports.17(1):5.

HTTPS://DOI.ORG/10.1007/S11882-017-0670-9

PURPOSE OF REVIEW: Our goal is to summarize the airway disease literature since September 11, 2001 (9/11), focusing on studies published since 2011 in WTC-exposed rescue/recovery workers.

RECENT FINDINGS: Since 2011, studies have confirmed relationships between initial WTC exposure intensity, severity of symptoms, airway disease diagnoses, and biomarkers of disease progression. Studies continue to document ongoing morbidity in rescue/recovery workers over 10 years after 9/11. Future research should further identify correlates of symptom persistence and new airway disease diagnoses. The unique characteristics of the airway diseases in this population warrant ongoing monitoring and treatment. [review article]

Liu X, Yip J, Zeig-Owens R, et al. 2017. The Effect of World Trade Center Exposure on the Timing of Diagnoses of Obstructive Airway Disease, Chronic Rhinosinusitis, and Gastroesophageal Reflux Disease. Frontiers in public health 5: 2.

HTTPS://DOI.ORG/10.3389/FPUBH.2017.00002

OBJECTIVES: In a cohort of rescue/recovery workers exposed to the dust that resulted from the collapse of the World Trade Center (WTC), we assessed how a diagnosis of obstructive airways disease (OAD) affected the likelihood of a subsequent diagnosis of chronic rhinosinusitis (CRS) or gastroesophageal reflux disease (GERD). We also assessed whether OAD acted as a mediator of the association between exposure to the WTC rescue/recovery effort and CRS and GERD diagnoses.

METHODS: In this prospective cohort study, we analyzed Fire Department of the City of New York physician diagnoses of OAD, CRS, and GERD that were first documented between September 11, 2001, and September 10, 2011, among 8,968 WTC-exposed firefighters. We used piecewise exponential survival models to evaluate whether OAD was a risk factor for either CRS or GERD and to assess OAD as a possible mediator.

RESULTS: An OAD diagnosis significantly increased the risks for subsequent CRS [relative rate (RR), 4.24; 95% CI, 3.78-4.76] and GERD (RR, 3.21; 95% CI, 2.93-3.52) diagnoses. Further, 21% of the WTC exposure effect (high vs. low intensity) on GERD and 13% of the effect (high vs. low

intensity) on CRS were mediated by a prior OAD diagnosis.

CONCLUSION: Individuals with an OAD diagnosis had elevated risks for subsequent diagnoses of CRS or GERD. Part of the effect of WTC exposure on CRS and GERD diagnoses is mediated by prior diagnoses of OAD; this mediation effect of OAD may reflect biological pathways or healthcare utilization practices.

Vossbrinck M, Zeig-Owens R, Hall CB, et al. 2017. Post-9/11/2001 lung function trajectories by sex and race in World Trade Center-exposed New York City emergency medical service workers. Occupational and Environmental Medicine 74(3):200-203.

HTTP://DX.DOI.ORG/10.1136/OEMED-2016-103619

OBJECTIVE: To determine whether lung function trajectories after 9/11/2001 (9/11) differed by sex or race/ethnicity in World Trade Center-exposed Fire Department of the City of New York emergency medical service (EMS) workers.

METHOD: Serial cross-sectional study of pulmonary function tests (PFTs) taken between 9/11 and 9/10/2015. We used data from routine PFTs (forced expiratory volume in 1 s (FEV1) and FEV1% predicted), conducted at 12–18 month intervals. FEV1 and FEV1% predicted were assessed over time, stratified by sex, and race/ethnicity. We also assessed FEV1 and FEV1% predicted in current, former and never-smokers.

RESULTS: Among 1817 EMS workers, 334 (18.4%) were women, 979 (53.9%) self-identified as white and 939 (51.6%) were never-smokers. The median follow-up was 13.1 years (IQR 10.5–13.6), and the median number of PFTs per person was 11 (IQR 7–13). After large declines associated with 9/11, there was no discernible recovery in lung function. In analyses limited to never-smokers, the trajectory of decline in adjusted FEV1 and FEV1% predicted was relatively parallel for men and women in the 3 racial/ethnic groups. Similarly, small differences in FEV1 annual decline between groups were not clinically meaningful. Analyses including ever-smokers were essentially the same.

CONCLUSIONS: 14 years after 9/11, most EMS workers continued to demonstrate a lack of lung function recovery. The trajectories of lung function decline, however, were parallel by sex and by race/ethnicity. These findings support the use of routine, serial measures of lung function over time in first responders and demonstrate no sex or racial sensitivity to exposure-related lung function decline.

Webber M, Yip J, Zeig-Owens R, et al. 2017. Post-9/11 sarcoidosis in WTC-exposed firefighters and emergency medical service workers. Respiratory Medicine. 132(2017): 232-237.

HTTPS://DOI.ORG/10.1016/J.RMED.2017.06.004

INTRODUCTION: The World Trade Center (WTC) disaster released a huge quantity and variety of toxicants into the environment. To-date, studies from each of the

three major cohorts of WTC-exposed workers have suggested "greater than expected" numbers of post-9/11 cases in some workers. We undertook this study to estimate the incidence of post-9/11 sarcoidosis in approximately 13,000 male firefighters and EMS workers enrolled in The Fire Department of the City of New York (FDNY) WTC Health Program; to compare FDNY incidence to rates from unexposed, demographically similar men in the Rochester Epidemiology Project (REP); and, to examine rates by level of WTC exposure.

METHODS: We calculated incidence of sarcoidosis diagnosed from 9/12/2001 to 9/11/2015, and generated expected sex- and age-specific rates based on REP rates. Standardized incidence ratios (SIR) based on REP rates, and 95% confidence intervals (95% CI) were estimated. Two sensitivity analyses limited cases to those with intra-thoracic symptoms or biopsy confirmation.

RESULTS: We identified 68 post-9/11 cases in the FDNY cohort. Overall, FDNY rates were significantly higher than expected rates (SIR=2.8; 95% CI=2.2, 3.6). Including only symptomatic cases, the SIR decreased (SIR=2.2; 95% CI=1.5, 3.0), but remained significantly elevated. SIRs ranged from 2.7 (95% CI=2.0, 3.5) in the lower WTC exposure group to 4.2 (95% CI = 1.9, 8.0) in the most highly exposed.

CONCLUSIONS: We found excess incident post-9/11 sarcoidosis in WTC-exposed workers. Continued surveillance, particularly of those most highly exposed, is necessary to identify those with sarcoidosis and to follow them for possible adverse effects including functional impairments and organ damage.

Year Published 2018 (7)

Crowley G, Kwon S, Haider SH, et al. 2018. Metabolomics of World Trade Center Lung Injury: a machine learning approach. BMJ Open Respiratory Research. 5(1):e000274.

HTTPS://DOI.ORG/10.1136/BMJRESP-2017-000274

INTRODUCTION: Biomarkers of metabolic syndrome expressed soon after World Trade Center (WTC) exposure predict development of WTC Lung Injury (WTC-LI). The metabolome remains an untapped resource with potential to comprehensively characterise many as-pects of WTC-LI. This case–control study identified a clinically relevant, robust subset of metabolic contributors of WTC-LI through comprehensive high-dimensional metabolic profiling and integration of machine learning techniques.

METHODS: Never-smoking, male, WTC-exposed firefighters with normal pre-9/11 lung function were segregated by post-9/11 lung function. Cases of WTC-LI (forced expiratory volume in 1s <lower limit of normal, n=15) and

controls (n=15) were identified from previ-ous cohorts. The metabolome of serum drawn within 6 months of 9/11 was quantified. Machine learning was used for dimension reduction to identify metabolites associated with WTC-LI.

RESULTS: 580 metabolites qualified for random forests (RF) analysis to identify a refined metabolite profile that yielded maximal class separation. RF of the re-fined profile correctly classified subjects with a 93.3% estimated success rate. 5 clusters of metabolites emerged within the refined profile. Prominent subpath-ways include known mediators of lung dis-ease such as sphingolipids (elevated in cases of WTC-LI), and branched-chain amino acids (reduced in cases of WTC-LI). Principal component analysis of the refined profile explained 68.3% of variance in five components, demon-strating class separation.

CONCLUSION: Analysis of the metab-olome of WTC-exposed 9/11 rescue workers has identi-fied biologically plau-sible pathways associated with loss of lung function. Since metabo-lites are proximal markers of disease processes, metabolites could capture the complex-ity of past exposures and better inform treatment. These pathways warrant further mechanis-tic research.

Haider SH, Kwon S, Lam R, et al. 2018. Predictive biomarkers of gastroesophageal reflux disease and barrett's esophagus in World Trade Center exposed firefighters: A 15 year longitudinal study. Scientific Reports 18(1): 3106.

HTTPS://DOI.ORG/10.1038/S41598-018-21334-9

Gastroesophageal reflux dis-ease (GERD) and Barrett's Esoph-agus (BE), which are prevalent in the World Trade Center (WTC) exposed and general populations, neg-atively impact quality of life and cost of healthcare. GERD, a risk factor of BE, is linked to obstructive airways disease (OAD). We aim to identify serum bio-markers of GERD/BE, and assess the respiratory and clinical phenotype of a longitudinal cohort of never-smok-ing, male, WTC-exposed rescue work-ers presenting with pulmonary symp-toms. Biomarkers collected soon after WTC-exposure were evaluated in opti-mized predictive models of GERD/BE. In the WTC-exposed cohort, the prev-alence of BE is at least 6 times higher than in the general population. GERD/BE cases had similar lung function, D LCO , bronchodilator response and long-acting beta-agonist use compared to controls. In confounder-adjusted re-gression models, TNF-α ≥ 6 pg/mL pre-dicted both GERD and BE. GERD was also predicted by C-peptide ≥ 360 pg/mL, while BE was predicted by fractal-kine ≥ 250 pg/mL and IP-10 ≥ 290 pg/mL. Finally, participants with GERD had significantly increased use of short-act-ing beta-agonist compared to controls. Overall, biomarkers sampled prior to GERD/BE presentation showed strong predictive abilities of disease develop-ment. This study frames future investi-gations to further our understanding of aerodigestive pathology due to partic-ulate matter exposure.

Hena KM, Yip J, Jaber N, et al. 2018. Clinical course of sarcoidosis in World Trade Center-exposed firefighters. Chest 153: 114–123.

HTTPS://DOI.ORG/10.1016/J.CHEST.2017.10.014

BACKGROUND: Sarcoidosis is believed to represent a genetically primed, abnormal immune response to an antigen exposure or inflammatory trigger, with both genetic and environmental factors playing a role in disease onset and phenotypic expression. In a population of firefighters with post-World Trade Center (WTC) 9/11/2001 (9/11) sarcoidosis, we have a unique opportunity to describe the clinical course of incident sarcoidosis during the 15 years postexposure and, on average, 8 years following diagnosis.

METHODS: Among the WTC-exposed cohort, 74 firefighters with post-9/11 sarcoidosis were identified through medical records review. A total of 59 were enrolled in follow-up studies. For each participant, the World Association of Sarcoidosis and Other Granulomatous Diseases organ assessment tool was used to categorize the sarcoidosis involvement of each organ system at time of diagnosis and at follow-up.

RESULTS: The incidence of sarcoidosis post-9/11 was 25 per 100,000. Radiographic resolution of intrathoracic involvement occurred in 24 (45%) subjects. Lung function for nearly all subjects was within normal limits. Extrathoracic involvement increased, most prominently joints (15%) and cardiac (16%) involvement. There was no evidence of calcium dysmetabolism. Few subjects had ocular (5%) or skin (2%) involvement, and none had beryllium sensitization. Most (76%) subjects did not receive any treatment.

CONCLUSIONS: Extrathoracic disease was more prevalent in WTC-related sarcoidosis than reported for patients with sarcoidosis without WTC exposure or for other exposure-related granulomatous diseases (beryllium disease and hypersensitivity pneumonitis). Cardiac involvement would have been missed if evaluation stopped after ECG, 48-h recordings, and echocardiogram. Our results also support the need for advanced cardiac screening in asymptomatic patients with strenuous, stressful, public safety occupations, given the potential fatality of a missed diagnosis.

Landgren O, Zeig-Owens R, Giricz O, et al. 2018. Multiple Myeloma and Its Precursor Disease Among Firefighters Exposed to the World Trade Center Disaster. JAMA Oncol. 4(6):821-827.

HTTPS://DOI.ORG/10.1001/JAMAONCOL.2018.0509

IMPORTANCE: The World Trade Center (WTC) attacks on September 11, 2001, created an unprecedented environmental exposure to known and suspected carcinogens suggested to increase the risk of multiple myeloma. Multiple myeloma is consistently preceded by the precursor states of monoclonal gammopathy of undetermined significance (MGUS) and light-chain MGUS, detectable in peripheral blood.

OBJECTIVE: To characterize WTC-exposed firefighters with a diagnosis of multiple myeloma and to conduct a screening study for MGUS and light-chain MGUS.

DESIGN, SETTING, AND PARTICIPANTS: Case series of multiple meloma in firefighters diagnosed between September 11, 2001, and July 1, 2017, together with a seroprevalence study of MGUS in serum samples collected from Fire Department of the City of New York (FDNY) firefighters between December 2013 and October 2015. Participants included all WTC-exposed FDNY white, male firefighters with a confirmed physician diagnosis of multiple myeloma (n = 16) and WTC-exposed FDNY white male firefighters older than 50 years with available serum samples (n = 781).

EXPOSURES: WTC exposure defined as rescue and/or recovery work at the WTC site between September 11, 2001, and July 25, 2002.

MAIN OUTCOMES AND MEASURES: Multiple myeloma case information, and age-adjusted and age-specific prevalence rates for overall MGUS (ie, MGUS and light-chain MGUS), MGUS, and light-chain MGUS.

RESULTS: Sixteen WTC-exposed white male firefighters received a diagnosis of multiple myeloma after September 11, 2001; median age at diagnosis was 57 years (interquartile range, 50-68 years). Serum/urine monoclonal protein isotype/free light-chain data were available for 14 cases; 7 (50%) had light-chain multiple myeloma. In a subset of 7 patients, myeloma cells were assessed for CD20 expression; 5 (71%) were CD20 positive. In the screening study, we assayed peripheral blood from 781 WTC-exposed firefighters. The age-standardized prevalence rate of MGUS and light-chain MGUS combined was 7.63 per 100 persons (95% CI, 5.45-9.81), 1.8-fold higher than rates from the Olmsted County, Minnesota, white male reference population (relative rate, 1.76; 95% CI, 1.34-2.29). The age-standardized prevalence rate of light-chain MGUS was more than 3-fold higher than in the same reference population (relative rate, 3.13; 95% CI, 1.99-4.93).

CONCLUSIONS AND RELEVANCE: Environmental exposure to the WTC disaster site is associated with myeloma precursor disease (MGUS and light-chain MGUS) and may be a risk factor for the development of multiple myeloma at an earlier age, particularly the light-chain subtype.

Singh A, Zeig-Owens R, Moir W, et al. 2018. Estimation of Future Cancer Burden Among Rescue and Recovery Workers Exposed to the World Trade Center Disaster. JAMA Oncol.4(6):828-831.

HTTPS://DOI.ORG/10.1001/JAMAONCOL.2018.0504

IMPORTANCE: Elevated rates of cancer have been reported in individuals exposed to the World Trade Center (WTC) disaster, including Fire Department of the City of New York (FDNY) rescue and recovery workers.

OBJECTIVE: To project the future burden of cancer in WTC-exposed FDNY rescue and recovery workers by estimating the 20-year cancer incidence.

DESIGN, SETTING, AND PARTICIPANTS: A total of 14474 WTC-exposed FDNY employees who were cancer-free on January 1, 2012; subgroup analyses were conducted of the cohort's white male population (n = 12374). In this closed-cohort study, we projected cancer incidence for the January 1, 2012, to December 31, 2031, period. Simulations were run using demographic-specific New York City (NYC) cancer and national mortality rates for each individual, summed for the whole cohort, and performed 1000 times to produce mean estimates. Additional analyses in the subgroup of white men compared case counts produced by using 2007-2011 FDNY WTC Health Program (FDNY-WTCHP) cancer rates vs NYC rates. Average and 20-year aggregate costs of first-year cancer care were estimated using claims data.

EXPOSURES: World Trade Center disaster exposure defined as rescue and recovery work at the WTC site at any time from September 11, 2001, to July 25, 2002.

MAIN OUTCOMES AND MEASURES: (1) Projected number of incident cancers in the full cohort, based on NYC cancer rates; (2) cancer incidence estimates in the subgroup projected using FDNY-WTCHP vs NYC rates; and (3) estimated first-year treatment costs of incident cancers.

RESULTS: On January 1, 2012, the cohort was 96.8% male, 87.1% white, and had a mean (SD) age of 50.2 (9.2) years. The projected number of incident cancer cases was 2960 (95% CI, 2883-3037). In our subgroup analyses using FDNY-WTCHP vs NYC cancer rates, the projected number of new cases in white men was elevated (2714 [95% CI, 2638-2786] vs 2596 [95% CI, 2524-2668]). Accordingly, we expect more prostate (1437 [95% CI, 1383-1495] vs 863 [95% CI, 816-910]), thyroid (73 [95% CI, 60-86] vs 57 [95% CI, 44-69]), and melanoma cases (201 [95% CI, 179-223] vs 131 [95% CI, 112-150), but fewer lung (237 [95% CI, 212-262] vs 373 [95% CI, 343-405]), colorectal (172 [95% CI, 152-191] vs 267 [95% CI, 241-292]), and kidney cancers (66 [95% CI, 54-80] vs 132 [95% CI, 114-152]) ($P < .001$ for all comparisons). The estimated 20-year cost of first-year treatment was $235835412 (95% CI, $187582227-$284088597).

CONCLUSIONS AND RELEVANCE: We project that the FDNY-WTCHP cohort will experience a greater cancer burden than would be expected from a demographically similar population. This underscores the importance of cancer prevention efforts and routine screening in WTC-exposed rescue and recovery workers.

Webber MP, Liu Y, Cohen HW, et al. 2018. Incidence and prevalence of antibody to hepatitis C virus in FDNY first responders before and after work at the World Trade Center disaster site. Am J Ind Med. 61(9): 733-740.

HTTPS://DOI.ORG/10.1002/AJIM.22871

BACKGROUND: The goals of this study were to assess the impact of work at the World Trade Center (WTC) site in relation to new, post-9/11/2001 (9/11) antibody to hepatitis C Virus (anti-HCV); and, evaluate secular trends in WTC-exposed male Fire Department of New York City (FDNY) Firefighters and Emergency Medical Services (EMS) responders.

METHODS: FDNY monitors responder health through physical exams and routine blood work. We used descriptive statistics to compare trans-9/11 and post-9/11 incidence and to assess trends in prevalence from 2000 to 2012.

RESULTS: Trans-9/11 incidence of new anti-HCV was 0.42 per 100 persons compared with post-9/11 incidence of 0.34 (P = 0.68). Overall seroprevalence was 1.3%; rates declined from 1.79 per 100 to 0.49 per 100 over time (P < 0.0001).

CONCLUSIONS: Work at the WTC was not associated with new infection. Biennial seroprevalence in responders declined over time, supporting the FDNY decision to discontinue routine annual testing in this cohort.

Zeig-Owens R, Singh A, Aldrich TK, et al 2018. Blood Leukocyte Concentrations, FEV1 Decline, and Airflow Limitation. A 15-Year Longitudinal Study of World Trade Center-exposed Firefighters. Annals of the American Thoracic Society. 15(2):173–183.

HTTPS://DOI.ORG/10.1513/ANNALSATS.201703-276OC

RATIONALE: Rescue/recovery work at the World Trade Center disaster site (WTC) caused a proximate decline in lung function in Fire Department of the City of New York firefighters. A subset of this cohort experienced an accelerated rate of lung function decline over 15 years of post-September 11, 2001 (9/11) follow-up.

OBJECTIVES: To determine if early postexposure blood leukocyte concentrations are biomarkers for subsequent FEV1 decline and incident airflow limitation.

METHODS: Individual rates of forced expiratory volume in 1 second (FEV1) change were calculated for 9,434 firefighters using 88,709 spirometric measurements taken between September 11, 2001, and September 10, 2016. We categorized FEV1 change rates into three trajectories: accelerated FEV1 decline (FEV1 loss >64 ml/yr), expected FEV1 decline (FEV1 loss between 0 and 64 ml/yr), and improved FEV1 (positive rate of change >0 ml/yr). Occurrence of FEV1/FVC less than 0.70 after 9/11 defined incident airflow limitation. Using regression models, we assessed associations of post-9/11 blood eosinophil and neutrophil concentrations with subsequent FEV1 decline and airflow limitation, adjusted for age, race, smoking, height, WTC exposure level, weight change, and baseline lung function.

RESULTS: Accelerated FEV1 decline occurred in 12.7% of par-

ticipants (1,199 of 9,434), whereas post-9/11 FEV1 improvement occurred in 8.3% (780 of 9,434). Higher blood eosinophil and neutrophil concentrations were each associated with accelerated FEV1 decline after adjustment for covariates (odds ratio [OR], 1.10 per 100 eosinophils/mm3; 95% confidence interval [CI], 1.05-1.15; and OR, 1.10 per 1,000 neutrophils/mm3; 95% CI, 1.05-1.15, respectively). Multivariable-adjusted linear regression models showed that a higher blood neutrophil concentration was associated with a faster rate of FEV1 decline (1.14 ml/yr decline per 1,000 neutrophils/mm3; 95% CI, 0.69-1.60 ml/yr; P < 0.001). Higher blood eosinophil concentrations were associated with a faster rate of FEV1 decline in ever-smokers (1.46 ml/yr decline per 100 eosinophils/mm3; 95% CI, 0.65-2.26 ml/yr; P < 0.001) but not in never-smokers (P for interaction = 0.004). Higher eosinophil concentrations were also associated with incident airflow limitation (adjusted hazard ratio, 1.10 per 100 eosinophils/mm3; 95% CI, 1.04-1.15). Compared with the expected FEV1 decline group, individuals experiencing accelerated FEV1 decline were more likely to have incident airflow limitation (adjusted OR, 4.12; 95% CI, 3.30-5.14).

CONCLUSIONS: Higher post-9/11 blood neutrophil and eosinophil concentrations were associated with subsequent accelerated FEV1 decline in WTC-exposed firefighters. Both higher blood eosinophil concentrations and accelerated FEV1 decline were associated with incident airflow limitation in WTC-exposed firefighters.

Year Published 2019 (9)

Cleven KL, Ye K, Zeig-Owens R, et al. 2019. Genetic variants associated with FDNY WTC-related sarcoidosis. International journal of environmental research and public health. 16 (10)

HTTPS://DOI.ORG/10.3390/IJERPH16101830

BACKGROUND: Sarcoidosis is a systemic granulomatous disease of unknown etiology. It may develop in response to an exposure or inflammatory trigger in the background of a genetically primed abnormal immune response. Thus, genetic studies are potentially important to our understanding of the pathogenesis of sarcoidosis. We developed a case-control study which explored the genetic variations between firefighters in the Fire Department of the City of New York (FDNY) with World Trade Center (WTC)-related sarcoidosis and those with WTC exposure, but without sarcoidosis. The loci of fifty-one candidate genes related to granuloma formation, inflammation, immune response, and/or sarcoidosis were sequenced at high density in enhancer/promoter, exonic, and 5' untranslated regions. Seventeen allele variants of human leukocyte antigen (HLA) and non-HLA genes were

found to be associated with sarcoidosis, and all were within chromosomes 1 and 6. Our results also suggest an association between extrathoracic involvement and allele variants of HLA and non-HLA genes found not only on chromosomes 1 and 6, but also on chromosomes 16 and 17. We found similarities between genetic variants with WTC-related sarcoidosis and those reported previously in sporadic sarcoidosis cases within the general population. In addition, we identified several allele variants never previously reported in association with sarcoidosis. If confirmed in larger studies with known environmental exposures, these novel findings may provide insight into the gene-environment interactions key to the development of sarcoidosis.

Cohen HW, Zeig-Owens R, Joe C, et al. 2019. Long-term cardiovascular disease risk among firefighters after the World Trade Center disaster. JAMA Network Open. 2 (9):e199775–e199775.

HTTPS://DOI.ORG/10.1001/JAMANETWORKOPEN.2019.9775 %J JAMA NETWORK OPEN

BACKGROUND: Published studies examining the association between World Trade Center (WTC) exposure on and after September 11, 2001, and longer-term findings of the study suggest a significant association between greater WTC exposure and long-term CVD risk. outcomes have reported mixed findings.To assess whether WTC exposure was associated with elevated CVD risk in Fire Department of the City of New York (FDNY) firefighters.In this cohort study, the association between WTC exposure and the risk of CVD was assessed between September 11, 2001, and December 31, 2017, in FDNY male firefighters. Multivariable Cox regression analyses were used to estimate CVD risk in association with 2 measures of WTC exposure: arrival time to the WTC site and duration of work at the WTC site. Data analyses were conducted from May 1, 2018, to March 8, 2019.The primary CVD outcome included myocardial infarction, stroke, unstable angina, coronary artery surgery or angioplasty, or CVD death. The secondary outcome (all CVD) included all primary outcome events or any of the following: transient ischemic attack; stable angina, defined as either use of angina medication or cardiac catheterization without intervention; cardiomyopathy; and other CVD (aortic aneurysm, peripheral arterial vascular intervention, and carotid artery surgery).There were 489 primary outcome events among 9796 male firefighters (mean [SD] age on September 11, 2001, was 40.3 [7.4] years and 7210 individuals [73.6%] were never smokers). Age-adjusted incident rates of CVD were higher for firefighters with greater WTC exposure. The multivariable adjusted hazard ratio (HR) for the primary CVD outcome was 1.44 (95% CI, 1.09-1.90) for the earliest arrival group compared with those who arrived later. Similarly, those who worked at the WTC site for 6 or more months vs those who worked less time at the site were more likely to have a CVD event (HR, 1.30; 95% CI, 1.05-1.60). Well-established CVD risk factors, including hypertension (HR, 1.41; 95% CI, 1.10-1.80), hypercholesterolemia (HR, 1.56; 95% CI, 1.28-1.91), diabetes (HR, 1.99; 95% CI, 1.33-2.98),

and smoking (current: HR, 2.13; 95% CI, 1.68-2.70; former: HR, 1.55; 95% CI, 1.23-1.95), were significantly associated with CVD in the multivariable models. Analyses with the all-CVD outcome were similar.The findings of the study suggest a significant association between greater WTC exposure and long-term CVD risk. The findings appear to reinforce the importance of long-term monitoring of the health of survivors of disasters.

Colbeth HL, Zeig-Owens R, Liu Y, et al. 2019. Persistent self-reported ear and hearing problems among World Trade Center-exposed firefighters and emergency medical service workers, 2001-2017—a longitudinal cohort analysis. American Journal of Industrial Medicine. 62 (1):43–49.

HTTPS://DOI.ORG/10.1002/AJIM.22925

BACKGROUND: The goal of this study was to estimate the impact of exposure to the World Trade Center (WTC) site on annual and persistent rates of otalgia and hearing impairment among Fire Department of the City of New York (FDNY) Firefighters and Emergency Medical Service Workers (EMS).

METHODS: Responders completed routine physical health questionnaires at monitoring visits. We used logistic and marginal logistic regression models to explore the association between otalgia and hearing impairment and WTC arrival time.

RESULTS: The highest-exposed group had greater odds of persistent ear symptoms (OR 1.33, 95%CI 1.11-1.59) compared with the least-exposed; the odds of persistent hearing problems between the groups were not significantly different. We found consistent WTC-exposure gradients when the average population odds of these outcomes were assessed each year. Conclusions Our findings demonstrate that the odds of long-term ear symptoms were significantly associated with the intensity of WTC exposure.

Colbeth HL, Zeig-Owens R, Webber MP, et al. 2019. Post-9/11 peripheral neuropathy symptoms among World Trade Center-exposed firefighters and emergency medical service workers. International journal of environmental research and public health. 16 (10)

HTTPS://DOI.ORG/10.3390/IJERPH16101727

BACKGROUND: Peripheral neuropathy can result from numerous conditions including metabolic disorders, inflammatory disease, or exposure to environmental or biological toxins. We analyzed questionnaire data from 9239 Fire Department of the City of New York (FDNY) World Trade Center (WTC)-exposed firefighters and emergency medical service workers (EMS) to evaluate the association between work at the WTC site and subsequent peripheral neuropathy symptoms using the validated Diabetic Neuropathy Symptom (DNS) score. We grouped the population into an "Indicated" group with conditions known to be associated with paresthesia (N = 2059) and a "Non-Indicated" group without conditions known to be associated (N = 7180). The level of WTC exposure was categorized by time of arrival to the WTC.

Overall, 25% of workers aged 40 and older reported peripheral neuropathy symptoms: 30.6% in the Indicated and 23.8% in the Non-Indicated groups, respectively. Multivariable logistic models performed on the Non-Indicated group, and on the Non-Indicated in comparison with non-WTC exposed National Health and Nutrition Examination Survey (NHANES), found that the highest level of WTC-exposure was significantly associated with DNS positive outcomes, after controlling for potential confounders. In conclusion, this study suggests that symptoms of peripheral neuropathy and paresthesias are common and are associated with WTC-exposure intensity.

Crowley G, Kwon S, Ostrofsky DF, et al. 2019. Assessing the protective metabolome using machine learning in World Trade Center particulate exposed firefighters at risk for lung injury. Sci Rep. 9 (1):11939.

HTTPS://DOI.ORG/10.1038/S41598-019-48458-W

BACKGROUND: The metabolome of World Trade Center (WTC) particulate matter (PM) exposure has yet to be fully defined and may yield information that will further define bioactive pathways relevant to lung injury. A subset of Fire Department of New York firefighters demonstrated resistance to subsequent loss of lung function. We intend to characterize the metabolome of never smoking WTC-exposed firefighters, stratified by resistance to WTC-Lung Injury (WTC-LI) to determine metabolite pathways significant in subjects resistant to the loss of lung function. The global serum metabolome was determined in those resistant to WTC-LI and controls (n = 15 in each). Metabolites most important to class separation (top 5% by Random Forest (RF) of 594 qualified metabolites) included elevated amino acid and long-chain fatty acid metabolites, and reduced hexose monophosphate shunt metabolites in the resistant cohort. RF using the refined metabolic profile was able to classify cases and controls with an estimated success rate of 93.3%, and performed similarly upon cross-validation. Agglomerative hierarchical clustering identified potential influential pathways of resistance to the development of WTC-LI. These pathways represent potential therapeutic targets and warrant further research.

Kwon S, Crowley G, Caraher EJ, et al. 2019. Validation of predictive metabolic syndrome biomarkers of World Trade Center lung injury: A 16-year longitudinal study. Chest. 156 (3):486–496.

HTTPS://DOI.ORG/10.1016/J.CHEST.2019.02.019

BACKGROUND: Metabolic Syndrome (MetSyn) predicted future development of World Trade Center lung injury(WTC-LI) in a subgroup of never smoking, male firefighters. An intra-cohort validation of MetSyn as predictors of WTC-LI is examined in the WTC-exposed cohort that has been longitudinally followed for 16 years.

METHODS: PFTs(N=98,221) of WTC-exposed workers(N=9,566) were evaluated. A baseline cohort of firefighters with normal FEV1 prior to 9/11 and had serum drawn prior to site closure on July

24, 2002(N=7,487) was investigated. Cases of WTC-LI(N=1,208) were identified if they had at least two measured FEV1<LLN. Cox-proportional hazards modeled early MetSyn biomarker ability to predict development of FEV1<LLN.

RESULTS: Cases were more likely to smoke, be highly exposed, and have MetSyn. There was a significant exposure dose response; the most highly-exposed individuals had 30.1%-increased risk of developing WTC-LI; having MetSyn increased risk of WTC-LI by 55.7%; smoking increased risk by 15.2%. There was significant interaction between smoking and exposure.

CONCLUSIONS: We validated the utility of MetSyn to predict future WTC-LI in a larger population of exposed individuals. MetSyn defined by dyslipidemia, insulin resistance, and cardiovascular disease suggests that systemic inflammation can contribute to future lung function loss.

Kwon S, Crowley G, Mikhail M, et al. 2019. Metabolic syndrome biomarkers of World Trade Center airway hyperreactivity: A 16-year prospective cohort study. International journal of environmental research and public health. 16 (9)

HTTPS://DOI.ORG/10.3390/IJERPH16091486

BACKGROUND: Airway hyperreactivity (AHR) related to environmental exposure is a significant public health risk worldwide. Similarly, metabolic syndrome (MetSyn), a risk factor for obstructive airway disease (OAD) and systemic inflammation, is a significant contributor to global adverse health. This prospective cohort study followed N = 7486 World Trade Center (WTC)-exposed male firefighters from 11 September 2001 (9/11) until 1 August 2017 and investigated N = 539 with newly developed AHR for clinical biomarkers of MetSyn and compared them to the non-AHR group. Male firefighters with normal lung function and no AHR pre-9/11 who had blood drawn from 9 September 2001-24 July 2002 were assessed. World Trade Center-Airway Hyperreactivity (WTC-AHR) was defined as either a positive bronchodilator response (BDR) or methacholine challenge test (MCT). The electronic medical record (EMR) was queried for their MetSyn characteristics (lipid profile, body mass index (BMI), glucose), and routine clinical biomarkers (such as complete blood counts). We modeled the association of MetSyn characteristics at the first post-9/11 exam with AHR. Those with AHR were significantly more likely to be older, have higher BMIs, have high intensity exposure, and have MetSyn. Smoking history was not associated with WTC-AHR. Those present on the morning of 9/11 had 224% increased risk of developing AHR, and those who arrived in the afternoon of 9/11 had a 75.9% increased risk. Having ≥3 MetSyn parameters increased the risk of WTC-AHR by 65.4%. Co-existing MetSyn and high WTC exposure are predictive of future AHR and suggest that systemic inflammation may be a contributor.

Liu C, Putman B, Singh A, et al. 2019. Abnormalities on chest computed tomography and lung

function following an intense dust exposure: A 17-year longitudinal study. International Journal of Environmental Research and Public Health. 16 (9)

HTTPS://DOI.ORG/10.3390/IJERPH16091655

BACKGROUND: Fire Department of the City of New York (FDNY) firefighters experienced intense dust exposure working at the World Trade Center (WTC) site on and after 11/9/2001 (9/11). We hypothesized that high-intensity WTC exposure caused abnormalities found on chest computed tomography (CT). Between 11/9/2001–10/9/2018, 4277 firefighters underwent a clinically-indicated chest CT. Spirometric measurements and symptoms were recorded during routine medical examinations. High-intensity exposure, defined as initial arrival at the WTC on the morning of 9/11, increased the risk of bronchial wall thickening, emphysema, and air trapping. Early post-9/11 symptoms of wheeze and shortness of breath were associated with bronchial wall thickening, emphysema, and air trapping. The risk of accelerated forced expiratory volume at one second (FEV1) decline (>64 mL/year decline) increased with bronchial wall thickening and emphysema, but decreased with air trapping. The risk of airflow obstruction also increased with bronchial wall thickening and emphysema but decreased with air trapping. In a previously healthy occupational cohort, high-intensity WTC exposure increased the risk for CT abnormalities. Bronchial wall thickening and emphysema were associated with respiratory symptoms, accelerated FEV1 decline, and airflow obstruction. Air trapping was associated with respiratory symptoms, although lung function was preserved. Physiologic differences between CT abnormalities suggest that distinct types of airway injury may result from a common exposure.

Putman B, Lahousse L, Zeig-Owens R, et al. 2019. Low serum iga and airway injury in World Trade Center-exposed firefighters: A 17-year longitudinal study. Thorax. 74 (12):1182–1184.

HTTPS://DOI.ORG/10.1136/THORAXJNL-2019-213715

ABSTRACT: Serum IgA ≤70 mg/dL (low IgA) is associated with exacerbations of chronic obstructive pulmonary disease. The association of low IgA with longitudinal lung function is poorly defined. This study included 917 World Trade Center (WTC)-exposed firefighters with longitudinal spirometry measured between September 2001 and September 2018 and IgA measured between October 2001 and March 2002. Low IgA, compared with IgA >70 mg/dL, was associated with lower forced expiratory volume in 1 s (FEV1) % predicted in the year following 11 September 2001 (94.1% vs 98.6%, p<0.001), increased risk of FEV1/FVC <0.70 (HR 3.8, 95% CI 1.6 to 8.8) and increased antibiotic treatment (22.5/100 vs 11.6/100 person-years, p=0.002). Following WTC exposure, early IgA ≤70 mg/dL was associated with worse lung function and increased antibiotic treatment.

Year Published 2020 (9)

Colbeth HL, Genere N, Hall CB, et al. 2020. Evaluation of medical surveillance and incidence of post-September 11, 2001, thyroid cancer in World Trade Center-exposed firefighters and emergency medical service workers. JAMA Intern Med. 180 (6):888–895.

HTTPS://DOI.ORG/10.1001/JAMAINTERNMED.2020.0950

IMPORTANCE: Elevated incidence rates of thyroid cancer among World Trade Center (WTC)-exposed individuals may be associated with the identification of asymptomatic cancers during medical surveillance. Objective: To examine the association between WTC exposure and thyroid cancer among Fire Department of the City of New York (hereafter, Fire Department) rescue/recovery workers as well as the association with medical surveillance. Design, Setting, and Participants: This closed-cohort study classified the method of detection (asymptomatic and symptomatic) of thyroid cancers in 14987 men monitored through the Fire Department-WTC Health Program diagnosed from September 12, 2001, to December 31, 2018. Age-, sex-, and histologic-specific Fire Department incidence rates were calculated and compared with demographically similar men in Olmsted County, Minnesota, from the Rochester Epidemiology using age-standardized rates, relative rates (RRs), and 95% CIs. The secondary analysis was restricted to papillary carcinomas.

EXPOSURES: World Trade Center exposure was defined as rescue/recovery work at the WTC site from September 11, 2001, to July 25, 2002. Main Outcomes and Measures: The outcomes evaluated comprised (1) number of incident thyroid cancers and their detection method categorizations in the Fire Department and Rochester Epidemiology cohorts; (2) Fire Department, Rochester Epidemiology Project, and Surveillance, Epidemiology, and End Results-21 age-standardized incidence rates of thyroid cancer; and (3) RRs comparing Fire Department and Rochester Epidemiology overall and by detection method categorization.

RESULTS: Seventy-two post-9/11 Fire Department cases of thyroid cancer were identified. Among the 65 cases (90.3%) with a categorized detection method, 53 cases (81.5%) were asymptomatic and 12 cases (18.5%) were symptomatic. Median (interquartile range) age at diagnosis was 50.2 (44.0-58.6) vs 46.6 (43.9-52.9) years for asymptomatic vs symptomatic cases. Associated primarily with asymptomatic cancers, the overall age-standardized incidence of Fire Department thyroid cancers (24.7; 95% CI, 17.4-52.3) was significantly higher than the Rochester Epidemiology (10.4; 95% CI, 8.5-12.7) and Surveillance, Epidemiology, and End Results-21 (9.1; 95% CI, 9.0-9.1) per 100000 person-years. Furthermore, the RR of thyroid cancer among symptomatic men in Fire Department cases was not significantly different from that of men in the Rochester Epidemiology (0.8; 95% CI, 0.4-1.5); however, the rate

of asymptomatic cancers was more than 3-fold that of the Rochester Epidemiology rate (RR, 3.1; 95% CI, 2.1-4.7).

CONCLUSIONS AND RELEVANCE: Excess asymptomatic thyroid cancer in Fire Department WTC-exposed rescue/recovery workers is apparently attributable to the identification of occult lesions during medical surveillance. Among WTC-exposed cohorts and the general population, these findings appear to have important implications for how thyroid cancer incidence rates are interpreted and how diagnoses should be managed.

Colbeth HL, Zeig-Owens R, Hall CB, et al. 2020. Mortality among Fire Department of the City of New York rescue and recovery workers exposed to the World Trade Center disaster, 2001–2017. International Journal of Environmental Research and Public Health. 17 (17)

HTTPS://DOI.ORG/10.3390/IJERPH17176266

ABSTRACT: The World Trade Center (WTC) attacks on 9/11/2001 have consistently been associated with elevated rates of physical and mental health morbidities, while evidence about mortality has been limited. We examined mortality between 9/12/2001 and 12/31/2017 among 15,431 WTC-exposed Fire Department of the City of New York (FDNY) firefighters and emergency medical service providers (EMS), specifically assessing associations between intensity of WTC-exposure and mortality risk. Standardized mortality ratios (SMR) and 95% confidence intervals (CI) compared FDNY cohort mortality with the US general population using life table analysis. Deaths were identified via linkage to the National Death Index. Cox proportional hazards regression models were used to identify associations between intensity of WTC-exposure and mortality, accounting for age, sex, race/ethnicity, smoking history, and other relevant confounders. We identified 546 deaths and a lower than expected all-cause mortality rate (SMR = 0.22; 95% CI, 0.20–0.24). No cause-specific SMRs were meaningfully elevated. Mortality hazard ratios showed no association or linear trend with level of WTC-exposure. Our results provide evidence of the healthy worker effect, despite exposure to the World Trade Center. More follow-up time may be needed to assess the full impact of WTC-exposure on mortality in this occupational population.

Flamme GA, Deiters KK, Stephenson MR, et al. 2020. Population-based age adjustment tables for use in occupational hearing conservation programs. Int J Audiol. 59 (0):S20–S30.

HTTPS://DOI.ORG/10.1080/14992027.2019.1698068

OBJECTIVE: In occupational hearing conservation programmes, age adjustments may be used to subtract expected age effects. Adjustments used in the U.S. came from a small dataset and overlooked important demographic factors, ages, and stimulus frequencies. The present study derived a set of population-based age adjustment tables and validated them using a database of exposed workers.

DESIGN: Cross-sectional population-based study and retrospective longitudinal cohort study for validation. Study sample: Data from the U.S. National Health and Nutrition Examination Survey (unweighted n = 9937) were used to produce these tables. Male firefighters and emergency medical service workers (76,195 audiograms) were used for validation.

RESULTS: Cross-sectional trends implied less change with age than assumed in current U.S. regulations. Different trends were observed among people identifying with non-Hispanic Black race/ethnicity. Four age adjustment tables (age range: 18-85) were developed (women or men; non-Hispanic Black or other race/ethnicity). Validation outcomes showed that the population-based tables matched median longitudinal changes in hearing sensitivity well.

CONCLUSIONS: These population-based tables provide a suitable replacement for those implemented in current U.S. regulations. These tables address a broader range of worker ages, account for differences in hearing sensitivity across race/ethnicity categories, and have been validated for men using longitudinal data.

Haider SH, Veerappan A, Crowley G, et al. 2020. Multiomics of WTC-particulate induced persistent airway hyperreactivity: Role of receptor for advanced glycation end products. Am J Respir Cell Mol Biol. 63 (2):219–233.

HTTPS://DOI.ORG/10.1165/RCMB.2019-0064OC

BACKGROUND: Pulmonary disease after World Trade Center particulate matter(WTC-PM) exposure is associated with dyslipidemia and the receptor for advanced glycation end products (RAGE); however, the mechanisms are not well understood. We utilized a murine model and a multiOMIC assessment to understand the role of RAGE in the pulmonary long-term effects of a single high intensity exposure to WTC-PM. After 1-month(1-M), WTC-PM exposed wild-type(WT) mice had airway hyperreactivity(AHR) while RAGE-deficient(Ager-/-) were protected. PM-exposed WT mice also had histologic evidence of airspace disease while Ager-/- remained unchanged. Inflammatory mediators such as G-CSF, IP-10, and KC were differentially expressed after WTC-PM exposure. WTC-PM induced alpha-SMA, DIAPH1, RAGE and significant lung collagen deposition in WT compared to Ager-/-. Compared to WT with PM exposure, relative expression of phosphorylated to total CREB and JNK were significantly increased in the lung of PM-exposed Ager-/-, whereas Akt was decreased. Random forests of the refined lung metabolomic profile classified subjects with 92% accuracy; principal components analysis captured 86.7% of the variance in 3 components and demonstrated prominent sub-pathway involvement including known mediators of lung disease such as vitamin B6 metabolites, sphingolipids, fatty acids, and phosphatidylcholines. Treatment with a partial RAGE antagonist, pioglitazone, yielded similar fold-change expression of metabolites(N6-carboxymethyllysine, 1-methylnicotin-

amide, (N(1)+N(8))-acetylspermidine and Succinylcarnitine(C4-DC)) between WT and Ager-/- exposed to WTC-PM. RAGE can mediate WTC-PM-induced AHR, and warrants further investigation.

Lam R, Haider SH, Crowley G, et al. 2020. Synergistic effect of WTC-particulate matter and lysophosphatidic acid exposure and the role of rage: In-vitro and translational assessment. International Journal of Environmental Research and Public Health. 17 (12):4318.

HTTPS://DOI.ORG/10.3390/IJERPH17124318

BACKGROUND: World Trade Center particulate matter (WTC-PM)-exposed firefighters with metabolic syndrome (MetSyn) have a higher risk of WTC lung injury (WTC-LI). Since macrophages are crucial innate pulmonary mediators, we investigated WTC-PM/lysophosphatidic acid (LPA) co-exposure in macrophages. LPA, a low-density lipoprotein metabolite, is a ligand of the advanced glycation end-products receptor (AGER or RAGE). LPA and RAGE are biomarkers of WTC-LI. Human and murine macrophages were exposed to WTC-PM, and/or LPA, and compared to controls. Supernatants were assessed for cytokines/chemokines; cell lysate immunoblots were assessed for signaling intermediates after 24 h. To explore the translatability of our in-vitro findings, we assessed serum cytokines/chemokines and metabolites of symptomatic, never-smoking WTC-exposed firefighters. Agglomerative hierarchical clustering identified phenotypes of WTC-PM-induced inflammation. WTC-PM induced GM-CSF, IL-8, IL-10, and MCP-1 in THP-1-derived macrophages and induced IL-1alpha, IL-10, TNF-alpha, and NF-kappaB in RAW264.7 murine macrophage-like cells. Co-exposure induced synergistic elaboration of IL-10 and MCP-1 in THP-1-derived macrophages. Similarly, co-exposure synergistically induced IL-10 in murine macrophages. Synergistic effects were seen in the context of a downregulation of NF-kappaB, p-Akt, -STAT3, and -STAT5b. RAGE expression after co-exposure increased in murine macrophages compared to controls. In our integrated analysis, the human cytokine/chemokine biomarker profile of WTC-LI was associated with discriminatory metabolites (fatty acids, sphingolipids, and amino acids). LPA synergistically elaborated WTC-PM's inflammatory effects in vitro and was partly RAGE-mediated. Further research will focus on the intersection of MetSyn/PM exposure.

Putman B, Lahousse L, Goldfarb DG, et al. 2020. Factors predicting treatment of World Trade Center-related lung injury: A longitudinal cohort study. Int J Environ Res Public Health. 17 (23):9056.

HTTPS://DOI.ORG/10.3390/IJERPH17239056

BACKGROUND: The factors that predict treatment of lung injury in occupational cohorts are poorly defined. We aimed to identify patient characteristics associated with initiation of treatment with inhaled corticosteroid/long-acting beta-agonist (ICS/LABA) >2 years among World Trade Center (WTC)-exposed firefighters. The study population included 8530 WTC-exposed firefighters. Multivariable logistic regression assessed

the association of patient characteristics with ICS/LABA treatment for >2 years over two-year intervals from 11 September 2001-10 September 2017. Cox proportional hazards models measured the association of high probability of ICS/LABA initiation with actual ICS/LABA initiation in subsequent intervals. Between 11 September 2001-1 July 2018, 1629/8530 (19.1%) firefighters initiated ICS/LABA treatment for >2 years. Forced Expiratory Volume in 1 s (FEV1), wheeze, and dyspnea were consistently and independently associated with ICS/LABA treatment. High-intensity WTC exposure was associated with ICS/LABA between 11 September 2001-10 September 2003. The 10th percentile of risk for ICS/LABA between 11 September 2005-10 Septmeber 2007 was associated with a 3.32-fold increased hazard of actual ICS/LABA initiation in the subsequent 4 years. In firefighters with WTC exposure, FEV1, wheeze, and dyspnea were independently associated with prolonged ICS/LABA treatment. A high risk for treatment was identifiable from routine monitoring exam results years before treatment initiation.

Putman B, Lahousse L, Singh A, et al. 2020. Dyspnea and inhaled corticosteroid and long-acting β-agonist therapy in an occupational cohort: A longitudinal study. Annals of the American Thoracic Society. 17 (6):770–773.

HTTPS://DOI.ORG/10.1513/ANNALSATS.201910-794RL

NO ABSTRACT AVAILABLE

Singh A, Zeig-Owens R, Hall CB, et al. 2020. World Trade Center exposure, post-traumatic stress disorder, and subjective cognitive concerns in a cohort of rescue/recovery workers. Acta Psychiatr Scand. 141 (3):275–284.

HTTPS://DOI.ORG/10.1111/ACPS.13127

OBJECTIVE: To determine whether World Trade Center (WTC)-exposure intensity and post-traumatic stress disorder (PTSD) are associated with subjective cognitive change in rescue/recovery workers.

METHOD: The population included 7875 rescue/recovery workers who completed a subjective cognition measure, the Cognitive Function Instrument (CFI), between 3/1/2018 and 2/28/2019 during routine monitoring, indicating whether they had experienced cognitive and functional difficulties in the past year. Higher scores indicated greater self-perceived cognitive change. Probable PTSD, depression, and alcohol abuse were evaluated by validated mental health screeners. Logistic regression assessed the associations of WTC exposure and current PTSD with top-quartile (>/=2) CFI score, and of early post-9/11 PTSD with top-quartile CFI in a subpopulation (N = 6440). Models included demographics, smoking, depression, and alcohol abuse as covariates.

RESULTS: Mean age at CFI completion was 56.7 +/- 7.7 (range: 36-81). Participants with high-intensity WTC exposure had an increased likelihood of top-quartile CFI score (odds ratio[OR] vs. low exposure: 1.32, 95%CI: 1.07-1.64), controlling

for covariates. Current and early PTSD were both associated with top-quartile CFI (OR: 3.25, 95%CI: 2.53-4.19 and OR: 1.56, 95%CI: 1.26-1.93) respectively.

CONCLUSIONS: High-intensity WTC exposure was associated with self-reported cognitive change 17 years later in rescue/recovery workers, as was PTSD. Highly WTC-exposed subgroups may benefit from additional cognitive evaluation and monitoring of cognition over time.

Singh A, Zeig-Owens R, Rabin L, et al. 2020. PTSD and depressive symptoms as potential mediators of the association between World Trade Center exposure and subjective cognitive concerns in rescue/recovery workers. Int J Environ Res Public Health. 17 (16)

HTTPS://DOI.ORG/10.3390/IJERPH17165683

BACKGROUND: We observed that World Trade Center (WTC) exposure, post-traumatic stress disorder (PTSD) symptoms and depressive symptoms were associated with subjective cognitive concerns in Fire Department of the City of New York (FDNY) rescue/recovery workers. This follow-up study examined whether PTSD symptoms and/or depressive symptoms mediate the observed association between WTC exposure and subjective cognitive concerns. We included WTC-exposed FDNY workers who completed the Cognitive Function Instrument (CFI), measuring self-perceived cognitive decline (N = 9516). PTSD symptoms and depressive symptoms were assessed using the PCL-S and CES-D, respectively. Multivariable linear regression estimated the association between WTC exposure and CFI score, adjusting for confounders. Mediation analyses followed the methods of Vanderweele (2014). Participants' average age at CFI assessment was 56.6 +/- 7.6 years. Higher-intensity WTC exposure was associated with worse CFI score, an effect that was entirely mediated by PTSD symptoms (%mediated: 110.9%; 95%CI: 83.1-138.9). When substituting depressive symptoms for PTSD symptoms, the WTC exposure-CFI association was largely mediated (%mediated: 82.1%; 95%CI: 60.6-103.7). Our findings that PTSD symptoms and depressive symptoms mediate the association between WTC exposure and subjective cognitive concerns indicate that in the absence of these symptoms, WTC exposure in rescue/recovery workers would not be associated with subjective cognition. Interventions targeting PTSD and depression may have additional value in mitigating cognitive decline in WTC-exposed populations.

Year Published 2021 (13)

Abbasi J. 2021. Twenty years after 9/11, responders are still healing. Jama. 326 (11):995–998.

HTTPS://DOI.ORG/10.1001/JAMA.2021.14010

NO ABSTRACT AVAILABLE

Brackbill RM, Kahn AR, Li J, et al. 2021. Combining three cohorts of World Trade Center rescue/recovery workers for assessing cancer incidence and mortality. International Journal of Environmental Research and Public Health. 18 (4):1386.

HTTPS://DOI.ORG/10.3390/IJERPH18041386

BACKGROUND: Three cohorts including the Fire Department of the City of New York (FDNY), the World Trade Center Health Registry (WTCHR), and the General Responder Cohort (GRC), each funded by the World Trade Center Health Program have reported associations between WTC-exposures and cancer. Results have generally been consistent with effect estimates for excess incidence for all cancers ranging from 6 to 14% above background rates. Pooling would increase sample size and de-duplicate cases between the cohorts. However, pooling required time consuming steps: obtaining Institutional Review Board (IRB) approvals and legal agreements from entities involved; establishing an honest broker for managing the data; de-duplicating the pooled cohort files; applying to State Cancer Registries (SCRs) for matched cancer cases; and finalizing analysis data files. Obtaining SCR data use agreements ranged from 6.5 to 114.5 weeks with six states requiring >20 weeks. Records from FDNY (n = 16,221), WTCHR (n = 29,372), and GRC (n = 33,427) were combined de-duplicated resulting in 69,102 unique individuals. Overall, 7894 cancer tumors were matched to the pooled cohort, increasing the number cancers by as much as 58% compared to previous analyses. Pooling resulted in a coherent resource for future research for studies on rare cancers and mortality, with more representative of occupations and WTC-exposure. Note--This paper describes the processes involved with combining data across the three WTC-exposed cohorts and linking the pooled data with state cancer registries; and the strategies for overcoming administrative challenges. To our knowledge, studies that use pooled data do not typically provide a detailed description of their combining process. The transparency of this approach is important for a fuller understanding of the findings derived from analyses of WTC-exposure and health in our case, as well as, other endeavors that also use information combined from multiple sources.

Cleven KL, Rosenzvit C, Nolan A, et al. 2021. Twenty-year reflection on the impact of World Trade Center exposure on pulmonary outcomes in fire department of the city of New York (FDNY) rescue and recovery workers. Lung. 199 (6):569–578.

HTTPS://DOI.ORG/10.1007/S00408-021-00493-Z

BACKGROUND: After the terrorist attacks on September 11, 2001 (9/11), many rescue/recovery workers developed respiratory symptoms and pulmonary diseases due to their extensive World Trade Center (WTC) dust cloud exposure. Nearly all Fire Department of the City of New York (FDNY) workers were present within 48 h of 9/11 and for the next several months. Since the FDNY had a well-established occupational health service for its firefighters and

Emergency Medical Services workers prior to 9/11, the FDNY was able to immediately start a rigorous monitoring and treatment program for its WTC-exposed workers. As a result, respiratory symptoms and diseases were identified soon after 9/11. This focused review summarizes the WTC-related respiratory diseases that developed in the FDNY cohort after 9/11, including WTC cough syndrome, obstructive airways disease, accelerated lung function decline, airway hyperreactivity, sarcoidosis, and obstructive sleep apnea. Additionally, an extensive array of biomarkers has been identified as associated with WTC-related respiratory disease. Future research efforts will not only focus on further phenotyping/treating WTC-related respiratory disease but also on additional diseases associated with WTC exposure, especially those that take decades to develop, such as cardiovascular disease, cancer, and interstitial lung disease.

Cleven KL, Vaeth B, Zeig-Owens R, et al. 2021. Performance of risk factor-based guidelines and model-based chest ct lung cancer screening in World Trade Center-exposed fire department rescue/recovery workers. Chest. 159 (5):2060–2071.

HTTPS://DOI.ORG/10.1016/J.CHEST.2020.11.028

BACKGROUND: Lung cancer is a leading cause of cancer incidence and death in the United States. Risk factor-based guidelines and risk model-based strategies are used to identify patients who could benefit from low-dose chest CT (LDCT) screening. Few studies compare guidelines or models within the same cohort. We evaluate lung cancer screening performance of two risk factor-based guidelines (US Preventive Services Task Force 2014 recommendations [USPSTF-2014] and National Comprehensive Cancer Network Group 2 [NCCN-2]) and two risk model-based strategies, Prostate Lung Colorectal and Ovarian Cancer Screening (PLCOm2012) and the Bach model) in the same occupational cohort.

RESEARCH QUESTION: Which risk factor-based guideline or model-based strategy is most accurate in detecting lung cancers in a highly exposed occupational cohort?

STUDY DESIGN AND METHODS: Fire Department of City of New York (FDNY) rescue/recovery workers exposed to the September 11, 2001 attacks underwent LDCT lung cancer screening based on smoking history and age. The USPSTF-2014, NCCN-2, PLCOm2012 model, and Bach model were retrospectively applied to determine how many lung cancers were diagnosed using each approach.

RESULTS: Among the study population (N = 3,953), 930 underwent a baseline scan that met at least one risk factor or model-based LDCT screening strategy; 73% received annual follow-up scans. Among the 3,953, 63 lung cancers were diagnosed, of which 50 were detected by at least one LDCT screening strategy. The NCCN-2 guideline was the most sensitive (79.4%; 50/63). When compared with NCCN-2, stricter age and smoking

criteria reduced sensitivity of the other guidelines/models (USPSTF-2014 [44%], PLCOm2012 [51%], and Bach[46%]). The 13 missed lung cancers were mainly attributable to smoking less and quitting longer than guideline/model eligibility criteria. False-positive rates were similar across all four guidelines/models.

INTERPRETATION: In this cohort, our findings support expanding eligibility for LDCT lung cancer screening by lowering smoking history from >/=30 to >/=20 pack-years and age from 55 years to 50 years old. Additional studies are needed to determine its generalizability to other occupational/environmental exposed cohorts.

Crowley G, Kim J, Kwon S, et al. 2021. PEDF, a pleiotropic WTC-LI biomarker: Machine learning biomarker identification and validation. PLoS Comput Biol. 17 (7):e1009144.

HTTPS://DOI.ORG/10.1371/JOURNAL.PCBI.1009144

BACKGROUND: Biomarkers predict World Trade Center-Lung Injury (WTC-LI); however, there remains unaddressed multicollinearity in our serum cytokines, chemokines, and high-throughput platform datasets used to phenotype WTC-disease. To address this concern, we used automated, machine-learning, high-dimensional data pruning, and validated identified biomarkers. The parent cohort consisted of male, never-smoking firefighters with WTC-LI (FEV1, %Pred< lower limit of normal (LLN); n = 100) and controls (n = 127) and had their biomarkers assessed. Cases and controls (n = 15/group) underwent untargeted metabolomics, then feature selection performed on metabolites, cytokines, chemokines, and clinical data. Cytokines, chemokines, and clinical biomarkers were validated in the non-overlapping parent-cohort via binary logistic regression with 5-fold cross validation. Random forests of metabolites (n = 580), clinical biomarkers (n = 5), and previously assayed cytokines, chemokines (n = 106) identified that the top 5% of biomarkers important to class separation included pigment epithelium-derived factor (PEDF), macrophage derived chemokine (MDC), systolic blood pressure, macrophage inflammatory protein-4 (MIP-4), growth-regulated oncogene protein (GRO), monocyte chemoattractant protein-1 (MCP-1), apolipoprotein-AII (Apo-AII), cell membrane metabolites (sphingolipids, phospholipids), and branched-chain amino acids. Validated models via confounder-adjusted (age on 9/11, BMI, exposure, and pre-9/11 FEV1, %Pred) binary logistic regression had AUCROC [0.90(0.84-0.96)]. Decreased PEDF and MIP-4, and increased Apo-AII were associated with increased odds of WTC-LI. Increased GRO, MCP-1, and simultaneously decreased MDC were associated with decreased odds of WTC-LI. In conclusion, automated data pruning identified novel WTC-LI biomarkers; performance was validated in an independent cohort. One biomarker-PEDF, an antiangiogenic agent-is a novel, predictive biomarker of particulate-matter-related lung disease. Other biomarkers-GRO, MCP-1, MDC, MIP-4-reveal immune cell involvement in WTC-LI pathogenesis. Findings of our automated biomarker

identification warrant further investigation into these potential pharmacotherapy targets.

Fire Department of New York. 2021. World trade center health impacts on FDNY rescue workers: 20 years: 2001 to 2021. FDNY Report: New York.

HTTPS://WWW1.NYC.GOV/ASSETS/FDNY/DOWNLOADS/PDF/ABOUT/2021-9-11-20TH%20ANNIVERSARY-WTC-HEALTH.PDF

NO ABSTRACT AVAILABLE

Goldfarb DG, Colbeth HL, Skerker M, et al. 2021. Impact of healthcare services on thyroid cancer incidence among World Trade Center-exposed rescue and recovery workers. American Journal of Industrial Medicine. 64 (10):861–872.

HTTPS://DOI.ORG/10.1002/AJIM.23277

BACKGROUND: A recent study of World Trade Center (WTC)-exposed firefighters and emergency medical service workers demonstrated that elevated thyroid cancer incidence may be attributable to frequent medical testing, resulting in the identification of asymptomatic tumors. We expand on that study by comparing the incidence of thyroid cancer among three groups: WTC-exposed rescue/recovery workers enrolled in a New York State (NYS) WTC-medical monitoring and treatment program (MMTP); WTC-exposed rescue/recovery workers not enrolled in an MMTP (non-MMTP); and the NYS population.

METHODS: Person-time began on 9/12/2001 or at enrollment in a WTC cohort and ended at death or on 12/31/2015. Cancer data were obtained through linkages with 13 state cancer registries. We used Poisson regression to estimate rate ratios (RRs) and 95% confidence intervals (CIs) for MMTP and non-MMTP participants. NYS rates were used as the reference. To estimate potential changes over time in WTC-associated risk, change points in RRs were estimated using profile likelihood.

RESULTS: The thyroid cancer incidence rate among MMTP participants was more than twice that of NYS population rates (RR = 2.31; 95% CI = 2.00–2.68). Non-MMTP participants had a risk similar to NYS (RR = 0.96; 95% CI = 0.72–1.28). We observed no change points in the follow-up period.

CONCLUSION: Our findings support the hypothesis that no-cost screening (a benefit provided by WTC-MMTPs) is associated with elevated identification of thyroid cancer. Given the high survival rate for thyroid cancer, it is important to weigh the costs and benefits of treatment, as many of these cancers were asymptomatic and may have been detected incidentally.Goldfarb DG, Putman B, Lahousse L, et al. 2021. Lung function decline before and after treatment of World Trade Center associated obstructive airways disease with inhaled corticosteroids and long-acting beta agonists. Am J Ind Med. 64 (10):853–860.

HTTPS://DOI.ORG/10.1002/AJIM.23272

BACKGROUND: Greater than average loss of one-second forced expiratory volume (FEV(1)) is a risk factor for asthma, chronic obstructive pulmonary disease (COPD), and asthma/COPD overlap syndrome in World Trade Center (WTC)-exposed firefighters. Inhaled corticosteroids and long-acting beta agonists (ICS/LABA) are used to treat obstructive airways disease but their impact on FEV(1) -trajectory in this population is unknown.

METHODS: The study population included WTC-exposed male firefighters who were treated with ICS/LABA for 2 years or longer (with initiation before 2015), had at least two FEV(1) measurements before ICS/LABA initiation and two FEV(1) measurements posttreatment between September 11, 2001 and September 10, 2019. Linear mixed-effects models were used to estimate FEV(1) -slope pre- and post-treatment.

RESULTS: During follow-up, 1023 WTC-exposed firefighters were treated with ICS/LABA for 2 years or longer. When comparing intervals 6 years before and 6 years after treatment, participants had an 18.7 ml/year (95% confidence interval [CI]: 11.3-26.1) improvement in FEV(1) -slope after adjustment for baseline FEV(1) , race, height, WTC exposure, weight change, blood eosinophil concentration, and smoking status. After stratification by median date of ICS/LABA initiation (January 14, 2010), earlier ICS/LABA-initiators had a 32.5 ml/year (95% CI: 19.5-45.5) improvement in slope but later ICS/LABA-initiators had a nonsignificant FEV(1) -slope improvement (7.9 ml/year, 95% CI: -0.5 to 17.2).

CONCLUSIONS: WTC-exposed firefighters treated with ICS/LABA had improved FEV(1) slope after initiation, particularly among those who started earlier. Treatment was, however, not associated with FEV(1) -slope improvement if started after the median initiation date (1/14/2010), likely because onset of disease began before treatment initiation. Research on alternative treatments is needed for patients with greater than average FEV(1) -decline who have not responded to ICS/LABA.

Goldfarb DG, Zeig-Owens R, Kristjansson D, et al. 2021. Temporal association of prostate cancer incidence with World Trade Center rescue/recovery work. Occup Environ Med. 78 (10):699–706.

HTTPS://DOI.ORG/10.1136/OEMED-2021-107405

BACKGROUND: The World Trade Center (WTC) attacks on 11 September 2001 created a hazardous environment with known and suspected carcinogens. Previous studies have identified an increased risk of prostate cancer in responder cohorts compared with the general male population.

OBJECTIVES: To estimate the length of time to prostate cancer among WTC rescue/recovery workers by determining specific time periods during which the risk was significantly elevated.

METHODS: Person-time accruals began 6 months after enrolment into a WTC

cohort and ended at death or 12/31/2015. Cancer data were obtained through linkages with 13 state cancer registries. New York State was the comparison population. We used Poisson regression to estimate hazard ratios and 95% CIs; change points in rate ratios were estimated using profile likelihood.

RESULTS: The analytic cohort included 54 394 male rescue/recovery workers. We observed 1120 incident prostate cancer cases. During 2002-2006, no association with WTC exposure was detected. Beginning in 2007, a 24% increased risk (HR: 1.24, 95% CI 1.16 to 1.32) was observed among WTC rescue/recovery workers when compared with New York State. Comparing those who arrived earliest at the disaster site on the morning of 11 September 2001 or any time on 12 September 2001 to those who first arrived later, we observed a positive, monotonic, dose-response association in the early (2002-2006) and late (2007-2015) periods.

CONCLUSIONS: Risk of prostate cancer was significantly elevated beginning in 2007 in the WTC combined rescue/recovery cohort. While unique exposures at the disaster site might have contributed to the observed effect, screening practices including routine prostate specific antigen screening cannot be discounted.

Kwon S, Lee M, Crowley G, et al. 2021. Dynamic metabolic risk profiling of World Trade Center-lung disease: A longitudinal cohort study. Am J Respir Crit Care Med. 204 (9):1035–1047.

HTTPS://DOI.ORG/10.1164/RCCM.202006-2617OC

RATIONALE: Metabolic Syndrome (MetSyn) increases the risk of World Trade Center-Lung Injury (WTC-LI). However, the temporal relationship of MetSyn, exposure intensity, and lung dysfunction is not well understood. We modeled the association of longitudinal MetSyn characteristics with WTC-lung disease to define modifiable risk.

METHODS: Consented firefighters (N=5,738) were active-duty on 9/11/01 (9/11). WTC-LI (N=1,475; FEV1%predicted<LLN) and non-WTC-LI (N=4,263; FEV1%predicted≥LLN at all exams) was the primary-outcome, FVC%,predicted<LLN and FEV1/FVC<0.70 were secondary-outcomes. We assessed: I. effect of concurrent MetSyn on longitudinal lung function by linear mixed models; II. temporal effect of MetSyn and exposure by Weibull-proportional hazards (PH); III. effects of MetSyn's rate of change by two-stage models; IV. nonlinear joint effect of longitudinal MetSyn components by partially linear single index models (PLSI).

RESULTS: WTC-LI cases were more often ever-smokers, arrived the morning (9/11), and had MetSyn. BMI≥30kg/m2 and HDL<40mg/dL were most contributory to concurrent loss of FEV1%,predicted and FVC%,predicted while conserving FEV1/FVC. BMI≥30kg/m2 and dyslipidemia significantly predicted WTC-LI, FVC%,predicted<LLN in a Weibull-PH model. Dynamic risk assessment of WTC-LI based on MetSyn and exposure

showed how reduction of MetSyn-factors further reduce WTC-LI likelihood in susceptible populations. PLSI demonstrates that MetSyn has a nonlinear relationship on WTC-lung disease, and increases in cumulative MetSyn risk factors exponentially increase WTC-LI risk. Interactive metabolic-risk modeling application developed to simplify PLSI interpretation.

CONCLUSION: MetSyn and WTC-exposure contribute to the development of lung disease. Dynamic risk assessment may be utilized to encourage treatment of MetSyn in susceptible populations. Future studies will focus on dietary intervention as a disease-modifier.

Lam R, Kwon S, Riggs J, et al. 2021. Dietary phenotype and advanced glycation end-products predict WTC-obstructive airways disease: A longitudinal observational study. Respiratory Research. 22 (1):19.

HTTPS://DOI.ORG/10.1186/S12931-020-01596-6

BACKGROUND: Diet is a modifier of metabolic syndrome which in turn is associated with World Trade Center obstructive airways disease (WTC-OAD). We have designed this study to (1) assess the dietary phenotype (food types, physical activity, and dietary habits) of the Fire Department of New York (FDNY) WTC-Health Program (WTC-HP) cohort and (2) quantify the association of dietary quality and its advanced glycation end product (AGE) content with the development of WTC-OAD.

METHODS: WTC-OAD, defined as developing WTC-Lung Injury (WTC-LI; FEV1 < LLN) and/or airway hyperreactivity (AHR; positive methacholine and/or positive bronchodilator response). Rapid Eating and Activity Assessment for Participants-Short Version (REAP-S) deployed on 3/1/2018 in the WTC-HP annual monitoring assessment. Clinical and REAP-S data of consented subjects was extracted (7/17/2019). Diet quality [low-(15–19), moderate-(20–29), and high(30–39)] and AGE content per REAP-S questionnaire were assessed for association with WTC-OAD. Regression models adjusted for smoking, hyperglycemia, hypertension, age on 9/11, WTC-exposure, BMI, and job description.

RESULTS: N = 9508 completed the annual questionnaire, while N = 4015 completed REAP-S and had spirometry. WTCOAD developed in N = 921, while N = 3094 never developed WTC-OAD. Low- and moderate-dietary quality, eating more (processed meats, fried foods, sugary drinks), fewer (vegetables, whole-grains),and having a diet abundant in AGEs were significantly associated with WTC-OAD. Smoking was not a significant risk factor of WTC-OAD.

CONCLUSIONS: REAP-S was successfully implemented in the FDNY WTC-HP monitoring questionnaire and produced valuable dietary phenotyping. Our observational study has identified low dietary quality and AGE abundant dietary habits as risk factors for pulmonary disease in the context of WTC-exposure. Dietary phenotyping, not only focuses our metabolomic/biomarker profiling

but also further informs future dietary interventions that may positively impact particulate matter associated lung disease.

Maura F, Diamond B, Maclachlan KH, et al. 2021. Initial whole-genome sequencing of plasma cell neoplasms in first responders and recovery workers exposed to the world trade center attack of September 11, 2001. Clinical Cancer Research. 27 (7):2111–2118.

HTTPS://DOI.ORG/10.1158/1078-0432.CCR-20-2245

PURPOSE: The World Trade Center (WTC) attack of September 11, 2001 created an unprecedented environmental exposure to known and suspected carcinogens. High incidence of multiple myeloma and precursor conditions has been reported among first responders to the WTC disaster. To expand on our prior screening studies, and to characterize the genomic impact of the exposure to known and potential carcinogens in the WTC debris, we were motivated to perform whole-genome sequencing (WGS) of WTC first responders and recovery workers who developed a plasma cell disorder after the attack.

EXPERIMENTAL DESIGN: We performed WGS of nine CD138- positive bone marrow mononuclear samples from patients who were diagnosed with plasma cell disorders after the WTC disaster.

RESULTS: No significant differences were observed in comparing the post-WTC driver and mutational signature landscapes with 110 previously published WGSs from 56 patients with multiple myeloma and the CoMMpass WGS cohort (n = 752). Leveraging constant activity of the single-base substitution mutational signatures 1 and 5 over time, we estimated that tumor-initiating chromosomal gains were windowed to both pre- and post-WTC exposure. Conclusions: Although limitations in sample size preclude any definitive conclusions, our findings suggest that the observed increased incidence of plasma cell neoplasms in this population is due to complex and heterogeneous effects of theWTCexposure that may have initiated or contributed to progression of malignancy.

Webber MP, Singh A, Zeig-Owens R, et al. 2021. Cancer incidence in World Trade Center-exposed and non-exposed male firefighters, as compared with the us adult male population: 2001-2016. Occupational and environmental medicine. 78 (10):707–714.

HTTPS://DOI.ORG/10.1136/OEMED-2021-107570

OBJECTIVE: To compare cancer incidence in Fire Department of the City of New York (FDNY) firefighters who worked at the World Trade Center (WTC) site to incidence in a population of non-WTC-exposed firefighters, the Career Firefighter Health Study (CFHS) cohort, and to compare rates from each firefighter cohort to rates in demographically similar US males.

METHODS: FDNY (N=10 786) and CFHS (N=8813) cohorts included male firefighters who were active on 11 September

2001 (9/11) and were followed until death or 31 December 2016. Cases were identified from 15 state cancer registries. Poisson regression models assessed cancers in each group (FDNY and CFHS) versus US males, and associations between group and cancer rates; these models estimated standardised incidence ratios (SIRs) and adjusted relative rates (RRs), respectively. Secondary analyses assessed surveillance bias and smoking history.

RESULTS: We identified 915 cancer cases in 841 FDNY firefighters and 1002 cases in 909 CFHS firefighters. FDNY had: higher rates for all cancers (RR=1.13; 95% CI 1.02 to 1.25), prostate (RR=1.39; 95% CI 1.19 to 1.63) and thyroid cancer (RR=2.53; 95% CI 1.37 to 4.70); younger median ages at diagnosis (55.6 vs 59.4; p<0.001, all cancers); and more cases with localised disease when compared with CFHS. Compared with US males, both firefighter cohorts had elevated SIRs for prostate cancer and melanoma. Control for surveillance bias in FDNY reduced most differences.

CONCLUSIONS: Excess cancers occurred in WTC-exposed firefighters relative to each comparison group, which may partially be explained by heightened surveillance. Two decades post-9/11, clearer understanding of WTC-related risk requires extended follow-up and modelling studies (laboratory or animal based) to identify workplace exposures in all firefighters.

Year Published 2022 (4)

Boffetta P, Goldfarb DG, Zeig-Owens R, et al. 2022. Temporal aspects of the association between exposure to the World Trade Center disaster and risk of skin melanoma. Journal. 2 (1):100063.

HTTPS://DOI.ORG/10.1101/2021.03.10.21253261

BACKGROUND: Rescue/recovery workers who responded to the World Trade Center (WTC) attacks on 9/11/2001 were exposed to known/suspected carcinogens. Studies have identified an increased risk of skin melanoma in this population, but the temporal aspects of the association have not been investigated. A total of 44,540 non-Hispanic White workers from the WTC Combined Rescue/Recovery Cohort were observed between 3/12/2002 and 12/31/2015. Cancer data were obtained via linkages with 13 state registries. Poisson regression was used to estimate hazard ratios (HR) and 95% confidence intervals (CI), using the New York State population as reference; change points in the HRs were estimated using profile likelihood. We observed 247 incident cases of skin melanoma. No increase in incidence was detected between 2002 and 2004. Beginning in 2005, the HR was 1.34 (95% CI 1.18-1.52). A dose-response relationship was observed according to time worked on the WTC effort. Risk of mela-

noma among non-Hispanic White WTC rescue/recovery workers was elevated, beginning in 2005. While WTC-related exposure to ultraviolet radiation or other agents might have contributed to this result, exposures other than the WTC effort and enhanced medical surveillance cannot be discounted. Our results support the continued surveillance of this population for melanoma.

Boffetta P, Hall CB, Todd AC, et al. 2022. Cancer risk among World Trade Center rescue and recovery workers: A review. CA Cancer J Clin.

HTTPS://DOI.ORG/10.3322/CAAC.21723

BACKGROUND: Twenty years after the September 11th, 2001 terrorist attacks, the association between exposures present at the World Trade Center (WTC) site and the risk of several specific types of cancer has been reported among rescue and recovery workers. The authors' objective was to conduct an updated review of these data. Most studies have found elevated rates of both prostate and thyroid cancers compared with rates in the general population, and some have reported statistically significant differences for the rates of all cancers as well. Studies including a larger combined cohort of WTC-exposed rescue and recovery workers from 3 main cohorts have since replicated findings for these cancers, with additional years of follow-up. Among this combined cohort, although a lower-than-expected standardized incidence ratio for all cancers was observed, WTC exposure was also related to an increased risk of cutaneous melanoma and tonsil cancer. Importantly, another study found that WTC-exposed rescue and recovery workers who are enrolled in the federally funded medical monitoring and treatment program experienced improved survival post-cancer diagnosis compared with New York state patients with cancer. On the basis of these combined cohort studies, the full effect of WTC exposure on cancer risk is becoming clearer. Consequently, the authors believe that surveillance of those with WTC exposure should be continued, and in-depth analysis of epidemiologic, molecular, and clinical aspects of specific cancers in these workers should be pursued.

Jasra S, Giricz O, Zeig-Owens R, et al. 2022. High burden of clonal hematopoiesis in first responders exposed to the World Trade Center disaster. Nature Medicine.

HTTPS://DOI.ORG/10.1038/S41591-022-01708-3

BACKGROUND: The terrorist attacks on the World Trade Center (WTC) created an unprecedented environmental exposure to aerosolized dust, gases and potential carcinogens. Clonal hematopoiesis (CH) is defined as the acquisition of somatic mutations in blood cells and is associated with smoking and exposure to genotoxic stimuli. Here we show that deep targeted sequencing of blood samples identified a significantly higher proportion of WTC-exposed first responders with CH (10%; 48 out of 481) when compared with non-WTC-exposed firefighters (6.7%; 17 out of 255; odds ratio, 3.14; 95% confidence interval, 1.64–6.03; P = 0.0006) after con-

trolling for age, sex and race/ethnicity. The frequency of somatic mutations in WTC-exposed first responders showed an age-related increase and predominantly affected DNMT3A, TET2 and other CH-associated genes. Exposure of lymphoblastoid cells to WTC particulate matter led to dysregulation of DNA replication at common fragile sites in vitro. Moreover, mice treated with WTC particulate matter developed an increased burden of mutations in hematopoietic stem and progenitor cell compartments. In summary, the high burden of CH in WTC-exposed first responders provides a rationale for enhanced screening and preventative efforts in this population.

Lin NW and Maier LA. 2022. Occupational exposures and sarcoidosis: Current understanding and knowledge gaps. Curr Opin Pulm Med. 28 (2):144–151

HTTPS://DOI.ORG/10.1097/MCP.0000000000000835

PURPOSE OF REVIEW: Sarcoidosis is an idiopathic granulomatous disease that primarily affects the lungs. Several lines of evidence suggest that occupational exposures are associated with disease risk. This review critically evaluates studies using the Bradford Hill criteria for causation to determine if a causal relationship can be established between occupational exposure and sarcoidosis.

RECENT FINDINGS: Large epidemiological studies have proposed multiple occupational exposures associated with sarcoidosis but lack consistency of results. Many convincing studies demonstrate an association between World Trade Center (WTC) dust and sarcoidosis, which illustrates a causal relationship based on the fulfillment of the Bradford Hill criteria. Studies describing an association between silica/metals and sarcoidosis are intriguing but fulfill a limited number of the Bradford Hill criteria and warrant further investigation before a causal relationship can be determined. Finally, we also discuss preliminary studies associating sarcoidosis phenotypes with specific occupational exposures.

SUMMARY: Using the Bradford Hill criteria for causation, we demonstrate that WTC dust has a causative relationship with sarcoidosis, which reinforces the theory that sarcoidosis is an exposure-related disease. More research is needed to determine other specific occupational exposures causing disease.

Appendix 2, Section 4

WTC General Responders Data Center• Research Publications

Year Published 2002 (1)

Levin S, Herbert R, Skloot G, et al. 2002. Health effects of World Trade Center site workers. Am J Ind Med. 42 (6):545–547.

HTTPS://DOI.ORG/10.1002/AJIM.10154

By October 2001, the Mount Sinai-Irving J. Selikoff Center for Occupational and Environmental Medicine (COEM) began evaluating individuals, who presented with respiratory complaints, related to their exposure to airborne irritants. Exposure-related factors (when they were at or near "Ground Zero," performing what tasks, over what time period, with what level of respiratory protection) appeared to be significant determinants of the severity of respiratory reactions; but host biological factors appeared to play a role as well, with some exhibiting greater susceptibility to the irritant-induced effects.

Year Published 2004 (4)

Landrigan PJ, Lioy PJ, Thurston G, et al. 2004. Health and environmental consequences of the World Trade Center disaster. Environ Health Perspect. 112 (6):731–739.

HTTPS://DOI.ORG/10.1289/EHP.6702

The attack on the World Trade Center (WTC) created an acute environmental disaster of enormous magnitude. This study characterizes the environmental exposures resulting from destruction of the WTC and assesses their effects on health. Methods include ambient air sampling; analyses of outdoor and indoor settled dust; high-altitude imaging and modeling of the atmospheric plume; inhalation studies of WTC dust in mice; and clinical examinations, community surveys, and prospective epidemiologic studies of exposed populations. WTC dust was found to consist predominantly (95%) of coarse particles and contained pulverized cement, glass fibers, asbestos, lead, polycyclic aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs), and polychlorinated furans and dioxins. Airborne particulate levels were highest immediately after the attack and declined thereafter. Particulate levels decreased sharply with distance from the WTC. Dust pH was highly alkaline (pH 9.0-11.0). Mice exposed to WTC dust showed only moderate pulmonary inflammation but marked bronchial hyperreactivity. Evaluation of 10,116 firefighters showed exposure-related increases in cough and bronchial hyperreactivity. Evaluation of 183 cleanup workers showed new-onset cough (33%), wheeze (18%), and phlegm production (24%). Increased frequency of new-onset cough, wheeze, and shortness of breath were also observed in community residents. Follow-up of 182 pregnant women who were either inside or near the WTC on 11 September showed a 2-fold increase

in small-for-gestational-age (SGA) infants. In summary, environmental exposures after the WTC disaster were associated with significant adverse effects on health. The high alkalinity of WTC dust produced bronchial hyperreactivity, persistent cough, and increased risk of asthma. Plausible causes of the observed increase in SGA infants include maternal exposures to PAH and particulates. Future risk of mesothelioma may be increased, particularly among workers and volunteers exposed occupationally to asbestos. Continuing follow-up of all exposed populations is required to document the long-term consequences of the disaster.

Levin S, Herbert R, Moline JM, et al. 2004. Physical health status of World Trade Center rescue and recovery workers and volunteers - New York City, july 2002-august 2004. MMWR Morb Mortal Wkly Rep. 53 (35):807–812.

NO ABSTRACT AVAILABLE

Skloot G, Goldman M, Fischler D, et al. 2004. Respiratory symptoms and physiologic assessment of ironworkers at the World Trade Center disaster site. Chest. 125 (4):1248–1255.

HTTPS://DOI.ORG/10.1378/CHEST.125.4.1248

STUDY OBJECTIVES: To characterize respiratory abnormalities in a convenience sample of ironworkers exposed at the World Trade Center (WTC) disaster site for varying lengths of time between September 11, 2001, and February 8, 2002.

DESIGN: Cross-sectional study. SETTING: The Mount Sinai Medical Center, a large tertiary hospital.

PARTICIPANTS: Ninety-six ironworkers engaged in rescue and recovery with exposure onset between September 11, 2001, and September 15, 2001, who responded to an invitation to undergo respiratory evaluation.

MEASUREMENTS: Medical and exposure history, physical examination, spirometry, forced oscillation (FO), and chest radiographs. The relationships of prevalence of respiratory symptoms and presence of obstructive physiology to smoking, exposure on September 11, duration of exposure, and type of respiratory protection were examined using univariate and linear and logistic regression analyses.

RESULTS: Seventy-four of 96 workers (77%) had one or more respiratory symptoms (similar in smokers [49 of 63 subjects, 78%] and nonsmokers [25 of 33 subjects, 76%]). Cough was the most common symptom (62 of 96 subjects, 65%), and was associated with exposure on September 11. Chest examination and radiograph findings were abnormal in 10 subjects (10%) and 19 subjects (20%), respectively. FO revealed dysfunction in 34 of 64 subjects tested (53%), while spirometry suggested obstruction in only 11 subjects (17%). Lack of a respirator with canister was a risk factor for large airway dysfunction, and cigarette smoking was a risk factor for small airway dysfunction. No other relationships reached statistical significance.

CONCLUSIONS: Respiratory symptoms occurred in the majority of ironworkers at the WTC disaster site and were not attributable to smoking. Exposure on September 11 was associated with a greater prevalence of cough. Objective evidence of lung disease was less common. Spirometry underestimated the prevalence of lung

function abnormalities in comparison to FO. Continuing evaluation of symptoms, chest radiographs, and airway dysfunction should determine whether long-term clinical sequelae will exist.

Smith R, Katz CL, Holmes A, et al. 2004. Mental health status of World Trade Center rescue and recovery workers and volunteers - New York City, july 2002-august 2004. MMWR Morb Mortal Wkly Rep. 53 (35):812–815.

After the September 11, 2001, attacks on the World Trade Center (WTC), a comprehensive screening program was established to evaluate the physical and mental health of rescue and recovery workers and volunteers. Persons were eligible for this program if they participated in the WTC rescue or recovery efforts and met specific time criteria for exposure to the site. During July 16, 2002--August 6, 2004, the program evaluated 11,768 workers and volunteers. This report summarizes data analyzed from a subset of 1,138 of the 11,768 participants evaluated at the Mount Sinai School of Medicine during July 16--December 31, 2002. On the basis of one or more standardized screening questionnaires, approximately half (51%) of participants met threshold criteria for a clinical mental health evaluation. Continued surveillance is needed to assess the long-term psychological impact of the aftermath of the 9/11 attacks and to determine needs for continued treatment.

Year Published 2005 (2)

Boscarino JA, Adams RE, Stuber J, et al. 2005. Disparities in mental health treatment following the World Trade Center disaster: Implications for mental health care and health services research. J Trauma Stress. 18 (4):287–297.

HTTPS://DOI.ORG/10.1002/JTS.20039

To assess disparities in mental health treatment in New York City (NYC) after the World Trade Center Disaster (WTCD) reported previously related to care access, we conducted analyses among a cross-sectional survey of adults who had posttraumatic stress disorder (PTSD) or major depression (N = 473) one year after the event. The dependent variables examined were use of mental health services, in general, and use of mental health services related to the WTCD. Similar dependent variables were developed for medication usage. Although a number of bivariate results were statistically significant for postdisaster mental health visits, in a multivariate logistic regression model, only WTCD exposure remained significant. For service utilization related to the WTCD, the multivariate results indicated that African Americans were less likely to have had these visits compared to Whites, while those with a regular doctor, who had greater exposure to WTCD events, and those who had a perievent panic attack were more likely to have had such visits. In terms of medication use, multivariate results suggested that African Americans were less likely to use postdisaster medications, whereas persons 45 + years old and those with a regular doctor, were more likely to use them. For WTCD-related medication use, multivariate models

indicated that African Americans were less likely to use medications, relative to Whites, while those between 45 and 64 years old, those with a regular doctor, those exposed to more WTCD events, and those who had a perievent panic attack, were more likely to have taken medications related to the disaster. The primary reason respondents gave for not seeking treatment (55% of subsample) was that they did not believe that they had a problem (73%). Other reasons were that they wanted to solve the problem on their own (5%), had problems accessing services (6%), had financial problems (4%), or had a fear of treatment (4%). Despite the availability of free mental health services offered in a supportive and potentially less stigmatizing environment post disaster, there still appeared to be barriers to receiving postdisaster services among those presumably in need of care.

Wolff MS, Teitelbaum SL, Lioy PJ, et al. 2005. Exposures among pregnant women near the World Trade Center site on 11 September 2001. Environ Health Perspect. 113 (6):739–748.

HTTPS://DOI.ORG/10.1289/EHP.7694

We have characterized environmental exposures among 187 women who were pregnant, were at or near the World Trade Center (WTC) on or soon after 11 September 2001, and are enrolled in a prospective cohort study of health effects. Exposures were assessed by estimating time spent in five zones around the WTC and by developing an exposure index (EI) based on plume reconstruction modeling. The daily reconstructed dust levels were correlated with levels of particulate matter < or = 2.5 microm in aerodynamic diameter (PM2.5; r = 0.68) or PM10 (r = 0.73-0.93) reported from 26 September through 8 October 2001 at four of six sites near the WTC whose data we examined. Biomarkers were measured in a subset. Most (71%) of these women were located within eight blocks of the WTC at 0900 hr on 11 September, and 12 women were in one of the two WTC towers. Daily EIs were determined to be highest immediately after 11 September and became much lower but remained highly variable over the next 4 weeks. The weekly summary EI was associated strongly with women's perception of air quality from week 2 to week 4 after the collapse ($p < 0.0001$). The highest levels of polycyclic aromatic hydrocarbon-deoxyribonucleic acid (PAH-DNA) adducts were seen among women whose blood was collected sooner after 11 September, but levels showed no significant associations with EI or other potential WTC exposure sources. Lead and cobalt in urine were weakly correlated with sigmaEI, but not among samples collected closest to 11 September. Plasma OC levels were low. The median polychlorinated biphenyl level (sum of congeners 118, 138, 153, 180) was 84 ng/g lipid and had a nonsignificant positive association with sigmaEI ($p > 0.05$). 1,2,3,4,6,7,8-Heptachlorodibenzodioxin levels (median, 30 pg/g lipid) were similar to levels reported in WTC-exposed firefighters but were not associated with EI. This report indicates intense bystander exposure after the WTC collapse and provides information about nonoccupational exposures among a vulnerable population of pregnant women.

Year Published 2006 (4)

Herbert R, Moline J, Skloot G, et al. 2006. The World Trade Center disaster and the health of workers: Five-year assessment of a unique medical screening program. Environ Health Perspect. 114 (12):1853–1858.

HTTPS://DOI.ORG/10.1289/EHP.9592

BACKGROUND: Approximately 40,000 rescue and recovery workers were exposed to caustic dust and toxic pollutants following the 11 September 2001 attacks on the World Trade Center (WTC). These workers included traditional first responders, such as firefighters and police, and a diverse population of construction, utility, and public sector workers.

METHODS: To characterize WTCrelated health effects, the WTC Worker and Volunteer Medical Screening Program was established. This multicenter clinical program provides free standardized examinations to responders. Examinations include medical, mental health, and exposure assessment questionnaires; physical examinations; spirometry; and chest X rays.

RESULTS: Of 9,442 responders examined between July 2002 and April 2004, 69% reported new or worsened respiratory symptoms while performing WTC work. Symptoms persisted to the time of examination in 59% of these workers. Among those who had been asymptomatic before September 11, 61% developed respiratory symptoms while performing WTC work. Twenty-eight percent had abnormal spirometry; forced vital capacity (FVC) was low in 21%; and obstruction was present in 5%. Among nonsmokers, 27% had abnormal spirometry compared with 13% in the general U.S. population. Prevalence of low FVC among nonsmokers was 5-fold greater than in the U.S. population (20% vs. 4%). Respiratory symptoms and spirometry abnormalities were significantly associated with early arrival at the site.

CONCLUSION: WTC responders had exposure-related increases in respiratory symptoms and pulmonary function test abnormalities that persisted up to 2.5 years after the attacks. Longterm medical monitoring is required to track persistence of these abnormalities and identify late effects, including possible malignancies. Lessons learned should guide future responses to civil disasters.

Katz CL SR, Herbert R, Levin S, and Gross R. 2006. The World Trade Center worker/volunteer mental health screening program.. In Y. Neria, R. Gross, R. D. Marshall, & E. S. Susser (Eds.), 9/11: Mental health in the wake of terrorist attacks. 0:355–377.

HTTPS://DOI.ORG/10.1017/CBO9780511544132.023

The World Trade Center (WTC) Worker/Volunteer Mental Health Screening Program (MHSP) has provided an unprecedented opportunity to offer mental health evaluation and assistance to a population whose medical and emotional needs previously have been too often overlooked amid the competing priorities of recovery from past disasters. Following in the wake of the tragedy of 9/11, this carefully calibrated program has enabled mental health professionals to offer whatever they can to an astounding number of individuals whose work or volun-

teerism directly exposed them to the events of 9/11 in New York City. Topics discussed in this chapter include traumatic exposure; mental health sequelae in relief and recovery workers; experiences of salvage, volunteer, and rescue workers at Ground Zero; development of the MHSP; program design; operation of the MHSP; preliminary findings; and case examples.

Katz CL, Smith R, Silverton M, et al. 2006. A mental health program for ground zero rescue and recovery workers: Cases and observations. Psychiatr Serv. 57 (9):1335–1338.

HTTPS://DOI.ORG/10.1176/APPI.PS.57.9.1335

Clinical vignettes from the World Trade Center Worker and Volunteer Mental Health Monitoring and Treatment Program at the Mount Sinai Medical Center in New York City are presented. The hospital-based program pairs mental health screenings with federally funded occupational medical screenings to identify persons with mental health problems related to their rescue and recovery roles. The program also provides on-site mental health treatment. The cases illustrate the diverse mental health needs of the rescue and recovery workers, some of whom initially sought treatment years after September 11, 2001. The cases show that in addition to symptoms of posttraumatic stress disorder, workers experienced survivor guilt, distressing memories of childhood trauma, shame associated with intense feelings, substance abuse relapse, psychosis, and problems with family relationships.

Moline J, Herbert R, and Nguyen N. 2006. Health consequences of the September 11 World Trade Center attacks: A review. Cancer Invest. 24 (3):294–301.

HTTPS://DOI.ORG/10.1080/07357900600633965

In the aftermath of the September 11 World Trade Center (WTC) attack, a large number of people sustained potential exposures to smoke, dust, particulate matter, and a variety of toxins, including asbestos, pulverized concrete, glass fibers, polycyclic aromatic hydrocarbons (PAHs), and polychlorinated furans and dioxins. Additionally, many had exposure to psychological traumatogens. The most common effects seen to date are respiratory and mental health consequences. The long-term consequences of exposures are not yet known, and there remains concern about the potential for late-emerging diseases such as cancers. This article reviews WTC-related health effects, the spectrum of exposures and how they were documented, and discusses future preventive efforts.

Year Published 2007 (2)

Mendelson DS, Roggeveen M, Levin SM, et al. 2007. Air trapping detected on end-expiratory high-resolution computed tomography in symptomatic World Trade Center rescue and recovery workers. J Occup Environ Med. 49 (8):840–845.

HTTPS://DOI.ORG/10.1097/JOM.0B013E3180D09E87

OBJECTIVES: We utilized end-expiratory chest computed tomography (CT) to investigate air trapping (AT) in symptomatic former World Trade Center (WTC) workers,

and correlated the findings with clinical, physiological, and exposure-related characteristics.

METHODS: Twenty-nine WTC workers with lower respiratory symptoms were evaluated. Clinical data included symptom inventories, quantitative respiratory symptom scores, WTC dust exposure duration, pulmonary function tests, and inspiratory and end-expiratory high-resolution chest CT scans. The latter were scored quantitatively for AT (by two methods) and interstitial changes, and those scores were correlated with the clinical data.

RESULTS: The two AT scoring methods yielded highly correlated results. AT was demonstrated in 25 of 29 patients, with scores ranging from 0 to 24 (mean, 10.6). There was a statistically significant correlation between AT and the duration of dust exposure. AT scores were significantly higher in patients with restrictive lung function data, and in lifetime nonsmokers.

CONCLUSIONS: Our data suggest that AT from small airways disease may account for some of the reported clinical and pulmonary functional abnormalities in WTC dust-exposed workers, and support the use of high-resolution CT scans in the investigation and characterization of the pulmonary ailments of selected workers.

Tao XG, Massa J, Ashwell L, et al. 2007. The World Trade Center clean up and recovery worker cohort study:

BACKGROUND: Respiratory health amongst cleanup workers approximately 20 months after initial exposure at the disaster site. J Occup Environ Med. 49 (10):1063–1072.

HTTPS://DOI.ORG/10.1097/JOM.0B013E31815AC4F8

OBJECTIVE: Respiratory health among cleanup workers at the World Trade Center (WTC) disaster site was evaluated approximately 20 months after the initial exposure to assess the risk of lower respiratory symptoms.

METHODS: In 2003 a self-administered questionnaire requesting information about site experience, current respiratory and historical health, and smoking was sent to 4,546 workers employed at the site (response 25%), and 2103 workers who were never at the WTC (response 12%).

RESULTS: As compared with those never at the site, WTC workers were more than three times as likely to report any lower respiratory symptoms (rate ratio = 3.40, 95% confidence interval: 2.33-4.94).

CONCLUSIONS: These results suggest an impact on respiratory health related to work experience at the WTC and indicate further monitoring to address potential long-term effects.

Year Published 2008 (11)

Bills CB, Levy NA, Sharma V, et al. 2008. Mental health of workers and volunteers responding to events of 9/11: Review of the literature. Mt Sinai J Med. 75 (2):115–127.

HTTPS://DOI.ORG/10.1002/MSJ.20026

BACKGROUND: Disaster workers responding to the events of September 11th were exposed to traumatic events. No study has systematically investigated the diverse mental health status and needs of the heterogeneous population of disaster workers responding to the events of September 11th.

METHODS: Using PubMed and Medline and the search terms of "September 11, 2001" or "September 11" or "9/11" or "WTC" or "World Trade Center", the authors reviewed all articles that examined the mental health outcomes of workers at one of the three September 11th crash sites or the Fresh Kills landfill in New York City.

RESULTS: In total, 25 articles met study inclusion criteria, often using different methodologies. The articles described varying degrees of mental health symptomatology, risk factors for adverse mental health outcomes, and utilization of mental health services.

CONCLUSIONS: The mental health needs of workers exposed to the events of September 11th ranged from little to no care to pharmacotherapy. A range of risk factors, including exposures at the WTC site and occupational activities, impacted on these needs but the role of specific mental health interventions was less clear. These findings suggest the need for a future program for disaster workers consisting of an accessible mental health treatment service supported by comprehensive postdisaster surveillance and emphasis on pre-disaster mental wellness. A number of areas for further consideration and study were identified, including the need for a more diverse exploration of involved responder populations as well as investigation of potential mental health outcomes beyond post-traumatic stress disorder (PTSD).

de la Hoz RE, Christie J, Teamer JA, et al. 2008. Reflux symptoms and disorders and pulmonary disease in former World Trade Center rescue and recovery workers and volunteers. J Occup Environ Med. 50 (12):1351–1354.

HTTPS://DOI.ORG/10.1097/JOM.0B013E3181845F9B

BACKGROUND: Gastroesophageal reflux disease is one of the most prevalent conditions among former World Trade Center (WTC) rescue and recovery workers. The reason for this proposed association with an inhalation injury is unclear. In this study, we clinically characterized the reflux disorders in former WTC workers, and we investigated their association with pulmonary function abnormalities and with clinical diagnoses of other WTC-related diseases.

METHODS: Forty-two former WTC workers underwent the following testing: symptom inventories, physical examination, spirometry, esophagogastroduodenoscopy, and 24-hour pH monitoring studies for theevaluation of chronic reflux-like symptoms. Patients were classified into two groups based on clinical evaluation: group 1 (reflux patients) including definitive reflux disorders (gastroesophageal reflux, nonerosive reflux, nonacid reflux, and laryngopharyngeal reflux diseases) and group 2 (no-reflux patients) patients without clinically significant reflux disease, including functional heartburn, and hypersensitive esophagus disorder.

RESULTS: The reflux and no-reflux patients had significantly different Johnson-De-

Meester scores and esophageal acid exposure times. Patients with reflux disorders were more likely to have reduced forced vital capacity (chi2 = 5.49, P = 0.031) and also more likely to have been diagnosed with a lower airway disease (chi2 = 7.14, P = 0.008). We found no significant association between reflux and psychiatric disorders (chi2 = 0.02, P = 0.89), levels of exposure at the WTC site, or incidence of dry cough, or other upper airway disorders.

CONCLUSIONS: A spectrum of reflux symptoms and disorders are present in WTC responders. Our data suggest that the presence of reflux disease is related to that of pulmonary function abnormality suggestive of air trapping and a diagnosis of a lower respiratory disease.

de la Hoz RE, Hill S, Chasan R, et al. 2008. Health care and social issues of immigrant rescue and recovery workers at the World Trade Center site. J Occup Environ Med. 50 (12):1329–1334.

HTTPS://DOI.ORG/10.1097/JOM.0B013E31818FF6FD

This article reviews the experience of a unique occupational group of World Trade Center (WTC) workers: immigrant workers. This group is comprised largely of men, laborers, who are first-generation immigrants. The majority of these workers are from Latin America (predominantly from Ecuador and Colombia) or from Eastern Europe (predominantly from Poland). Our data shows that the disease profile observed in these workers was what we have previously reported for WTC working population as a whole. Recent reports have begun to document the disproportionate burden of occupational hazards, injuries, and illnesses experienced by immigrant workers in the United States. The WTC experience of immigrants exemplified this burden but, additionally, highlighted that this burden is exacerbated by limitations in access to appropriate health care, disability and compensation benefits, and vocational rehabilitation services. A clinical program that was designed to address the complex medical and psychosocial needs of these workers in a comprehensive manner was successfully established. Full justice for these workers depends on larger societal changes.

de la Hoz RE, Shohet MR, Bienenfeld LA, et al. 2008. Vocal cord dysfunction in former World Trade Center (WTC) rescue and recovery workers and volunteers. Am J Ind Med. 51 (3):161–165.

HTTPS://DOI.ORG/10.1002/AJIM.20541

BACKGROUND: Vocal cord dysfunction (VCD) is a condition characterized by paradoxical partial adduction of the vocal cords on inspiration. It has been associated with exposures to irritants, as well as with psychological illnesses and conditions. Workers who participated in the recovery of the WTC disaster site were exposed to a large amount of irritants as well as considerable psychological stressors. We describe the clinical characteristics of 10 symptomatic former WTC workers diagnosed with this condition, as well as the frequency of spirometric findings suggestive of variable extrathoracic obstruction.

METHODS: Workers who became symptomatic after their WTC work experience have been evaluated clinically by a multidisciplinary team at an academic medical center. The evaluation included history,

physical examination, chest radiograph, blood tests, and pre- and post-bronchodilator spirometry in all patients. Additional evaluations and diagnostic tests included otolaryngological evaluation with flexible rhinolaryngoscopy and stroboscopy, gastroenterological and psychiatric evaluations. A randomly selected sample of 172 spirometry results were reviewed for evidence of inspiratory flow limitation.

RESULTS: Variable extrathoracic obstruction was found in 18.6% of the spirometries. Ten patients were diagnosed with VCD. In addition to symptoms suggestive of co-morbid conditions (particularly rhinitis and acid reflux disease), most of the 10 patients had (1) hoarseness, (2) dyspnea that was not associated with bronchial hyperreactivity, or (3) dyspnea associated with asthma, with either mild bronchial hyperreactivity and/or poor response to asthma treatment.

CONCLUSIONS: VCD appears to be part of the spectrum of airway disorders caused by occupational exposures at the WTC disaster site. Further study of this association is warranted.

de la Hoz RE, Shohet MR, Chasan R, et al. 2008. Occupational toxicant inhalation injury: The World Trade Center (WTC) experience. Int Arch Occup Environ Health. 81 (4):479–485.

HTTPS://DOI.ORG/10.1007/S00420-007-0240-X

OBJECTIVE AND METHODS: Clinical descriptive data is presented on a group of 554 former workers and volunteers (with more than 90 different occupations) at the World Trade Center (WTC) disaster site. A subsample of 168 workers (30% of the group) was selected to examine lower airway disease risk in relation to smoking and WTC exposure variables.

RESULTS: Five diagnostic categories clearly predominate: upper airway disease (78.5%), gastroesophageal reflux disease (57.6%), lower airway disease (48.9%), psychological (41.9%) and chronic musculoskeletal illnesses (17.8%). The most frequent pattern of presentation was a combination of the first three of those categories (29.8%). Associations were found between arrival at the WTC site within the first 48 h of the terrorist attack and lower airway and gastroesophageal reflux disease, and between past or present cigarette smoking and lower airway disease.

CONCLUSION: Occupational exposures at the WTC remain consistently associated with a disease profile, which includes five major diagnostic categories. These conditions often coexist in different combinations, which (as expected) mutually enhances their clinical expression, complicates medical management, and slows recovery. Cigarette smoking and early arrival at the WTC site appear to be risk factors for lower airway disease diagnosis.

Enright P, Skloot G, and Herbert R. 2008. Standardization of spirometry in assessment of responders following man-made disasters: World Trade Center worker and volunteer medical screening program. Mt Sinai J Med. 75 (2):109–114.

HTTPS://DOI.ORG/10.1002/MSJ.20027

BACKGROUND: Spirometry is the most commonly used pulmonary function test to screen individuals for suspected lung

disease. It is also used for screening workers with exposures to agents associated with pulmonary diseases. Although the American Thoracic Society (ATS) provides guidelines for spirometers and spirometry techniques, many factors are not standardized, so that results from individual pulmonary function laboratories vary substantially. These differences can create substantial difficulties in using data pooled from multiple sites to understand health consequences of disasters that involve exposures to pulmonary toxins. This article describes the approach used to minimize these differences for a consortium of institutions who are providing medical monitoring examinations to World Trade Center (WTC) responders. The protocol improved upon the minimal ATS guidelines.

METHODS: Spirometric measurements were obtained before and after use of a bronchodilator. A fourth-generation spirometer was chosen that exceeded ATS spirometer accuracy standards. The accuracy was verified at the beginning of each day of testing. Technologists who performed the spirometry tests were centrally trained and certified and received regular reports on their performance. Reference values and normal ranges were obtained from the National Health and Nutrition Examination Survey (NHANES III) data set. A standardized interpretation flowchart was followed to reduce misclassification rates for airway obstruction and restriction. Patients with spirometric abnormalities were referred for more extensive diagnostic testing.

RESULTS: More than 12,000 spirometry tests were performed during the first examination. The 20 spirometers used at the 6 participating institutions maintained accuracy within 3% for more than 4 years. Overall, more than 80% of the test sessions met ATS quality goals. Spirometry abnormality rates exceeded those obtained for adults who participated in the NHANES III survey.

CONCLUSIONS: The program allowed standardization of the performance and interpretation of spirometry results across multiple institutions. This facilitated reliable and rapid diagnosis of lung disease in the large number of WTC responders screened. We recommend this approach for postdisaster pulmonary evaluations in other settings.

Landrigan PJ, Forman J, Galvez M, et al. 2008. Impact of September 11 World Trade Center disaster on children and pregnant women. Mt Sinai J Med. 75 (2):129–134.

HTTPS://DOI.ORG/10.1002/MSJ.20032

BACKGROUND: Children are uniquely sensitive to toxic exposures in the environment. This sensitivity reflects children's disproportionately heavy exposures coupled with the biologic vulnerability that is a consequence of their passage through the complex transitions of early development.

METHODS AND RESULTS: To assess effects on children's health associated with the attacks on the World Trade Center (WTC) of September 11, 2001, research teams at the Mount Sinai School of Medicine and other academic health centers in New York City launched a series of clinical and epidemiologic studies. Mount Sinai investigators undertook a prospective analysis of pregnancy outcomes in 182 women

who were pregnant on September 11, 2001, and who had been either inside or within 0.5 miles of the WTC at the time of the attacks; they found a doubling in incidence of intrauterine growth retardation (IUGR) among infants born to exposed mothers as compared to infants born to unexposed women in northern Manhattan. A Columbia research team examined pregnancy outcomes in 329 women who lived, worked or gave birth in lower Manhattan in the 9 months after September 11; they found that these women gave birth to infants with significantly lower birth weight and shorter length than women living at greater distances from Ground Zero. NYU investigators documented increased numbers of new asthma cases and aggravations of preexisting asthma in children living in lower Manhattan. Mount Sinai mental health researchers documented a significant increase in mental health problems in children who directly witnessed the attacks and subsequent traumatic events; these problems were most severe in children with a past history of psychological trauma. The New York City Department of Health and Mental Hygiene established a WTC Registry that has enrolled over 70,000 persons of all ages in lower Manhattan and will follow the health of these populations to document on a continuing basis the health consequences of September 11.

Moline JM, Herbert R, Levin S, et al. 2008. WTC medical monitoring and treatment program: Comprehensive health care response in aftermath of disaster. Mt Sinai J Med. 75 (2):67–75.

HTTPS://DOI.ORG/10.1002/MSJ.20022

The attack on the World Trade Center (WTC) on September 11th, 2001 exposed thousands of individuals to an unprecedented mix of chemicals, combustion products and micronized building materials. Clinicians at the Mount Sinai Irving Selikoff Center for Occupational and Environmental Medicine, in partnership with affected stakeholder organizations, developed a medical screening program to evaluate the health status of workers and volunteers who spent time at the WTC site and thus sustained exposure in the aftermath of September 11th. Standardized questionnaires were adapted for use in this unique population and all clinicians underwent training to ensure comparability. The WTC Worker and Volunteer Medical Screening Program (MSP) received federal funding in April 2002 and examinations began in July 2002. The MSP and the follow up medical monitoring program has successfully recruited nearly 22,000 responders, and serves as a model for the rapid development of a medical screening program to assess the health of populations exposed to environmental hazards as a result of natural and man-made disasters. The MSP constitutes a successful screening program for WTC responders. We discuss the challenges that confronted the program; the absence of a prior model for the rapid development of a program to evaluate results from mixed chemical exposures; little documentation of the size of the exposed population or of who might have been exposed; and uncertainty about both the nature and potential severity of immediate and long-term health effects.

Reissman DB and Howard J. 2008. Responder safety and health: Preparing for future disasters. Mt Sinai J Med. 75 (2):135–141.

HTTPS://DOI.ORG/10.1002/MSJ.20024

This article reviews lessons learned about managing the safety and health of workers who were involved in disaster response, recovery, and cleanup after the 2001 World Trade Center (WTC) disaster. The first two sections review ongoing responder health burdens and the tragic toll of this disaster from a worker safety and health perspective. The remaining sections address changes in federal infrastructure, response planning, and resources for protection of response and recovery personnel. Proper preparation includes pre-event and "just-in-time" disaster-worker training on likely hazards, organizational assets for hazard monitoring, and hands-on instruction in the use of assigned protective equipment. Good planning includes predeployment medical review to ensure "fitness for duty" and considers the following: (1) personal risk factors, (2) hazards likely to be associated with particular field locations, and (3) risks involved with assigned tasks (eg, workload and pace, work/rest cycles, available resources, and team/supervisory dynamics). Planning also should address worker health surveillance, medical monitoring, and availability of medical care (including mental health services). Disaster safety managers should anticipate likely hazards within planning scenarios and prepare asset inventories to facilitate making timely safety decisions. Disaster safety management begins immediately and provides ongoing real-time guidance to incident leadership at all levels of government. Robust standards must be met to reliably protect workers/responders. An integrated and measurable multiagency safety management function must be built into the incident command system before an incident occurs. This function delineates roles and responsibilities for rapid exposure assessments, ensuring cross-agency consistency in data interpretation, and timely, effective communication of information and control strategies. The ability to perform this safety management function should be tested and evaluated in exercise simulations and drills at multiple levels. Joint planning and exercising of the safety management plan and its function are effective ways to build interagency relationships and to be more systemic in managing logistics for safety equipment and converging personnel. Planning must include mechanisms to enable safety decisions to be implemented-such as effective and rapid scene control (site access), personnel tracking, and safety enforcement. Worker safety and health preparedness and leadership are essential for protecting workers and promoting resiliency among personnel involved in disaster response, recovery, and cleanup.

Savitz DA, Oxman RT, Metzger KB, et al. 2008. Epidemiologic research on man-made disasters: Strategies and implications of cohort definition for World Trade Center worker and volunteer surveillance program. Mt Sinai J Med. 75 (2):77–87.

HTTPS://DOI.ORG/10.1002/MSJ.20023

Studies of long-term health consequences of disasters face unique methodologic challenges. The authors focused on studies of the health of cleanup and recovery workers, who are often poorly enumerated at the outset and difficult to follow over time. Comparison of the experience at the World Trade Center disaster with 4 past incidents of chemical and radiation releases at Seve-

so, Italy; Bhopal, India; Chernobyl, Ukraine; and Three Mile Island, USA, provided useful contrasts. Each event had methodologic advantages and disadvantages that depended on the nature of the disaster and the availability of records on area residents, and the emergency-response and cleanup protocol. The World Trade Center Worker Monitoring Program has well-defined eligibility criteria but lacks information on the universe of eligible workers to characterize response proportions or the potential for distortion of reported health effects. Nonparticipation may result from lack of interest, lack of awareness of the program, availability of another source of medical care, medical conditions precluding participation, inability to take time off from work, moving out of the area, death, or shift from initially ineligible to eligible status. Some of these considerations suggest selective participation by the sickest individuals, whereas others favor participation by the healthiest. The greatest concern with the validity of inferences regarding elevated health risks relative to external populations is the potential for selective enrollment among those who are affected. If there were a large pool of nonparticipating workers and those who suffered ill health were most motivated to enroll, the rates of disease among participants would be substantially higher than among all those eligible for the program. Future disaster follow-up studies would benefit substantially by having access to accurate estimates of the number of workers and information on the individuals who contributed to the cleanup and recovery effort.

Szeinuk J, Padilla M, and de la Hoz RE. 2008. Potential for diffuse parenchymal lung disease after exposures at World Trade Center disaster site. Mt Sinai J Med. 75 (2):101–107.

HTTPS://DOI.ORG/10.1002/MSJ.20025

OBJECTIVE: The diffuse parenchymal lung diseases (DPLDs) are a heterogeneous group of disorders that result from damage to the lung parenchyma. While the cause of most DPLDs remains unknown, extensive epidemiological and experimental evidence has linked exposure to environmental toxins to the pathogenesis of some of those diseases. The purpose of this review is to examine the potential relation between exposure to toxins released from the World Trade Center (WTC) collapse on September 11th, 2001 and the development of DPLD based on published evidence up to date.

METHODS: We examine such evidence from two points of view, (1) exposure, and (2) histopathogenesis.

EXPOSURE: Analyses of WTC-dust and particle size demonstrate that some portion of the dust was composed of particles small enough to penetrate deep into the lungs, reaching distal airways and alveoli. The presence of such particles has been confirmed in studies of induced sputum and bronchoalveolar lavage in WTC-exposed firefighters. Histopathogenesis: In vitro and animal experiments and patient evidence suggest that WTC dust is capable of inducing a pulmonary interstitial inflammatory response.

RESULTS: To date, there have been limited clinical reports documenting the development of diffuse parenchymal responses following exposure to WTC dust. No single common pathologic response has been

described. The one common denominator in the reports is that the individuals who developed disease were heavily exposed either during the disaster or during the initial 2-to-3 days following the disaster.

CONCLUSION: DLPDs are probably associated with heavy or extended exposure to the toxins released at the WTC disaster site. Coupled with the historical experience with exposures to occupational toxins this mandates continued long-term clinical observation of this cohort.

Year Published 2009 (5)

Bills CB, Dodson N, Stellman JM, et al. 2009. Stories behind the symptoms: A qualitative analysis of the narratives of 9/11 rescue and recovery workers. Psychiatr Q. 80 (3):173–189.

HTTPS://DOI.ORG/10.1007/S11126-009-9105-7

A qualitative study of the experiences of rescue and recovery workers/volunteers at Ground Zero following the terrorist attacks of 9/11/01 is reported. Information was extracted from a semi-structured clinical evaluation of 416 responders who were the initial participants in a large scale medical and mental health screening and treatment program for 9/11 responders. Qualitative analysis revealed themes that spanned four categories- occupational roles, exposures, attitudes/experiences, and outcomes related to the experience of Ground Zero. Themes included details regarding Ground Zero roles, grotesque experiences such as smells, the sense of the surreal nature of responding, and a turning to rituals to cope after leaving Ground Zero. These findings personalize the symptom reports and diagnoses that have resulted from the 9/11 responders' exposure to Ground Zero, yielding richer information than would otherwise be available for addressing the psychological dimensions of disasters. This work shows that large scale qualitative surveillance of trauma-exposed populations is both relevant and feasible.

de la Hoz RE, Shohet MR, Wisnivesky JP, et al. 2009. Atopy and upper and lower airway disease among former World Trade Center workers and volunteers. J Occup Environ Med. 51 (9):992–995.

HTTPS://DOI.ORG/10.1097/JOM.0B013E3181B32093

OBJECTIVE: A large number of workers seemed to have developed upper and lower airway disease (UAD and LAD, respectively) in relation to their occupational exposures at the World Trade Center (WTC) disaster site. This study examined atopy as a risk factor for presumably WTC-related UAD and LAD.

METHODS: Atopy was examined in 136 former WTC workers and volunteers by radioallergosorbent test, skin prick testing, or both. Overall prevalence of atopy was estimated, and bivariate and multivariate logistic regression analyses were conducted to examine associations of atopy with WTC-related UAD and LAD.

RESULTS: Atopy was prevalent in 54.4% of these WTC workers. Atopy was associated with higher symptom severity scores for

both WTC-related UAD and LAD. Atopy was a predictor of WTC-related UAD but not LAD. Early arrival at the WTC site, and pre-2001 asthma diagnosis were predictors of LAD.

CONCLUSION: The prevalence of atopy in this population is similar to what has been described for the general U.S. population. Atopy seemed to be a risk factor for presumably WTC-related UAD but not for LAD.

Katz CL, Levin S, Herbert R, et al. 2009. Psychiatric symptoms in ground zero ironworkers in the aftermath of 9/11: Prevalence and predictors. Psychiatric Bulletin. 33 (2):49–52.

HTTPS://DX.DOI.ORG/10.1192/PB.BP.107.018663

AIMS AND METHOD: To establish the prevalence of, and risk factors for, psychiatric symptoms in Ground Zero ironworkers. Questionnaires commonly used to screen for psychiatric symptoms were completed by 124 workers.

RESULTS: We have established the prevalence of screening positive for symptoms of post-traumatic stress disorder, panic attacks, generalised anxiety, depression and alcohol misuse. Among the risk factors were alcohol misuse, injury to or death of a family member, friend or co-worker at Ground Zero and one or more adverse life events since 9/11. Clinical implications: Ironworkers at Ground Zero tend to have significant psychiatric symptoms likely to be associated with the traumatic experience of working there during the clean-up operation. Risk factors for psychiatric symptoms were established.

Moline JM, Herbert R, Crowley L, et al. 2009. Multiple myeloma in World Trade Center responders: A case series. J Occup Environ Med. 51 (8):896–902.

HTTPS://DOI.ORG/10.1097/JOM.0B013E3181AD49C8

OBJECTIVES: We report on cases of multiple myeloma (MM) observed in World Trade Center (WTC) responders registered in the WTC Medical Program.

METHODS: Possible cases of MM diagnosed between September 11, 2001, and September 10, 2007, in responders were confirmed if they met the World Health Organization and Mayo Clinic diagnostic criteria.

RESULTS: Among 28,252 responders of known sex and age, eight cases of MM were observed (6.8 expected). Four of these cases were observed in responders younger than 45 years at the time of diagnosis (1.2 expected). A slight deficit of MM cases was observed in responders older than 45 years (4 observed, 5.6 expected).

CONCLUSION: In this case series, we observe an unusual number of MM cases in WTC responders under 45 years. This finding underscores the importance of maintaining surveillance for cancer and other emerging diseases in this highly exposed population.

Skloot GS, Schechter CB, Herbert R, et al. 2009. Longitudinal assessment of spirometry in the World Trade Center medical monitoring program. Chest. 135 (2):492–498.

HTTPS://DOI.ORG/10.1378/CHEST.08-1391

BACKGROUND: Multiple studies have demonstrated an initial high prevalence of spirometric abnormalities following World Trade Center (WTC) disaster exposure. We assessed prevalence of spirometric abnormalities and changes in spirometry between baseline and first follow-up evaluation in participants in the WTC Worker and Volunteer Medical Monitoring Program. We also determined the predictors of spirometric change between the two examinations.

METHODS: Prebronchodilator and postbronchodilator spirometry, demographics, occupational history, smoking status, and respiratory symptoms and exposure onset were obtained at both examinations (about 3 years apart).

RESULTS: At the second examination, 24.1% of individuals had abnormal spirometry findings. The predominant defect was a low FVC without obstruction (16.1%). Between examinations, the majority of individuals did not have a greater-than-expected decline in lung function. The mean declines in prebronchodilator FEV(1) and FVC were 13 mL/yr and 2 mL/yr, respectively (postbronchodilator results were similar and not reported). Significant predictors of greater average decline between examinations were lack of bronchodilator responsiveness at examination 1 and weight gain [corrected].

CONCLUSIONS: Elevated rates of spirometric abnormalities were present at both examinations, with reduced FVC most common. Although the majority had a normal decline in lung function, lack of bronchodilator response at examination 1 and weight gain were significantly associated with greater-than-normal lung function declines [corrected]. Due to the presence of spirometric abnormalities > 5 years after the disaster in many exposed individuals, longer-term monitoring of WTC responders is essential.

Year Published 2010 (9)

Chiu S, Webber MP, Zeig-Owens R, et al. 2010. Validation of the center for epidemiologic studies depression scale in screening for major depressive disorder among retired firefighters exposed to the World Trade Center disaster. J Affect Disord. 121 (3):212–219.

HTTPS://DOI.ORG/10.1016/J.JAD.2009.05.028

BACKGROUND: We evaluated the performance of a modified Center of Epidemiologic Studies Depression Scale (CES-D-m), which captured symptoms in the past month, in comparison to the Diagnostic Interview Schedule (DIS) in identification of major depressive disorder (MDD) in World Trade Center (WTC)-exposed retired Fire Department, City of New York (FDNY) firefighters.

METHODS: From 12/2005 to 7/2007, FDNY enrolled retired firefighters in its Medical Monitoring and Treatment Program. All participants completed the CES-D-m and the DIS on the same day. Sensitivity, specificity, receiver operating characteristic (ROC) curves, and Youden's index were used to assess properties of the CES-D-m.

Multivariate logistic regression analyses were also used.

RESULTS: 7% of 1915 retired male firefighters were diagnosed with MDD using the DIS. Using the most common CES-D cutoff score of 16, the prevalence of elevated risk was 36%, which declined to 23% using a cutoff score of 22, as determined by Youden's index. At 22, CES-D-m sensitivity was 0.84, specificity was 0.82, and the area under the ROC curve was 0.89 relative to DIS MDD diagnosis.

LIMITATIONS: Participants were more likely than non-participants to live in the New York City area.

CONCLUSIONS: This is the first study of WTC rescue/recovery workers to assess the performance of a one-month version of the CES-D. The CES-D-m performed well in identifying those at elevated risk. Since diagnostic follow-up is time consuming and costly, it is important to correctly distinguish those at elevated risk using a screening tool that has been validated in the population under study.

Dalton PH, Opiekun RE, Gould M, et al. 2010. Chemosensory loss: Functional consequences of the World Trade Center disaster. Environ Health Perspect. 118 (9):1251–1256.

HTTPS://DOI.ORG/10.1289/EHP.1001924

BACKGROUND: Individuals involved in rescue, recovery, demolition, and cleanup at the World Trade Center (WTC) site were exposed to a complex mixture of airborne smoke, dust, combustion gases, acid mists, and metal fumes. Such exposures have the potential to impair nasal chemosensory (olfactory and trigeminal) function.

OBJECTIVE: The goal of this study was to evaluate the prevalence of chemosensory dysfunction and nasal inflammation among these individuals.

METHODS: We studied 102 individuals who worked or volunteered at the WTC site in the days and weeks during and after 11 September 2001 (9/11) and a comparison group with no WTC exposure matched to each participant on age, sex, and job title. Participants were comprehensively evaluated for chemosensory function and nasal inflammation in a single session. Individual exposure history was obtained from self-reported questionnaires.

RESULTS: The prevalence of olfactory and trigeminal nerve sensitivity loss was significantly greater in the WTC-exposed group relative to the comparison group [prevalence ratios (95% confidence intervals) = 1.96 (1.2-3.3) and 3.28 (2.7-3.9) for odor and irritation thresholds, respectively]. Among the WTC responders, however, individuals caught in the dust cloud from the collapse on 9/11 exhibited the most profound trigeminal loss. Analysis of the nasal lavage samples supported the clinical findings of chronic nasal inflammation among the WTC-exposed cohort.

CONCLUSIONS: The prevalence of significant chemosensory impairment in the WTC-exposed group more than 2 years after their exposure raises concerns for these individuals when the ability to detect airborne odors or irritants is a critical safety factor.

RELEVANCE TO CLINICAL PRACTICE: This outcome highlights the need for chemosen-

sory evaluations among individuals with exposure to acute high or chronic levels of airborne pollutants.

de la Hoz RE. 2010. Occupational asthma and lower airway disease among World Trade Center workers and volunteers. Current Allergy and Asthma Reports. 10 (4):287–294.

HTTPS://DOI.ORG/10.1007/S11882-010-0120-4

The World Trade Center (WTC) disaster and its recovery work involved a range of hazardous occupational exposures that have not been fully characterized but can be reasonably assumed to have the potential to cause mucosal inflammation in the upper and lower airways. A high prevalence of lower airway disease (LAD) symptoms was reported by several early surveys. Clinical studies further categorized the diagnoses as irritant-induced asthma (of subacute onset), nonspecific chronic bronchitis, chronic bronchiolitis, or aggravated preexistent obstructive pulmonary disease in a substantial proportion of patients. Risk factors for WTC-related LAD included early (on September 11 or 12, 2001) arrival at the WTC site and work at the pile of the collapsed towers. Cigarette smoking (but not atopy) also seemed to be a risk factor for LAD. No data thus far suggest an increased incidence of neoplastic or interstitial lung disease, but ongoing surveillance is clearly necessary.

de la Hoz RE, Aurora RN, Landsbergis P, et al. 2010. Snoring and obstructive sleep apnea among former World Trade Center rescue workers and volunteers. J Occup Environ Med. 52 (1):29–32.

HTTPS://DOI.ORG/10.1097/JOM.0B013E3181C2BB18

BACKGROUND: Snoring is a common symptom among workers with adverse health effects from their World Trade Center (WTC) occupational exposures. Rhinitis and upper airway disease are highly prevalent among these workers. Rhinitis has been associated with snoring and, in some studies, with obstructive sleep apnea (OSA). We examined the association of WTC exposure and findings on nocturnal polysomnogram, as well as known predictors of OSA in this patient population.

METHODS: One hundred participants with snoring underwent a polysomnogram to exclude OSA. Comorbidities had been previously evaluated and treated. The apnea-hypopnea index (AHI) defined and categorized the severity of OSA. Age, sex, body mass index (BMI), and WTC exposure variables were examined in bivariate and multiple regression analyses.

RESULTS: Our study sample had a similar prevalence of five major disease categories, as we previously reported. OSA was diagnosed in 62% of the patients and was not associated with any of those disease categories. A trend toward increasing AHI with increasing WTC exposure duration failed to reach the statistical significance ($P = 0.14$) in multiple regression analysis. An elevated AHI was associated with BMI ($P = 0.003$) and male sex ($P < 0.001$).

CONCLUSIONS: OSA was associated with BMI and male sex but not with occupational WTC exposure indicators in this patient population.

de la Hoz RE, Shohet MR, and Cohen JM. 2010. Occupational rhinosinusitis and upper airway disease:

The World Trade Center experience. Curr Allergy Asthma Rep. 10 (2):77–83.

HTTPS://DOI.ORG/10.1007/S11882-010-0088-0

The World Trade Center disaster and its recovery work involved a range of hazardous occupational exposures that have not been fully characterized but that can be reasonably assumed to have the potential to cause mucosal inflammation, preferentially (but not exclusively) in the upper airway. A high prevalence of rhinosinusitis and upper airway disease (UAD) symptoms was reported by several early surveys. Clinical studies demonstrated objective, clinically significant, and persistent chronic perennial rhinosinusitis and UAD-with or without seasonal exacerbation-in a large proportion of patients. Demonstration of an association between UAD and available exposure indicators has been limited. Atopy seemed to be associated with increased UAD symptom severity and to be a risk factor for upper, but not lower, airway disease. World Trade Center-related UAD is considered an irritant-induced disease but not, in many cases, of acute onset. No data thus far suggest an increased upper airway cancer incidence.

Enright PL, Skloot GS, Cox-Ganser JM, et al. 2010. Quality of spirometry performed by 13,599 participants in the World Trade Center worker and volunteer medical screening program. Respir Care. 55 (3):303–309.

OBJECTIVE: To determine the ability of spirometry technicians in the World Trade Center Worker and Volunteer Medical Screening Program to meet American Thoracic Society spirometry quality goals.

METHODS: Spirometry technicians were trained centrally and performed spirometry sessions at 6 sites in the greater New York City area. We reviewed and graded the spirometry results for quality every month.

RESULTS: About 80% (range 70-88%) of the spirometry sessions met the American Thoracic Society spirometry goals. In general, the spirometry technicians with the most experience were more successful in meeting the quality goals. Participant characteristics explained very little of the quality variability.

CONCLUSIONS: The overall spirometry quality in this multicenter program was very good. Efforts to improve spirometry quality should focus on the performance of individual spirometry technicians.

Skloot GS, Edwards NT, and Enright PL. 2010. Four-year calibration stability of the easyone portable spirometer. Respiratory Care. 55 (7):873–877.

BACKGROUND: Clinical practice guidelines recommend daily spirometer calibration checks and weekly linearity checks. The long-term stability of the volume and flow accuracy of a specific model of spirometer should be carefully characterized before modification of the frequency of calibration checks is considered for that model of spirometer.

METHODS: The EasyOne ultrasonic flow-sensing spirometer was chosen for use by the clinical centers at the 2002 inception of the World Trade Center Worker and Volunteer Medical Screening Program. The screening program quality-control procedure required that the expiratory and inspiratory volume accuracy of

each spirometer be checked every day of testing, and the flow accuracy (linearity) checked every week. The calibration check results were transferred to a central database for summary.

RESULTS: Over 5,000 calibration-check results (4,109 single-speed and 1,189 three-speed) were accumulated from a total of 34 spirometers during the period February 2003 through March 2007. The mean single-speed calibration errors (and 5th-95th percentiles) were -2 mL (-80 to 70 mL) for exhalation and -10 mL (-80 to 60 mL) for inhalation. 98% of the exhalation and 97% of the inhalation calibration checks were accurate within 3.0%. There was no evidence of significant non-linearity according to the results of the 3-speed calibration checks (mean errors of -3, -5, and -6 mL at each speed).

CONCLUSIONS: The EasyOne retained inhalation and exhalation volume accuracy of better than 3% for at least 4 years. Routine multiple-speed volume calibration checks may not be necessary with the EasyOne. The acceptability and repeatability of patient efforts should be the primary focus of quality-assurance programs with spirometers that have been demonstrated to remain accurate for long periods. 2010 Daedalus Enterprises.

Wallenstein S, Bodian C, and Herbert R. 2010. A capture-recapture problem when information is obtained from two qualitatively different sources. Communications in Statistics - Theory and Methods. 39 (15):2688–2700.

A potential application of these methods is to the follow-up of World Trade Center responders. Responders are disease-free when they arrive at the clean-up site and are asked to report for a visit after a fixed period of time, but some fail to do so. Some responders, whether they come to the scheduled return visit or not, spontaneously report a disease before the scheduled visit, but absence of disease is never reported in this manner. We use the methods developed to estimate the total number of subjects with disease by the time of the scheduled return visit.

Wu M, Gordon RE, Herbert R, et al. 2010. Case report: Lung disease in World Trade Center responders exposed to dust and smoke: Carbon nanotubes found in the lungs of World Trade Center patients and dust samples. Environ Health Perspect. 118 (4):499–504.

HTTPS://DOI.ORG/10.1289/EHP.0901159

CONTEXT: After the collapse of the World Trade Center (WTC) on 11 September 2001, a dense cloud of dust containing high levels of airborne pollutants covered Manhattan and parts of Brooklyn, New York. Between 60,000 and 70,000 responders were exposed. Many reported adverse health effects. CASE

PRESENTATION: In this report we describe clinical, pathologic, and mineralogic findings in seven previously healthy responders who were exposed to WTC dust on either 11 September or 12 September 2001, who developed severe respiratory impairment or unexplained radiologic findings and underwent video-assisted thoracoscopic surgical lung biopsy procedures at Mount Sinai Medical Center. WTC dust samples were also examined. We found that three of the seven responders had severe or moderate restrictive disease clin-

ically. Histopathology showed interstitial lung disease consistent with small airways disease, bronchiolocentric parenchymal disease, and nonnecrotizing granulomatous condition. Tissue mineralogic analyses showed variable amounts of sheets of aluminum and magnesium silicates, chrysotile asbestos, calcium phosphate, and calcium sulfate. Small shards of glass containing mostly silica and magnesium were also found. Carbon nanotubes (CNT) of various sizes and lengths were noted. CNT were also identified in four of seven WTC dust samples.

DISCUSSION: These findings confirm the previously reported association between WTC dust exposure and bronchiolar and interstitial lung disease. Long-term monitoring of responders will be needed to elucidate the full extent of this problem. The finding of CNT in both WTC dust and lung tissues is unexpected and requires further study.Year Published 2011 (8)

Altman KW, Desai SC, Moline J, et al. 2011. Odor identification ability and self-reported upper respiratory symptoms in workers at the post-9/11 World Trade Center site. Int Arch Occup Environ Health. 84 (2):131–137.

HTTPS://DOI.ORG/10.1007/S00420-010-0556-9

Following the World Trade Center (WTC) collapse on September 11, 2001, more than 40,000 people were exposed to a complex mixture of inhalable nanoparticles and toxic chemicals. While many developed chronic respiratory symptoms, to what degree olfaction was compromised is unclear. A previous WTC Medical Monitoring and Treatment Program study found that olfactory and nasal trigeminal thresholds were altered by the toxic exposure, but not scores on a 20-odor smell identification test.

OBJECTIVES: To employ a well-validated 40-item smell identification test to definitively establish whether the ability to identify odors is compromised in a cohort of WTC-exposed individuals and, if so, whether the degree of compromise is associated with self-reported severity of rhinitic symptoms.

METHODS: The University of Pennsylvania Smell Identification Test (UPSIT) was administered to 99 WTC-exposed persons and 99 matched normal controls. The Sino-Nasal Outcomes Test (SNOT-20) was administered to the 99 WTC-exposed persons and compared to the UPSIT scores.

RESULTS: The mean (SD) UPSIT scores were lower in the WTC-exposed group than in age-, sex-, and smoking history-matched controls [respective scores: 30.05 (5.08) vs 35.94 (3.76); $p = 0.003$], an effect present in a subgroup of 19 subjects additionally matched on occupation ($p < 0.001$). Fifteen percent of the exposed subjects had severe microsmia, but only 3% anosmia. SNOT-20 scores were unrelated to UPSIT scores ($r = 0.20$; $p = 0.11$).

CONCLUSION: Exposure to WTC air pollution was associated with a decrement in the ability to identify odors, implying that such exposure had a greater influence on smell function than previously realized.

Crowley LE, Herbert R, Moline JM, et al. 2011. Sarcoid like granulomatous pulmonary disease in World Trade Center disaster responders. Am J Ind Med. 54 (3):175–184.

HTTPS://DOI.ORG/10.1002/AJIM.20924

BACKGROUND: More than 20,000 responders have been examined through the World Trade Center (WTC) Medical Monitoring and Treatment Program since September 11, 2001. Studies on WTC firefighters have shown elevated rates of sarcoidosis. The main objective of this study was to report the incidence of "sarcoid like" granulomatous pulmonary disease in other WTC responders.

METHODS: Cases of sarcoid like granulomatous pulmonary disease were identified by: patient self-report, physician report and ICD-9 codes. Each case was evaluated by three pulmonologists using the ACCESS criteria and only "definite" cases are reported.

RESULTS: Thirty-eight patients were classified as "definite" cases. Six-year incidence was 192/100,000. The peak annual incidence of 54 per 100,000 person-years occurred between 9/11/2003 and 9/11/2004. Incidence in black responders was nearly double that of white responders. Low FVC was the most common spirometric abnormality.

CONCLUSIONS: Sarcoid like granulomatous pulmonary disease is present among the WTC responders. While the incidence is lower than that reported among firefighters, it is higher than expected.

Crowley LE, Herbert R, Moline JM, et al. 2011. Response to dr. Reich's letter: "'Sarcoid-like' granulomatous pulmonary disease in World Trade Center disaster responders: Influence of incidence computation methodology in inferring airborne dust causation" "Sarcoid-like" granulomatous pulmonary disease. Am J Ind Med. 54 (11):894–895.

HTTPS://DOI.ORG/10.1002/AJIM.20995

NO ABSTRACT AVAILABLE

de la Hoz RE. 2011. Occupational lower airway disease in relation to World Trade Center inhalation exposure. Curr Opin Allergy Clin Immunol. 11 (2):97–102.

HTTPS://DOI.ORG/10.1097/ACI.0B013E3283449063

PURPOSE OF REVIEW: To summarize the knowledge about the occupational lower airway diseases that seem related to exposures at the World Trade Center disaster site.

RECENT FINDINGS: Those diseases have been characterized as irritant-induced asthma, chronic nonspecific bronchitis, chronic bronchiolitis/small airway disease, and aggravated preexistent chronic obstructive lung disease (most frequently chronic obstructive pulmonary disease, but also asthma), with the expected overlapping features among them. One remarkable characteristic of the irritant-induced asthma observed among these workers was the slow onset of symptoms and long delay in clinical diagnoses.

SUMMARY: Longitudinal studies suggest that both the incidence and the associated functional decline of these predominantly obstructive lung diseases stabilized several years ago, but longer follow-up is clearly necessary.

Perritt KR, Herbert R, Levin SM, et al. 2011. Work-related injuries and illnesses reported by World Trade Center response workers and volunteers. Prehosp Disaster Med. 26 (6):401–407.

HTTPS://DOI.ORG/10.1017/S1049023X12000143

INTRODUCTION: In 2002, the Mount Sinai Center for Occupational and Environmental Medicine, with support from the National Institute for Occupational Safety and Health (NIOSH), began coordinating the World Trade Center (WTC) Worker and Volunteer Medical Screening Program (MSP) to monitor the health of qualified WTC responders. Enrolled participants were offered a clinical examination; interviewed to collect medical, mental health, and exposure information; and requested to complete a self-administered medical questionnaire. The objective of this study was to better understand work-related injuries and illnesses sustained on-site by WTC responders.

METHODS: A descriptive analysis of select data from the MSP self-administered medical questionnaire was conducted. Data collected July 2002 through April 2004 from MSP participants enrolled at the Mount Sinai clinic were reviewed using univariate statistical techniques.

RESULTS: Records from 7,810 participants were analyzed, with most participants associated with either the construction industry (n = 2,623, 34%) or law enforcement (n = 2,036, 26%). Approximately a third of the participants (n = 2,486, 32%) reported at least one injury or illness requiring medical treatment that was sustained during WTC work/volunteer activities. Of the total 4,768 injuries/illnesses reported by these participants, respiratory complaints were most common (n = 1,350, 28%), followed by traumatic injuries excluding eye injuries (n = 961, 20%), eye injuries/ailments (n = 709, 15%), chest pain (n = 375, 8%), headaches (n = 359, 8%), skin conditions (n = 178, 4%), and digestive system conditions (n = 163, 3%). Participants reported that 36% of injuries/illnesses were treated off-site and 29% were treated on-site, with the remaining not specifying treatment location. Off-site treatment was prevalent for respiratory complaints, psychological stress, and chest pain. On-site treatment was predominate for eye injuries/ailments and traumatic injuries excluding eye injuries.

CONCLUSION: Study results underscore the need for rapid deployment of personal protective equipment for disaster responders and medical care stations mobilized near disaster worksites. Additionally, the results, many of which are comparable to findings from previous WTC studies where data were collected in real-time, indicate that a screening program such as the MSP may be effective in retrospectively providing general information on disaster responder demographics and work-related injuries and illnesses.

Udasin I, Schechter C, Crowley L, et al. 2011. Respiratory symptoms were associated with lower spirometry results during the first examination of WTC responders. J Occup Environ Med. 53 (1):49–54.

HTTPS://DOI.ORG/10.1097/JOM.0B013E3182028E5C

OBJECTIVE: Determine if World Trade Center (WTC) disaster responders had lower lung function and higher bronchodilator responsiveness than those with respiratory symptoms and conditions.

METHODS: We evaluated cardinal respiratory symptoms (dyspnea, wheezing, dry cough, productive cough) and determined

the difference in FEV1, FVC, and bronchodilator responsiveness.

RESULTS: All respiratory symptoms were associated with a lower FEV1 and FVC, and a larger bronchodilator response. Responders reporting chronic productive cough, starting during WTC work and persisting, had a mean FEV1 109 mL lower than those without chronic persistent cough; their odds of having abnormally low FEV1 was 1.40 times higher; and they were 1.65 times as likely to demonstrate bronchodilator responsiveness.

CONCLUSIONS: Responders reporting chronic persistent cough, wheezing or dyspnea at first medical examination were more likely to have lower lung function and bronchodilator responsiveness.

Wisnivesky JP, Teitelbaum SL, Todd AC, et al. 2011. Persistence of multiple illnesses in World Trade Center rescue and recovery workers: A cohort study. Lancet. 378 (9794):888–897.

HTTPS://DOI.ORG/10.1016/S0140-6736(11)61180-X

BACKGROUND: More than 50,000 people participated in the rescue and recovery work that followed the Sept 11, 2001 (9/11) attacks on the World Trade Center (WTC). Multiple health problems in these workers were reported in the early years after the disaster. We report incidence and prevalence rates of physical and mental health disorders during the 9 years since the attacks, examine their associations with occupational exposures, and quantify physical and mental health comorbidities.

METHODS: In this longitudinal study of a large cohort of WTC rescue and recovery workers, we gathered data from 27,449 participants in the WTC Screening, Monitoring, and Treatment Program. The study population included police officers, firefighters, construction workers, and municipal workers. We used the Kaplan-Meier procedure to estimate cumulative and annual incidence of physical disorders (asthma, sinusitis, and gastro-oesophageal reflux disease), mental health disorders (depression, post-traumatic stress disorder [PTSD], and panic disorder), and spirometric abnormalities. Incidence rates were assessed also by level of exposure (days worked at the WTC site and exposure to the dust cloud).

FINDINGS: 9-year cumulative incidence of asthma was 27.6% (number at risk: 7027), sinusitis 42.3% (5870), and gastro-oesophageal reflux disease 39.3% (5650). In police officers, cumulative incidence of depression was 7.0% (number at risk: 3648), PTSD 9.3% (3761), and panic disorder 8.4% (3780). In other rescue and recovery workers, cumulative incidence of depression was 27.5% (number at risk: 4200), PTSD 31.9% (4342), and panic disorder 21.2% (4953). 9-year cumulative incidence for spirometric abnormalities was 41.8% (number at risk: 5769); three-quarters of these abnormalities were low forced vital capacity. Incidence of most disorders was highest in workers with greatest WTC exposure. Extensive comorbidity was reported within and between physical and mental health disorders.

INTERPRETATION: 9 years after the 9/11 WTC attacks, rescue and recovery workers continue to have a substantial burden of physical and mental health problems. These findings emphasise the need for

continued monitoring and treatment of the WTC rescue and recovery population.

FUNDING: Centers for Disease Control and Prevention and National Institute for Occupational Safety and Health.

Woskie SR, Kim H, Freund A, et al. 2011. World Trade Center disaster: Assessment of responder occupations, work locations, and job tasks. Am J Ind Med. 54 (9):681–695.

HTTPS://DOI.ORG/10.1002/AJIM.20997

BACKGROUND: To date there have been no comprehensive reports of the work performedby 9/11 World Trade Center responders.

METHODS: 18,969 responders enrolled in the WTC Medical Monitoring and Treatment Program were used to describe workers' pre-9/11 occupations, WTC work activities and locations from September 11, 2001 to June 2002.

RESULTS: The most common pre-9/11 occupation was protective services (47%); other common occupations included construction, telecommunications, transportation, and support services workers. 14% served as volunteers. Almost one-half began work on 9/11 and >80% reported working on or adjacent to the ''pile" at Ground Zero. Initially,the most common activity was search and rescue but subsequently, the activities of most responders related to their pre-9/11 occupations. Other major activities included security; personnel support; buildings and grounds cleaning; and telecommunications repair.

CONCLUSIONS: The spatial, temporal, occupational, and task-related taxonomy reported here will aid the development of a job-exposure matrix, assist in assessment of disease risk, and improve planning and training for responders in future urban disasters.Year Published

Year Published 2012 (6)

de la Hoz RE, Mallea JM, Kramer SJ, et al. 2012. Polysomnographic diagnoses among former World Trade Center rescue workers and volunteers. Arch Environ Occup Health. 67 (4):239–242.

HTTPS://DOI.ORG/10.1080/19338244.2012.725230

An increased risk for obstructive sleep apnea ***(OSA)*** has been suggested for World Trade Center (WTC)-exposed workers. The authors reviewed the results from nocturnal polysomnograms ***(PSGs)***, to investigate diagnostic differences between WTC-exposed and -unexposed subjects. Six hundred fifty-six nocturnal PSGs performed at our sleep center were reviewed, ***272*** of them in former WTC workers. Seven diagnostic categories were compared between the 2 groups by bivariate and logistic regression analyses. The WTC group had a significantly higher predominance of the male gender, but slightly lower body mass index (BMI). There was no significant difference in the distribution of PSG diagnoses between the 2 groups in unadjusted ***(p = .56)*** or adjusted ***(p = .49)*** analyses. The authors did not identify a significant difference in PSG diagnoses between the WTC-exposed and -unexposed subjects.

OSA was significantly associated with age, BMI, and gender in this patient population.

Katz CL, Jutras-Aswad D, Kiliman M, et al. 2012. Alcohol use in polish 9/11 responders: Implications for cross-cultural treatment. J Psychiatr Pract. 18 (1):55–63.

HTTPS://DOI.ORG/10.1097/01.PRA.0000410989.46346.14

More than 35,000 individuals are estimated to have responded to the World Trade Center (WTC) site following the terrorist attacks of September 11, 2001. The federally funded WTC Medical Monitoring and Treatment Program (WTCMMTP) provides medical monitoring and occupational medicine treatment as well as counseling regarding entitlements and benefits to the workers and volunteers who participated in the WTC response. A major component of the WTCMMTP is the WTC Mental Health Program (WTCMHP), which offers annual mental health assessments and ongoing treatment for those found to have 9/11 associated mental health problems. In the program's 9.5 years of evaluating and treating mental health problems in thousands of Ground Zero responders, diversity in multiple domains (e.g., gender, family, profession and employment status, state of physical health, cultural identity, and immigration status) has been a hallmark of the population served by the program. To illustrate the types of issues that arise in treating this diverse patient population, the authors first present a representative case involving a Polish asbestos worker with an alcohol use disorder. They then discuss how accepted alcohol treatment modalities can and often must be modified in providing psychiatric treatment to Polish responders, in particular, and to foreign-born patients in general. Treatment modalities discussed include cognitive and behavioral therapy, relapse prevention strategies, psychodynamic therapy, motivational approaches, family therapy, group peer support, and pharmacotherapy. Implications for the practice of addiction psychiatry, cultural psychiatry, and disaster psychiatry are discussed.

Kim H, Herbert R, Landrigan P, et al. 2012. Increased rates of asthma among World Trade Center disaster responders. Am J Ind Med. 55 (1):44–53.

HTTPS://DOI.ORG/10.1002/AJIM.21025

BACKGROUND: Studies have documented high rates of asthma symptoms among responders to the World Trade Center (WTC) disaster. However, whether there are increased rates of asthma among responders compared to the general population is unknown.

METHODS: The study population consisted of a prospective cohort of 20,834 responders participating in the WTC Medical Monitoring and Treatment Program between July 2002 and December 2007. We calculated prevalence and standardized morbidity ratios (SMRs) of lifetime asthma and 12-month asthma (defined as >/=1 attacks in the prior 12 months) among WTC responders. The comparison population consisted of >200,000 adults who completed the National Health Interview Survey in 2000 (for pre-9/11 comparisons) and between 2002 and 2007 (for post-9/11 comparisons).

RESULTS: WTC responders were on average 43 +/- 9 years old, 86% male, 59% white, and 42% had an occupation in protective

services. The lifetime prevalence of asthma in the general population was relatively constant at about 10% from 2000 to 2007. However, among WTC responders, lifetime prevalence increased from 3% in 2000, to 13% in 2002, and 19% in 2007. The age-adjusted overall SMR for lifetime asthma among WTC responders was 1.8 ***(95% CI: 1.8-1.9)*** for men and 2.0 ***(95% CI: 1.9-2.1)*** for women. Twelve-month asthma was also more frequent among WTC responders compared to the general population ***(SMR 2.4, 95% CI: 2.2-2.5)*** for men and 2.2 ***(95% CI: 2.0-2.5)*** for women.

CONCLUSIONS: WTC responders are at an increased risk of asthma as measured by lifetime prevalence or active disease.

Lucchini RG, Crane MA, Crowley L, et al. 2012. The World Trade Center health surveillance program: Results of the first 10 years and implications for prevention. G Ital Med Lav Ergon. 34 (0):529–533.

BACKGROUND: The terrorist attacks on the World Trade Center (WTC) of September 11, 2001 resulted in the deaths of 2,823 persons. They also generated a long-lasting burden of multiple physical and mental health illnesses among the cohort of 50,000 rescue workers who responded to the attacks and in the 400,000 residents and workers in nearby areas of New York City. A comprehensive health surveillance program was developed from the first months after the accidents and was further developed in the subsequent ears. Individual exposure and health data were stored in ad hoc databases and produced epidemiological outcomes on the various exposure-related illnesses.

METHODS: About 10 years of longitudinal assessment of this large cohort of WTC rescue and recovery workers, yielded data from participants in the WTC Screening, Monitoring, and Treatment Program. Police officers, firefighters, construction workers, and municipal workers were included in the cohort. Cumulative and annual incidence were estimated for various physical disorders including asthma, sinusitis, and gastroesophageal reflux disease, mental health disorders including depression, post-traumatic stress disorder [PTSD], and panic disorder. Respiratory functionality was also assessed. Exposure was characterized with qualitative parameter including working on the pile and being engulfed in the dust cloud, and quantitative parameters including the time of arrival on site and the exposure duration.

RESULTS: Upper and lower respiratory conditions such as rhinosinusitis and asthma have been found in a significant number of people in WTC-exposed populations. A lack of appropriate respiratory protection may have contributed to these effects. Other commonly observed physical health conditions include gastro-esophageal reflux disease, obstructive sleep apnea and musculo-skeletal injuries. Many WTC-exposed individuals also suffer from mental health conditions, primarily post-traumatic stress disorder, depression, panic disorder, and substantial stress reaction. Recent studies suggest that WTC exposure may increase the risk of cancer and of mortality from cardiac disease.

CONCLUSION: Ten years of systematic health surveillance after the 9/11 WTC attacks, show long lasting burden of physical and mental health problems. Continued mon-

itoring and treatment of this population is needed for early diagnoses of initial clinical conditions that can be treated more effectively. The experience of September 11 offers also indications on how to approach the acute and delayed health effects of civilian catastrophes. Critical lessons are derived about the importance of having trained responders--medical and non-medical--in place in advance of disasters, and about the need to proceed with adequate exposure assessment in a timely manner.

Luft BJ, Schechter C, Kotov R, et al. 2012. Exposure, probable PTSD and lower respiratory illness among World Trade Center rescue, recovery and clean-up workers. Psychol Med. 42 (5):1069–1079.

HTTPS://DOI.ORG/10.1017/S003329171100256X

BACKGROUND: Thousands of rescue and recovery workers descended on the World Trade Center (WTC) in the wake of the terrorist attack of September 11, 2001 (9/11). Recent studies show that respiratory illness and post-traumatic stress disorder (PTSD) are the hallmark health problems, but relationships between them are poorly understood. The current study examined this link and evaluated contributions of WTC exposures.

METHOD: Participants were 8508 police and 12 333 non-traditional responders examined at the WTC Medical Monitoring and Treatment Program (WTC-MMTP), a clinic network in the New York area established by the National Institute for Occupational Safety and Health (NIOSH). We used structural equation modeling (SEM) to explore patterns of association among exposures, other risk factors, probable WTC-related PTSD [based on the PTSD Checklist (PCL)], physician-assessed respiratory symptoms arising after 9/11 and present at examination, and abnormal pulmonary functioning defined by low forced vital capacity (FVC).

RESULTS: Fewer police than non-traditional responders had probable PTSD (5.9% v. 23.0%) and respiratory symptoms (22.5% v. 28.4%), whereas pulmonary function was similar. PTSD and respiratory symptoms were moderately correlated (r=0.28 for police and 0.27 for non-traditional responders). Exposure was more strongly associated with respiratory symptoms than with PTSD or lung function. The SEM model that best fit the data in both groups suggested that PTSD statistically mediated the association of exposure with respiratory symptoms.

CONCLUSIONS: Although longitudinal data are needed to confirm the mediation hypothesis, the link between PTSD and respiratory symptoms is noteworthy and calls for further investigation. The findings also support the value of integrated medical and psychiatric treatment for disaster responders.

Pietrzak RH, Schechter CB, Bromet EJ, et al. 2012. The burden of full and subsyndromal posttraumatic stress disorder among police involved in the World Trade Center rescue and recovery effort. J Psychiatr Res. 46 (7):835–842.

HTTPS://DOI.ORG/10.1016/J.JPSYCHIRES.2012.03.011

BACKGROUND: This study examined the prevalence, correlates, and perceived mental healthcare needs associated with

subsyndromal PTSD in police involved in the World Trade Center (WTC) rescue and recovery effort.

METHODS: A total of 8466 police completed an interview/survey as part of the WTC Medical monitoring and Treatment Program an average of four years after 9/11/2001.

RESULTS: The past month prevalence of full and subsyndromal WTC-related PTSD was 5.4% and 15.4%, respectively. Loss of someone or knowing someone injured on 9/11 (odds ratios [ORs]=1.56-1.86), pre-9/11 stressors (ORs=1.30-1.50), family support (ORs=0.83-0.94), and union membership (ORs=0.50-0.52) were associated with both full and subsyndromal PTSD. Exposure to the dust cloud (OR=1.36), performing search and rescue work (OR=1.29), and work support (OR=0.89) were additionally associated with subsyndromal PTSD. Rates of comorbid depression, panic disorder, and alcohol use problems (ORs=3.82-41.74), and somatic symptoms and functional difficulties (ORs=1.30-1.95) were highest among police with full PTSD, with intermediate rates among police with subsyndromal PTSD (ORs=2.93-7.02; and ORs=1.18-1.60, respectively). Police with full and subsyndromal PTSD were significantly more likely than controls to report needing mental healthcare (41.1% and 19.8%, respectively, versus 6.8% in trauma controls).

CONCLUSIONS: These results underscore the importance of a more inclusive and dimensional conceptualization of PTSD, particularly in professions such as police, as operational definitions and conventional screening cut-points may underestimate the psychological burden for this population. Accordingly, psychiatric clinicians should assess for disaster-related subsyndromal PTSD symptoms in disaster response personnel.

Year Published 2013 (3)

Crane MA, Milek DJ, Globina Y, et al. 2013. Health effects of the World Trade Center 9/11 disaster: An overview. Fire Technology. 49 (3):813–825.

HTTPS://DOI.ORG/10.1007/S10694-012-0284-7

More than ten years after the September 11, 2001 World Trade Center (WTC) disaster, 9/11 responders and lower Manhattan community residents still suffer from the adverse health consequences of this horrific event. Upper and lower respiratory conditions such as rhinosinusitis and asthma have been found in a significant number of people in WTC-exposed populations. A lack of appropriate respiratory protection may have contributed to these effects. Other commonly observed physical health conditions include gastro-esophageal reflux disease, obstructive sleep apnea and musculoskeletal injuries. Many WTC-exposed individuals also suffer from mental health conditions, primarily post-traumatic stress disorder, depression, panic disorder, and substantial stress reaction. Recent studies suggest that WTC exposure may increase the risk of cancer and of mortality from cardiac disease.

Further research should be conducted to fully understand the impact of the WTC disaster on the health of these populations.

Ruggero CJ, Kotov R, Callahan JL, et al. 2013. PTSD symptom dimensions and their relationship to functioning in World Trade Center responders. Psychiatry Res. 210 (3):1049–1055.

HTTPS://DOI.ORG/10.1016/J.PSYCHRES.2013.08.052

Post-traumatic stress disorder (PTSD) symptoms are common among responders to the 9/11 attacks on the World Trade Center and can lead to impairment, yet it is unclear which symptom dimensions are responsible for poorer functioning. Moreover, how best to classify PTSD symptoms remains a topic of controversy. The present study tested competing models of PTSD dimensions and then assessed which were most strongly associated with social/occupational impairment, depression, and alcohol abuse. World Trade Center responders (n=954) enrolled in the Long Island site of the World Trade Center Health Program between 2005 and 2006 were administered standard self-report measures. Confirmatory factor analysis confirmed the superiority of four-factor models of PTSD over the DSM-IV three-factor model. In selecting between four-factor models, evidence was mixed, but some support emerged for a broad dysphoria dimension mapping closely onto depression and contributing strongly to functional impairment. This study confirmed in a new population the need to revise PTSD symptom classification to reflect four dimensions, but raises questions about how symptoms are categorized. Results suggest that targeted treatment of symptoms may provide the most benefit, and that treatment of dysphoria-related symptoms in disaster relief workers may have the most benefit for social and occupational functioning.

Solan S, Wallenstein S, Shapiro M, et al. 2013. Cancer incidence in World Trade Center rescue and recovery workers, 2001-2008. Environ Health Perspect. 121 (6):699–704.

HTTPS://DOI.ORG/10.1289/EHP.1205894

BACKGROUND: World Trade Center (WTC) rescue and recovery workers were exposed to a complex mix of pollutants and carcinogens.

OBJECTIVE: The purpose of this investigation was to evaluate cancer incidence in responders during the first 7 years after 11 September 2001.

METHODS: Cancers among 20,984 consented participants in the WTC Health Program were identified through linkage to state tumor registries in New York, New Jersey, Connecticut, and Pennsylvania. Standardized incidence ratios (SIRs) were calculated to compare cancers diagnosed in responders to predicted numbers for the general population. Multivariate regression models were used to estimate associations with degree of exposure.

RESULTS: A total of 575 cancers were diagnosed in 552 individuals. Increases above registry-based expectations were noted for all cancer sites combined (SIR = 1.15; 95% CI: 1.06, 1.25), thyroid cancer (SIR = 2.39; 95% CI: 1.70, 3.27), prostate cancer (SIR = 1.21; 95% CI: 1.01, 1.44), combined hematopoietic and lymphoid cancers (SIR = 1.36; 95% CI: 1.07, 1.71), and soft

tissue cancers (SIR = 2.26; 95% CI: 1.13, 4.05). When restricted to 302 cancers diagnosed >/= 6 months after enrollment, the SIR for all cancers decreased to 1.06 (95% CI: 0.94, 1.18), but thyroid and prostate cancer diagnoses remained greater than expected. All cancers combined were increased in very highly exposed responders and among those exposed to significant amounts of dust, compared with responders who reported lower levels of exposure.

CONCLUSION: Estimates should be interpreted with caution given the short follow-up and long latency period for most cancers, the intensive medical surveillance of this cohort, and the small numbers of cancers at specific sites. However, our findings highlight the need for continued follow-up and surveillance of WTC responders.

Year Published 2014 (6)

Crane MA, Cho HG, and Landrigan PJ. 2014. Implications of the World Trade Center Health Program (WTChp) for the public health response to the great east japan earthquake. Ind Health. 52 (1):5–12.

HTTPS://DOI.ORG/10.2486/INDHEALTH.2013-0205

The attacks on the World Trade Center (WTC) on September 11, 2001 resulted in a serious burden of physical and mental illness for the 50,000 rescue workers that responded to 9/11 as well as the 400,000 residents and workers in the surrounding areas of New York City. The Zadroga Act of 2010 established the WTC Health Program (WTCHP) to provide monitoring and treatment of WTC exposure-related conditions and health surveillance for the responder and survivor populations. Several reports have highlighted the applicability of insights gained from the WTCHP to the public health response to the Great East Japan Earthquake. Optimal exposure monitoring processes and attention to the welfare of vulnerable exposed subgroups are critical aspects of the response to both incidents. The ongoing mental health care concerns of 9/11 patients accentuate the need for accessible and appropriately skilled mental health care in Fukushima. Active efforts to demonstrate transparency and to promote community involvement in the public health response will be highly important in establishing successful long-term monitoring and treatment programs for the exposed populations in Fukushima.

Crane MA, Levy-Carrick NC, Crowley L, et al. 2014. The response to September 11: A disaster case study. Ann Glob Health. 80 (4):320–331.

HTTPS://DOI.ORG/10.1016/J.AOGH.2014.08.215

BACKGROUND: The response to 9/11 continues into its 14th year. The World Trade Center Health Program (WTCHP), a long-term monitoring and treatment program now funded by the Zadroga Act of 2010, includes >60,000 World Trade Center (WTC) disaster responders and community members ("survivors"). The aim of this review is to identify several elements that have had a critical impact on the evolution of the WTC response and, directly or indirectly, the health of

the WTC-exposed population. It further explores post-disaster monitoring efforts, recent scientific findings from the WTCHP, and some implications of this experience for ongoing and future environmental disaster response.

FINDINGS: Transparency and responsiveness, site safety and worker training, assessment of acute and chronic exposure, and development of clinical expertise are interconnected elements determining efficacy of disaster response.

CONCLUSION: Even in a relatively well-resourced environment, challenges regarding allocation of appropriate attention to vulnerable populations and integration of treatment response to significant medical and mental health comorbidities remain areas of ongoing programmatic development.

Freund A, Zuckerman N, Luo H, et al. 2014. Diesel and silica monitoring at two sites following hurricane sandy. J Occup Environ Hyg. 11 (9):D131–143.

HTTPS://DOI.ORG/10.1080/15459624.2014.904518

Following Hurricane Sandy, which hit New York City and New Jersey in October 2012, industrial hygienists from the Mount Sinai and Belleview/New York University occupational medicine clinics conducted monitoring for diesel exhaust and silica in lower Manhattan and Rockaway Peninsula. Average daytime elemental carbon levels at three stations in lower Manhattan on December 4, 2012, ranged from 9 to18 mug/m(3). Sub-micron particle counts at various times on the same day were over 200,000 particles per cubic centimeter on many streets in lower Manhattan. In Rockaway Peninsula on December 12, 2012, all average daytime elemental carbon levels were below a detection limit of approximately 7 mug/m(3). The average daytime crystalline silica dust concentration was below detection at two sites on Rockaway Peninsula, and was 0.015 mg/m(3) quartz where sand was being replaced on the beach. The daily average levels of elemental carbon and airborne particulates that we measured are in the range of levels that have been found to cause respiratory effects in sensitive subpopulations like asthmatic patients after 2 hr of exposure. Control of exposure to diesel exhaust must be considered following natural disasters where diesel-powered equipment is used in cleanup and recovery. Although peak silica exposures were not likely captured in this study, but were reported by a government agency to have exceeded recommended guidelines for at least one cleanup worker, we recommend further study of silica exposures when debris removal operations or traffic create visible levels of suspended dust from soil or sand.

Litcher-Kelly L, Lam Y, Broihier JA, et al. 2014. Longitudinal study of the impact of psychological distress symptoms on new-onset upper gastrointestinal symptoms in World Trade Center responders. Psychosom Med. 76 (9):686–693.

HTTPS://DOI.ORG/10.1097/PSY.0000000000000116

OBJECTIVES: Research on the health of workers involved in the cleanup after the attack on the World Trade Center (WTC) on September 11, 2001, has documented high rates of psychological distress and upper gastrointestinal (GI) symptoms. The current article examines the concurrent and longitudinal associations of

psychological distress with development of new-onset upper GI symptoms in a large sample of WTC responders.

METHODS: A cohort of 10,953 WTC responders monitored by the WTC Health Program participated in the study. Two occupational groups were examined, police and nontraditional responders. The cohort was free of upper GI symptoms or diagnoses at their first visit (3 years after September 11, 2001). Logistic regression was used to analyze the relationships between concurrent and preceding psychological distress symptoms of depression, generalized anxiety, panic, and probable posttraumatic stress disorder with the development of new-onset upper GI symptoms at 3-year follow-up (6 years after September 11, 2001).

RESULTS: Across both occupation groups, psychological distress symptoms at Visit 1 were significantly related to the development of GI symptoms by Visit 2 (odd ratios ranging from 1.9 to 5.4). The results for the concurrent relationships were similar. In addition, there were significant dose-response relationships between the number of co-occurring psychological distress symptoms at Visits 1 and 2, and increased new-onset upper GI symptoms at Visit 2.

CONCLUSIONS: In this large sample of WTC responders, psychological distress symptoms assessed at 3 years after 9/11 are related to reporting upper GI symptoms 6 years after 9/11.

Pietrzak RH, Feder A, Schechter CB, et al. 2014. Dimensional structure and course of post-traumatic stress symptomatology in World Trade Center responders. Psychol Med. 44 (10):2085–2098.

HTTPS://DOI.ORG/10.1017/S0033291713002924

BACKGROUND: Post-traumatic stress disorder (PTSD) in response to the World Trade Center (WTC) disaster of 11 September 2001 (9/11) is one of the most prevalent and persistent health conditions among both professional (e.g. police) and non-traditional (e.g. construction worker) WTC responders, even several years after 9/11. However, little is known about the dimensionality and natural course of WTC-related PTSD symptomatology in these populations.

METHOD: Data were analysed from 10 835 WTC responders, including 4035 police and 6800 non-traditional responders who were evaluated as part of the WTC Health Program, a clinic network in the New York area established by the National Institute for Occupational Safety and Health. Confirmatory factor analyses (CFAs) were used to evaluate structural models of PTSD symptom dimensionality; and autoregressive cross-lagged (ARCL) panel regressions were used to examine the prospective interrelationships among PTSD symptom clusters at 3, 6 and 8 years after 9/11.

RESULTS: CFAs suggested that five stable symptom clusters best represent PTSD symptom dimensionality in both police and non-traditional WTC responders. This five-factor model was also invariant over time with respect to factor loadings and structural parameters, thereby demonstrating its longitudinal stability. ARCL panel regression analyses revealed that hyperarousal symptoms had a prominent role in predicting other symptom clusters of PTSD, with anxious arousal symptoms primarily driving re-experiencing symp-

toms, and dysphoric arousal symptoms primarily driving emotional numbing symptoms over time.

CONCLUSIONS: Results of this study suggest that disaster-related PTSD symptomatology in WTC responders is best represented by five symptom dimensions. Anxious arousal symptoms, which are characterized by hypervigilance and exaggerated startle, may primarily drive re-experiencing symptoms, while dysphoric arousal symptoms, which are characterized by sleep disturbance, irritability/anger and concentration difficulties, may primarily drive emotional numbing symptoms over time. These results underscore the importance of assessment, monitoring and early intervention of hyperarousal symptoms in WTC and other disaster responders.

Pietrzak RH, Feder A, Singh R, et al. 2014. Trajectories of PTSD risk and resilience in World Trade Center responders: An 8-year prospective cohort study. Psychol Med. 44 (1):205–219.

HTTPS://DOI.ORG/10.1017/S0033291713000597

BACKGROUND: Longitudinal symptoms of post-traumatic stress disorder (PTSD) are often characterized by heterogeneous trajectories, which may have unique pre-, peri- and post-trauma risk and protective factors. To date, however, no study has evaluated the nature and determinants of predominant trajectories of PTSD symptoms in World Trade Center (WTC) responders.

METHOD: A total of 10835 WTC responders, including 4035 professional police responders and 6800 non-traditional responders (e.g. construction workers) who participated in the WTC Health Program (WTC-HP), were evaluated an average of 3, 6 and 8 years after the WTC attacks.

RESULTS: Among police responders, longitudinal PTSD symptoms were best characterized by four classes, with the majority (77.8%) in a resistant/resilient trajectory and the remainder exhibiting chronic (5.3%), recovering (8.4%) or delayed-onset (8.5%) symptom trajectories. Among non-traditional responders, a six-class solution was optimal, with fewer responders in a resistant/resilient trajectory (58.0%) and the remainder exhibiting recovering (12.3%), severe chronic (9.5%), subsyndromal increasing (7.3%), delayed-onset (6.7%) and moderate chronic (6.2%) trajectories. Prior psychiatric history, Hispanic ethnicity, severity of WTC exposure and WTC-related medical conditions were most strongly associated with symptomatic trajectories of PTSD symptoms in both groups of responders, whereas greater education and family and work support while working at the WTC site were protective against several of these trajectories.

CONCLUSIONS: Trajectories of PTSD symptoms in WTC responders are heterogeneous and associated uniquely with pre-, peri- and post-trauma risk and protective factors. Police responders were more likely than non-traditional responders to exhibit a resistant/resilient trajectory. These results underscore the importance of prevention, screening and treatment efforts that target high-risk disaster responders, particularly those with prior psychiatric history, high levels of trauma exposure and work-related medical morbidities.

Year Published 2015 (5)

Farris SG, Paulus DJ, Gonzalez A, et al. 2015. Anxiety sensitivity mediates the association between post-traumatic stress symptom severity and interoceptive threat-related smoking abstinence expectancies among World Trade Center disaster-exposed smokers. Addict Behav. 51:204–210.

HTTPS://DOI.ORG/10.1016/J.ADDBEH.2015.07.031

INTRODUCTION: Anxiety sensitivity (fear of internal anxiety-relevant bodily sensations) is an individual difference variable that is associated with the development and maintenance of posttraumatic stress disorder (PTSD) and is also involved in the maintenance/relapse of smoking. Abstinence expectancies are crucial to smoking maintenance, yet, past work has not explored how PTSD symptom severity and anxiety sensitivity contribute to them.

METHOD: Participants were 122 treatment-seeking daily smokers (36.1% female; Mage=49.2, SD=9.7; cigarettes per day: M=18.3, SD=15.2) who were exposed to the World Trade Center disaster on September 11, 2001 and responded to an advertisement for a clinical smoking cessation trial. The indirect effect of anxiety sensitivity was tested in terms of the effect of PTSD symptom severity on smoking abstinence expectancies (i.e., anxiety sensitivity as a statistical mediator).

RESULTS: PTSD symptom severity was positively associated with interoceptive threat-related smoking abstinence expectancies: expecting harmful consequences (beta=.33, p<.001) and somatic symptoms (beta=.26, p=.007). PTSD symptom severity was also significantly associated with anxiety sensitivity (beta=.27, p=.003). Anxiety sensitivity mediated the association between PTSD symptom severity and expectancies about the harmful consequences (beta=.09, CI95%=.02-.21; DeltaR(2)=.076) and somatic symptoms (beta=.11, CI95%=.02-.24; DeltaR(2)=.123) from smoking abstinence, with medium effect sizes (Kappa(2)=.08 and .10, respectively).

CONCLUSIONS: These data document the role of PTSD symptoms in threat-based expectancies about smoking abstinence and suggest anxiety sensitivity may underlie the associations between PTSD symptom severity and abstinence expectancies.

Kotov R, Bromet EJ, Schechter C, et al. 2015. Posttraumatic stress disorder and the risk of respiratory problems in World Trade Center responders: Longitudinal test of a pathway. Psychosom Med. 77 (4):438–448.

HTTPS://DOI.ORG/10.1097/PSY.0000000000000179

OBJECTIVE: Posttraumatic stress disorder (PTSD) is associated with high medical morbidity, but the nature of this association remains unclear. Among responders to the World Trade Center (WTC) disaster, PTSD is highly comorbid with lower respiratory symptoms (LRS), which cannot be explained by exposure alone. We sought to examine this association longitudinally to establish the direction of the effects and evaluate potential pathways to comorbidity.

METHODS: 18,896 responders (8466 police and 10,430 nontraditional responders) participating in the WTC-Health Program were first evaluated between 2002 and 2010 and assessed again 2.5 years later. LRS were ascertained by medical staff, abnormal pulmonary function by spirometry, and probable WTC-related PTSD with a symptom inventory.

RESULTS: In both groups of responders, initial PTSD (standardized regression coefficient: beta = 0.20 and 0.23) and abnormal pulmonary function (beta = 0.12 and 0.12) predicted LRS 2.5 years later after controlling for initial LRS and covariates. At follow-up, LRS onset was 2.0 times more likely and remission 1.8 times less likely in responders with initial PTSD than in responders without. Moreover, PTSD mediated, in part, the association between WTC exposures and development of LRS ($p < .0001$). Initial LRS and abnormal pulmonary function did not consistently predict PTSD onset.

CONCLUSIONS: These analyses provide further evidence that PTSD is a risk factor for respiratory symptoms and are consistent with evidence implicating physiological dysregulation associated with PTSD in the development of medical conditions. If these effects are verified experimentally, treatment of PTSD may prove helpful in managing physical and mental health of disaster responders.

Zvolensky MJ, Farris SG, Kotov R, et al. 2015. Posttraumatic stress symptoms and smoking among World Trade Center disaster responders: A longitudinal investigation. Comprehensive Psychiatry. 63:46–54.

HTTPS://DOI.ORG/10.1016/J.COMPPSYCH.2015.08.006

PURPOSE: The current longitudinal study examined posttraumatic stress disorder (PTSD) symptom severity in relation to smoking abstinence and reduction over time among responders to the World Trade Center (WTC) disaster.

METHOD: Participants were 763 police and 1881 non-traditional (e.g., construction workers) WTC responders who reported being smokers at an initial examination obtained between July 2002 and July 2011 at the WTC Health Program (WTC-HP). WTC responders were reassessed, on average, 2.5years later. Results: For police WTC responders, higher levels of WTC-related PTSD symptoms at the initial visit were associated with a decreased likelihood of smoking abstinence (OR = 0.98, p = .002) and with decreased smoking reduction (beta = -.06, p = .012) at the follow-up visit. WTC-related PTSD symptom severity was not related to likelihood of smoking abstinence or change in number of cigarettes smoked among non-traditional responders. Post hoc analyses suggested that for police, hyperarousal PTSD symptoms were predictive of decreased abstinence likelihood at the follow-up visit (OR = 0.56, p = .006).

DISCUSSION: The present findings suggest that PTSD symptoms may be differentially related to smoking behavior among police and non-traditional WTC responders in a naturalistic, longitudinal investigation. Future work may benefit from exploring further which aspects of PTSD (as compared to each other and to common variance) explain smoking maintenance.

Zvolensky MJ, Farris SG, Kotov R, et al. 2015. World Trade Center disaster and sensitization to subsequent life stress: A longitudinal study of disaster responders. Prev Med. 75:70–74.

HTTPS://DOI.ORG/10.1016/J.YPMED.2015.03.017

PURPOSE: The current study examined the role of World Trade Center (WTC) disaster exposure (hours spent working on the site, dust cloud exposure, and losing friend/loved one) in exacerbating the effects of post-disaster life stress on posttraumatic stress disorder (PTSD) symptoms and overall functioning among WTC responders.

METHOD: Participants were 18,896 responders (8466 police officers and 10,430 non-traditional responders) participating in the WTC Health Program who completed an initial examination between July, 2002 and April, 2010 and were reassessed an average of two years later.

RESULTS: Among police responders, there was a significant interaction, such that the effect of post-disaster life stress on later PTSD symptoms and overall functioning was stronger among police responders who had greater WTC disaster exposure (beta's=.029 and .054, respectively, for PTSD symptoms and overall functioning). This moderating effect was absent in non-traditional responders. Across both groups, post-disaster life stress also consistently was related to the dependent variables in a more robust manner than WTC exposure.

DISCUSSION: The present findings suggest that WTC exposure may compound post-disaster life stress, thereby resulting in a more chronic course of PTSD symptoms and reduced functioning among police responders.

Zvolensky MJ, Kotov R, Schechter CB, et al. 2015. Post-disaster stressful life events and WTC-related posttraumatic stress, depressive symptoms, and overall functioning among responders to the World Trade Center disaster. J Psychiatr Res. 61:97–105.

HTTPS://DOI.ORG/10.1016/J.JPSYCHIRES.2014.11.010

BACKGROUND: The current study examined contributions of post-disaster stressful life events in relation to the maintenance of WTC-related posttraumatic stress, depressive symptoms, and overall functioning among rescue, recovery, and clean-up workers who responded to the September 11, 2001 World Trade Center (WTC) terrorist attacks.

METHODS: Participants were 18,896 WTC responders, including 8466 police officers and 10,430 non-traditional responders (85.8% male; 86.4% Caucasian; M(age) = 39.5, SD = 8.8) participating in the WTC Health Program who completed an initial examination between July, 2002 and April, 2010 and who were reassessed, on average, 2.5 years later.

RESULTS: Path analyses were conducted to evaluate contributions of life events to the maintenance of WTC-related posttraumatic stress, depressive symptoms, and overall functioning. These analyses were stratified by police and non-traditional responder groups and adjusted for age, sex, time from 9/11 to initial visit, WTC exposures (three WTC contextual exposures: co-worker, friend, or a relative died in the disaster; co-worker, friend, or a relative injured in the disaster; and responder was

exposed to the dust cloud on 9/11), and interval from initial to first follow-up visit. In both groups, WTC-related posttraumatic stress, depressive symptoms, and overall functioning were stable over the follow-up period. WTC exposures were related to these three outcomes at the initial assessment. WTC-related posttraumatic stress, depressive symptoms, and overall functioning, at the initial assessment each predicted the occurrence of post-disaster stressful life events, as measured by Disaster Supplement of the Diagnostic Interview Schedule. Post-disaster stressful life events, in turn, were associated with subsequent mental health, indicating partial mediation of the stability of observed mental health.

CONCLUSIONS: The present findings suggest a dynamic interplay between exposure, post-disaster stressful life events, and WTC-related posttraumatic stress, depressive symptoms, and overall functioning among WTC disaster responders.

Year Published 2016 (19)

Arie S. 2016. Health effects of 9/11 terror attacks continue to grow. BMJ. 354:i4979.

HTTPS://DOI.ORG/10.1136/BMJ.I4979

Some 15 years after the terrorist attack on New York on 11; September 2001, at least 1000 people, including many; emergency responders, are known to have died from illnesses; related to their exposure to toxic dust, and 37 000 people are; officially recognised as sick.; In the next five years, the death toll from health problems related; to the New York attacks is likely to exceed the 2753 deaths on; the day that two hijacked passenger jets were flown into the; twin towers of the World Trade Center, according to Jim Melius,; a doctor who also advises the White House on worker health; and chairs the steering committee overseeing the US; government's health programme for 9/11 responders.; "There are a lot of people who are very, very ill with lung; disease who will see at least 10 years taken from their normal; life span," he told the Guardian. "We are already seeing many; more premature deaths occurring, and among younger people,; from the cancers."; The dust and debris around the World Trade Center contained; asbestos, lead, glass, heavy metals, concrete, and poisonous; gases as well as exploding jet fuel and fragments of dead bodies.; The World Trade Center Health Program provides monitoring; and treatment for a list of conditions that are officially; recognised as 9/11 related, including airway and digestive; disorders, mental health conditions, musculoskeletal disorders,; and cancers (www.cdc.gov/wtc/conditions.html).; This year, Christine Todd Whitman, the head of the; Environmental Protection Agency in 2001, admitted for the first; time that she was wrong to assure people after the attack that; the air was safe.; "We did the very best we could at the time with the knowledge; we had," she said.

Boffetta P, Zeig-Owens R, Wallenstein S, et al. 2016. Cancer in World Trade Center responders: Findings from multiple cohorts and options for future study. Am

J Ind Med. 59 (2):96–105.

HTTPS://DOI.ORG/10.1002/AJIM.22555

BACKGROUND: Three longitudinal studies of cancer incidence in varied populations of World Trade Center responders have been conducted.

METHODS: We compared the design and results of the three studies.

RESULTS: Separate analyses of these cohorts revealed excess cancer incidence in responders for all cancers combined and for cancers of the thyroid and prostate. Methodological dissimilarities included recruitment strategies, source of cohort members, demographic characteristics, overlap between cohorts, assessment of WTC and other occupational exposures and confounders, methods and duration of follow-up, approaches for statistical analysis, and latency analyses.

CONCLUSIONS: The presence of three cohorts strengthens the effort of identifying and quantifying the cancer risk; the heterogeneity in design might increase sensitivity to the identification of cancers potentially associated with exposure. The presence and magnitude of an increased cancer risk remains to be fully elucidated. Continued long-term follow up with minimal longitudinal dropout is crucial to achieve this goal.

de la Hoz RE, Jeon Y, Miller GE, et al. 2016. Post-traumatic stress disorder, bronchodilator response, and incident asthma in World Trade Center rescue and recovery workers. Am J Respir Crit Care Med. 194 (11):1383–1391.

HTTPS://DOI.ORG/10.1164/RCCM.201605-10670C

RATIONALE: Post-traumatic stress disorder (PTSD) has been associated with asthma in cross-sectional studies. Whether PTSD leads to clinically significant bronchodilator response (BDR) or new-onset asthma is unknown.

OBJECTIVES: We sought to determine the relationship between probable PTSD and both BDR and incident asthma in a high-risk cohort of World Trade Center workers in New York (NY).

METHODS: This study was conducted on data from a high-risk cohort of 11,481 World Trade Center workers in New York, including 6,133 never smokers without a previous diagnosis of asthma. Of the 6,133 never smokers without asthma, 3,757 (61.3%) completed a follow-up visit several years later (mean = 4.95 yr, interquartile range = 3.74-5.90 yr). At the baseline visit, probable PTSD was defined as a score 44 points or greater in the PTSD Checklist questionnaire, and BDR was defined as both a change of 12% or greater and an increment of 200 ml or greater in FEV1 after bronchodilator administration. Incident asthma was defined as a self-report of new physician-diagnosed asthma after the baseline visit. Multivariable logistic regression was used for the analysis of probable PTSD and baseline BDR or incident asthma.

MEASUREMENTS AND MAIN AND RESULTS: At baseline, probable PTSD was associated with BDR among all participants (adjusted odds ratio = 1.43; 95% confidence interval = 1.19-1.72), with similar results among never smokers without asthma. Among 3,757 never smokers, probable PTSD at baseline was associated with incident

asthma, even after adjustment for baseline BDR (odds ratio = 2.41; 95% confidence interval = 1.85-3.13). This association remained significant in a confirmatory analysis after excluding 195 subjects with baseline BDR.

CONCLUSIONS: In a cohort of adult workers exposed to a severe traumatic event, probable PTSD is significantly associated with BDR at baseline and predicts incident asthma.

Farris SG, Paulus DJ, Gonzalez A, et al. 2016. Posttraumatic stress symptoms and body mass index among World Trade Center disaster-exposed smokers: A preliminary examination of the role of anxiety sensitivity. Psychiatry Research. 241:135–140.

HTTPS://DOI.ORG/10.1016/J.PSYCHRES.2016.04.074

Among individuals exposed to the World Trade Center (WTC) disaster on September 11, 2001, posttraumatic stress disorder (PTSD) and symptoms are both common and associated with increased cigarette smoking and body mass. However, there is little information on the specific processes underlying the relationship of PTSD symptoms with body mass. The current study is an initial exploratory test of anxiety sensitivity, the fear of internal bodily sensations, as a possible mechanism linking PTSD symptom severity and body mass index (BMI). Participants were 147 adult daily smokers (34.0% female) exposed to the WTC disaster (via rescue/recovery work or direct witness). The direct and indirect associations between PTSD symptom severity and BMI via anxiety sensitivity (total score and subscales of physical, cognitive, and social concerns) were examined. PTSD symptom severity was related to BMI indirectly via anxiety sensitivity; this effect was specific to physical concerns about the meaning of bodily sensations. Interventions focusing on anxiety sensitivity reduction (specifically addressing physical concerns about bodily sensations) may be useful in addressing elevated BMI among trauma-exposed persons.

Feder A, Mota N, Salim R, et al. 2016. Risk, coping and PTSD symptom trajectories in World Trade Center responders. J Psychiatr Res. 82:68–79.

HTTPS://DOI.ORG/10.1016/J.JPSYCHIRES.2016.07.003

Trajectories of disaster-related posttraumatic stress disorder (PTSD) symptoms are often heterogeneous, and associated with common and unique risk factors, yet little is known about potentially modifiable psychosocial characteristics associated with low-symptom and recovering trajectories in disaster responders. A total of 4487 rescue and recovery workers (1874 police and 2613 non-traditional responders) involved during and in the aftermath of the unprecedented World Trade Center (WTC) attacks, were assessed an average of 3, 6, 8, and 12 years post-9/11/2001. Among police responders, WTC-related PTSD symptoms were characterized by four trajectories, including no/low-symptom (76.1%), worsening (12.1%), improving (7.5%), and chronic (4.4%) trajectories. In non-traditional responders, a five-trajectory solution was optimal, with fewer responders in a no/low-symptom trajectory (55.5%), and the remainder in subtly worsening (19.3%), chronic (10.8%), improving (8.5%), and steeply worsening (5.9%) trajectories. Consistent factors associated with symptomatic PTSD trajectories across responder groups included Hispanic ethnic-

ity, pre-9/11 psychiatric history, greater WTC exposure, greater medical illness burden, life stressors and post-9/11 traumas, and maladaptive coping (e.g., substance use, avoidance coping). Higher perceived preparedness, greater sense of purpose in life, and positive emotion-focused coping (e.g., positive reframing, acceptance) were negatively associated with symptomatic trajectories. Findings in this unique cohort indicate considerable heterogeneity in WTC-related PTSD symptom trajectories over 12 years post-9/11/2001, with lower rates of elevated PTSD symptoms in police than in non-traditional responders. They further provide a comprehensive risk prediction model of PTSD symptom trajectories, which can inform prevention, monitoring, and treatment efforts in WTC and other disaster responders.

Friedberg F, Adamowicz JL, Caikauskaite I, et al. 2016. Fatigue severity in World Trade Center (9/11) responders: A preliminary study. Fatigue: Biomedicine, Health and Behavior. 4 (2):70–79.

HTTPS://DOI.ORG/10.1080/21641846.2016.1169726

PURPOSE: To assess fatigue severity in World Trade Center (9/11) responders 13 years later. Methods: The participant pool consisted of male 9/11 responders enrolled in the Stony Brook World Trade Center Health Program (WTC-HP), one of five centers of excellence established by the Centers for Disease Control and Prevention. Fatigue severity was assessed with the Fatigue Severity Scale. WTC-related medical conditions were certified by a physician and diagnoses of 9/11-related post-traumatic stress disorder (PTSD) and major depressive disorder (MDD) were determined with the Structured Clinical Interview for DSM-IV (SCID).

RESULTS: High fatigue severity was reported by 20.8% of the sample (N = 1079) and was significantly associated with PTSD, major depressive disorder, sleep apnea, gastro-esophageal reux disease, upper respiratory disease, and lower respiratory disease. These associations remained significant for PTSD, major depressive disorder and lower respiratory disease when adjusted for medications, age and BMI. Only 17.3% of the high fatigue subgroup did not have an identified medical or psychiatric diagnosis. Fewer fatigued (21.1%) than non-fatigued (72.0%) responders rated their physical health as 'good' or 'very good.' Also fewer fatigued (33.9%) than non-fatigued (54.1%) responders were employed full-time (p <.0001).

CONCLUSIONS: This study found clinically elevated fatigue in a high percentage of a male WTC responder cohort that prior to 9/11/2001 would be considered a 'healthy worker cohort.' To better understand the pathophysiology of fatigue, newer methodologies such as symptom provocation (e.g. exercise) designs may be useful.

Haugen PT, Werth AS, Foster AL, et al. 2016. The role of theory-specific techniques and therapeutic alliance in promoting positive outcomes: Integrative psychotherapy for World Trade Center responders. J Nerv Ment Dis. 204 (12):955–959.

HTTPS://DOI.ORG/10.1097/NMD.0000000000000631

World Trade Center responders demonstrate high symptom burden, underscoring the importance of refining treatment approaches for this cohort. One method is examining the impact of therapy techniques on out-

comes, and the interactions between technique and alliance (therapeutic elements shared across most treatment modalities) on outcomes. This study a) examined the interaction of early treatment techniques on integrative psychotherapy outcomes and b) explored whether associations differed at varying levels of alliance. Twenty-nine adult responders diagnosed with partial or full posttraumatic stress disorder received outpatient psychotherapy and completed weekly measures of alliance, technique, and symptom distress. Analyses indicated significant interactions between 1) alliance and psychodynamic interventions on outcomes and 2) alliance and cognitive behavioral (CB) interventions on outcomes. Clients with high alliance had better outcomes when their therapist used fewer CB techniques. No meaningful differences were found between technique and outcomes for clients with lower alliance. These findings reiterate the critical roles technique and responsiveness to the alliance play in engendering successful outcomes.

Horn SR, Charney DS, and Feder A. 2016. Understanding resilience: New approaches for preventing and treating PTSD. Exp Neurol. 0 (0):119–132.

HTTPS://DOI.ORG/10.1016/J.EXPNEUROL.2016.07.002

All individuals experience stressful life events, and up to 84% of the general population will experience at least one potentially traumatic event. In some cases, acute or chronic stressors lead to the development of posttraumatic stress disorder (PTSD) or other psychopathology; however, the majority of people are resilient to such effects. Resilience is the ability to adapt successfully in the face of stress and adversity. A wealth of research has begun to identify the genetic, epigenetic, neural, and environmental underpinnings of resilience, and has indicated that resilience is mediated by adaptive changes encompassing several environmental factors, neural circuits, numerous neurotransmitters, and molecular pathways. The first part of this review focuses on recent findings regarding the genetic, epigenetic, developmental, psychosocial, and neurochemical factors as well as neural circuits and molecular pathways that underlie the development of resilience. Emerging and exciting areas of research and novel methodological approaches, including genome-wide gene expression studies, immune, endocannabinoid, oxytocin, and glutamatergic systems, are explored to help delineate innovative mechanisms that may contribute to resilience. The second part reviews several interventions and preventative approaches designed to enhance resilience in both developmental and adult populations. Specifically, the review will delineate approaches aimed to bolster resilience in individuals with PTSD. Furthermore, we discuss novel pharmacologic approaches, including the N-methyl-d-aspartate (NMDA) receptor ketamine and neuropeptide Y (NPY), as exciting new prospects for not only the treatment of PTSD but as new targets to enhance resilience. Our growing understanding of resilience and interventions will hopefully lead to the development of new strategies for not just treating PTSD but also screening and early identification of at-risk youth and adults. Taken together, efforts aimed at dissemination and implementation of novel interventions to enhance resilience will have to keep pace with the growth of new preventive and treatment strategies.

Horn SR, Pietrzak RH, Schechter C, et al. 2016. Latent typologies of posttraumatic stress disorder in World Trade Center responders. J Psychiatr Res. 83:151–159.

HTTPS://DOI.ORG/10.1016/J.JPSYCHIRES.2016.08.018

Posttraumatic stress disorder (PTSD) is a debilitating and often chronic psychiatric disorder. Following the 9/11/2001 World Trade Center (WTC) attacks, thousands of individuals were involved in rescue, recovery and clean-up efforts. While a growing body of literature has documented the prevalence and correlates of PTSD in WTC responders, no study has evaluated predominant typologies of PTSD in this population. Participants were 4352 WTC responders with probable WTC-related DSM-IV PTSD. Latent class analyses were conducted to identify predominant typologies of PTSD symptoms and associated correlates. A 3-class solution provided the optimal representation of latent PTSD symptom typologies. The first class, labeled "High-Symptom (n = 1,973, 45.3%)," was characterized by high probabilities of all PTSD symptoms. The second class, "Dysphoric (n = 1,371, 31.5%)," exhibited relatively high probabilities of emotional numbing and dysphoric arousal (e.g., sleep disturbance). The third class, "Threat (n = 1,008, 23.2%)," was characterized by high probabilities of re-experiencing, avoidance and anxious arousal (e.g., hypervigilance). Compared to the Threat class, the Dysphoric class reported a greater number of life stressors after 9/11/2001 (OR = 1.06). The High-Symptom class was more likely than the Threat class to have a positive psychiatric history before 9/11/2001 (OR = 1.7) and reported a greater number of life stressors after 9/11/2001 (OR = 1.1). The first class, labeled "High-Symptom (n = 1,973, 45.3%)," was characterized by high probabilities of all PTSD symptoms. The second class, "Dysphoric (n = 1,371, 31.5%)," exhibited relatively high probabilities of emotional numbing and dysphoric arousal (e.g., sleep disturbance). The third class, "Threat (n = 1,008, 23.2%)," was characterized by high probabilities of re-experiencing, avoidance and anxious arousal (e.g., hypervigilance).

Icitovic N, Onyebeke LC, Wallenstein S, et al. 2016. The association between body mass index and gastroesophageal reflux disease in the World Trade Center Health Program general responder cohort. Am J Ind Med. 59 (9):761–766.

HTTPS://DOI.ORG/10.1002/AJIM.22637

BACKGROUND: There is increasing concern about the obesity epidemic in the United States. Obesity is a potential risk factor for a number of chronic diseases, including gastroesophageal reflux disease (GERD). This analysis examined whether body mass index (BMI) was associated with physician-diagnosed GERD in World Trade Center (WTC) general responders.

METHODS: 19,819 WTC general responders were included in the study. Cox proportional hazards regression models were used to compare time to GERD diagnosis among three BMI groups (normal (<25 kg/m(2)), overweight (>/=25 and <30 kg/m(2)), and obese (>/=30 kg/m(2))).

RESULTS: Among the responders, 43% were overweight and 42% were obese. The hazard ratio for normal versus overweight was 0.81 (95% Confidence Interval (CI), 0.75-0.88); normal versus obese 0.71 (95%CI, 0.66, 0.77); and overweight versus

obese 0.88 (95%CI, 0.83-0.92).

CONCLUSION: GERD diagnoses rates were higher in overweight and obese WTC responders. Am. J. Ind. Med. 59:761–766, 2016. © 2016 Wiley Periodicals, Inc.

Jiang J, Icitovic N, Crane MA, et al. 2016. Sex differences in asthma and gastroesophageal reflux disease incidence among the World Trade Center Health Program general responder cohort. Am J Ind Med. 59 (9):815–822.

HTTPS://DOI.ORG/10.1002/AJIM.22634

BACKGROUND: Asthma and gastroesophageal reflux disease (GERD) are two common conditions among the responders to the WTC attacks. This study examined whether the cumulative incidence rates of asthma and GERD differed by sex among 24,022 and 23,557 WTC responders, respectively.

METHODS: Cox proportional hazards regression was used to examine the sex difference in the rate of onset of physician-diagnosed asthma or GERD, from 9/12/2001 through 12/31/2015.

RESULTS: The cumulative incidence of asthma reached 23% for women and 17% for men by the end of 2015, and the cumulative incidence of GERD reached 45% for women and 38% for men. Comparing women to men, the hazard ratio was 1.48 (95% confidence interval (CI): 1.27, 1.74) for asthma, and 1.25 (95% CI: 1.13, 1.38) for GERD.

CONCLUSIONS: WTC general responders have a substantial burden of asthma and GERD, with higher incidence in women.

Jurek AM and Maldonado G. 2016. Quantitative bias analysis in an asthma study of rescue-recovery workers and volunteers from the 9/11 World Trade Center attacks. Ann Epidemiol. 26 (11):794–801.

HTTPS://DOI.ORG/10.1016/J.ANNEPIDEM.2016.09.002

PURPOSE: When learning bias analysis, epidemiologists are taught to quantitatively adjust for multiple biases by correcting study results in the reverse order of the error sequence. To understand the error sequence for a particular study, one must carefully examine the health study's epidemiologic data-generating process. In this article, we describe the unique data-generating process of a man-made disaster epidemiologic study.

METHODS: We described the data-generating process and conducted a bias analysis for a study associating September 11, 2001 dust cloud exposure and self-reported newly physician-diagnosed asthma among rescue-recovery workers and volunteers. We adjusted an odds ratio (OR) estimate for the combined effect of missing data, outcome misclassification, and nonparticipation.

RESULTS: Under our assumptions about systematic error, the ORs adjusted for all three biases ranged from 1.33 to 3.84. Most of the adjusted estimates were greater than the observed OR of 1.77 and were outside the 95% confidence limits (1.55, 2.01).

CONCLUSIONS: Man-made disasters present some situations that are not observed in other areas of epidemiology. Future epidemiologic studies of disasters could benefit from a proactive approach that focuses on the technical aspect of data collection and gathers information on bias parameters to provide more meaningful interpretations of results.

Mahaffey BL, Gonzalez A, Farris SG, et al. 2016. Smoking to regulate negative affect: Disentangling the relationship between posttraumatic stress and emotional disorder symptoms, nicotine dependence, and cessation-related problems. Nicotine Tob Res. 18 (6):1471–1478.

HTTPS://DOI.ORG/10.1093/NTR/NTV175

INTRODUCTION: Posttraumatic stress disorder (PTSD) is associated with various aspects of cigarette smoking, including higher levels of nicotine dependence and cessation difficulties. Affect-regulatory smoking motives are thought to, in part, underlie the association between emotional disorders such as PTSD and smoking maintenance, although few studies have empirically tested this possibility.

METHODS: Data were analyzed from 135 treatment-seeking smokers who were directly exposed to the World Trade Center disaster on September 11, 2001. We modeled the direct effect of 9/11 PTSD symptom severity on nicotine dependence, perceived barriers to smoking cessation, and severity of problematic symptoms experienced during prior cessation attempts. We also examined the indirect effect of PTSD on these outcomes via negative affect reduction smoking motives. Parallel models were constructed for additional emotional disorder symptoms, including panic and depressive symptoms.

RESULTS: PTSD symptom severity was associated with nicotine dependence and perceived barriers to cessation, but not problems during prior quit attempts indirectly via negative affect reduction smoking motives. Panic and depressive symptoms both had significant indirect effects, via negative affect reduction smoking motives, on all three criterion variables.

CONCLUSIONS: Affect-regulatory smoking motives appear to underlie associations between the symptoms of emotional disorders such as PTSD, panic, and depression in terms of smoking dependence and certain cessation-related criterion variables.

IMPLICATIONS: Overall, this investigation suggests negative affect reduction smoking motives help to explain the relationship of PTSD, depression, and panic symptoms to nicotine dependence, severity of problems experienced during prior quit attempts and perceived barriers to cessation. These results highlight the importance of assessing motivations for smoking in the context of cessation treatment, especially among those with emotional disorder symptoms. Future interventions might seek to utilize motivational interviewing and cognitive restructuring techniques to address coping-oriented motives for smoking, in addition to skills for managing negative affect, as a means of improving quit outcomes.

Moline JM, McLaughlin MA, Sawit ST, et al. 2016. The prevalence of metabolic syndrome among law

enforcement officers who responded to the 9/11 World Trade Center attacks. Am J Ind Med. 59 (9):752–760.

HTTPS://DOI.ORG/10.1002/AJIM.22649

BACKGROUND: Law enforcement officers (LEOs) experience high rates of cardiovascular events compared with the general US population. Metabolic syndrome (MetS) confers an increased risk of cardiovascular disease and all-cause mortality. Data regarding MetS among LEOs are limited.

METHODS: We sought to determine the prevalence of MetS and its associated risk factors as well as gender differences among LEOs who participated in the World Trade Center (WTC) Law Enforcement Cardiovascular Screening (LECS) Program from 2008 to 2010. We evaluated a total of 2,497 participants, 40 years and older, who responded to the 9/11 WTC attacks.

RESULTS: The prevalence of MetS was 27%, with abdominal obesity and hypertension being the most frequently occurring risk factors. MetS and its risk factors were significantly higher among male compared to female LEOs, except for reduced HDL-cholesterol levels.

CONCLUSIONS: MetS is a rising epidemic in the United States, and importantly, approximately one in four LEOs who worked at the WTC site after 9/11 are affected.

Napier CO, Mbadugha O, Bienenfeld LA, et al. 2016. Obesity and weight gain among former World Trade Center workers and volunteers. Arch Environ Occup Health. 72 (2):1–5.

HTTPS://DOI.ORG/10.1080/19338244.2016.1197174

A high prevalence of obesity has been observed among former World Trade Center (WTC) workers and volunteers. We hypothesized that unemployment and disability status would predict obesity. We surveyed 220 participants at the [INST] Mount Sinai WTC Clinical Center to assess their obesity and current employment and disability status, WTC occupational exposure level, medical comorbidities, and dietary and exercise habits. Bivariate and logistic regression multivariate analyses were used to explore associated risk factors. Obesity was associated with active employment status. Other significant covariates included non-Latino African American race, having a high number of comorbid chronic diseases, low exercise frequency, and not drinking any glass of juice daily. The association of obesity with active employment suggests that interventions that favor healthy habits among actively employed individuals are warranted.

Reibman J, Levy-Carrick N, Miles T, et al. 2016. Destruction of the World Trade Center towers. Lessons learned from an environmental health disaster. Ann Am Thorac Soc. 13 (5):577–583.

HTTPS://DOI.ORG/10.1513/ANNALSATS.201509-572PS

The assault and subsequent collapse of the World Trade Center towers in New York City on September 11, 2001 (9/11), released more than a million tons of debris and dust into the surrounding area, engulfing rescue workers as they rushed to aid those who worked in the towers, and the thousands of nearby civilians and children who were forced to flee. In December 2015, almost 15 years after the attack, and 5 years after first enactment, Congress reauthorized the James Zadroga 9/11 Health and Compensation Act, a law designed to respond to the adverse health

effects of the disaster. This reauthorization affords an opportunity to review human inhalation exposure science in relation to the World Trade Center collapse. In this Special Article, we compile observations regarding the collective medical response to the environmental health disaster with a focus on efforts to address the adverse health effects experienced by nearby community members including local residents and workers. We also analyze approaches to understanding the potential for health risk, characterization of hazardous materials, identification of populations at risk, and shortfalls in the medical response on behalf of the local community. Our overarching goal is to communicate lessons learned from the World Trade Center experience that may be applicable to communities affected by future environmental health disasters. The World Trade Center story demonstrates that communities lacking advocacy and preexisting health infrastructures are uniquely vulnerable to health disasters. Medical and public health personnel need to compensate for these vulnerabilities to mitigate long-term illness and suffering.

0.Stein CR, Wallenstein S, Shapiro M, et al. 2016. Mortality among World Trade Center rescue and recovery workers, 2002-2011. Am J Ind Med. 59 (2):87–95.

HTTPS://DOI.ORG/10.1002/AJIM.22558

BACKGROUND: Rescue and recovery workers responding to the 2001 collapse of the World Trade Center (WTC) sustained exposures to toxic chemicals and have elevated rates of multiple morbidities.

METHODS: Using data from the World Trade Center Health Program and the National Death Index for 2002-2011, we examined standardized mortality ratios (SMR) and proportional cancer mortality ratios (PCMR) with indirect standardization for age, sex, race, and calendar year to the U.S. general population, as well as associations between WTC-related environmental exposures and all-cause mortality.

RESULTS: We identified 330 deaths among 28,918 responders (SMR 0.43, 95%CI 0.39-0.48). No cause-specific SMRs were meaningfully elevated. PCMRs were elevated for neoplasms of lymphatic and hematopoietic tissue (PCMR 1.76, 95%CI 1.06-2.75). Mortality hazard ratios showed no linear trend with exposure.

CONCLUSIONS: Consistent with a healthy worker effect, all-cause mortality among responders was not elevated. There was no clear association between intensity and duration of exposure and mortality. Surveillance is needed to monitor the proportionally higher cancer mortality attributed to lymphatic/hematopoietic neoplasms.

Wolff MS. 2016. Birth outcomes soon after 9/11 (editoral). Am J Public Health. 106 (10):1724.

HTTPS://DOI.ORG/10.2105/AJPH.2016.303355

NO ABSTRACT AVAILABLE

Xu KY, Goodman E, Goswami R, et al. 2016. Determinants of asthma morbidity in World Trade Center rescue and recovery workers. Ann Allergy Asthma Immunol. 117 (5):568–570.

HTTPS://DOI.ORG/10.1016/J.ANAI.2016.08.033

Asthma is one the most common chronic conditions affecting World Trade Center (WTC) rescue and recovery workers in the

aftermath of the terrorist attacks on September 11, 2001. While exposure-response gradients between asthma risk and duration of work at the WTC site, exposure to the dust cloud, and work in the Ground Zero pit, compounded by inadequate protection have been described, there is limited knowledge about how exposure and other factors affect long-term asthma outcomes among WTC rescue and recovery workers. In this study, we used data from a cohort of WTC workers with a physician diagnosis of asthma to study factors associated with worse asthma control, acute asthma-related outpatient and inpatient resource utilization, and poor quality of life. We collected data on asthma history, levels of WTC exposures (categorized based on established criteria), and comorbidities from a prospective cohort of 218 WTC workers with physician-diagnosed asthma who were enrolled in the WTC Health Program (WTCHP). Structured clinical interviews assessed for post-traumatic stress disorder (PTSD) and major depression. A validated questionnaire was used to measure gastroesophageal reflux disease (GERD) symptoms.5 Outcomes included asthma control,6 self-report resource utilization, and quality of life. We performed multiple regression analyses to identify factors associated with increased morbidity. Our study revealed that WTC-related asthma is frequently poorly controlled and results in substantial impairment in quality of life. Furthermore, we found that lower income and physical and mental health comorbidities were independently associated with increased asthma morbidity in the WTC rescue and recovery worker populations. Our results highlight the medical needs of WTC workers with asthma and suggest potential targets for future interventions. Our findings are consistent with a study conducted among members of the WTC Health Registry, encompassing both local residents and rescue and recovery workers, which found participants to have low levels of asthma control. A potential reason for the high levels of asthma morbidity in WTC rescue and recovery workers is the high prevalence of comorbid GERD, estimated to affect almost 40% of WTC workers and identified as an important exacerbating factor in patients with poorly controlled asthma.4 In addition, our finding of a strong association between PTSD and worse asthma morbidity in adjusted analysis is consistent with some community-based studies that reported associations between mental health comorbidities and poor asthma control. In summary, we found high levels of asthma morbidity among WTC rescue and recovery workers over 15 years after exposure. Our finding that GERD symptom and PTSD are associated with worse asthma outcomes can help identify high-risk WTC workers and guide development of highly needed interventions.

Year Published 2017 (7)

Clouston S, Pietrzak RH, Kotov R, et al. 2017. Traumatic exposures, posttraumatic stress disorder, and cognitive functioning in World Trade Center responders. Alzheimer's and Dementia: Translational Research and Clinical Interventions. 3 (4):593–602.

HTTPS://DOI.ORG/10.1016/J.TRCI.2017.09.001

INTRODUCTION: This study examined whether World Trade Center (WTC)-related exposures and posttraumatic stress disorder (PTSD) were associated with cognitive function and whether WTC responders' cognition differed from normative data.

METHODS: A computer-assisted neuropsychological battery was administered to a prospective cohort study of 1193 WTC responders with no history of stroke or WTC-related head injuries. Data were linked to information collected prospectively since 2002. Sample averages were compared to published norms.

RESULTS: Approximately 14.8% of sampled responders had cognitive dysfunction. WTC responders had worse cognitive function compared to normative data. PTSD symptom severity and working >5 weeks on-site was associated with lower cognition. Discussion Results from this sample highlight the potential for WTC responders to be experiencing an increased burden of cognitive dysfunction and linked lowered cognitive functioning to physical exposures and to PTSD. Future research is warranted to understand the extent to which cognitive dysfunction is evident in neural dysfunction.

Clouston SAP, Guralnik JM, Kotov R, et al. 2017. Functional limitations among responders to the World Trade Center attacks 14 years after the disaster: Implications of chronic posttraumatic stress disorder. J Trauma Stress. 30 (5):443–452.

HTTPS://DOI.ORG/10.1002/JTS.22219

Posttraumatic stress disorder (PTSD) is associated with self-reported difficulties navigating the social and physical world and may also be associated with risk of functional limitations. The Short Physical Performance Battery (SPPB), an objective functional assessment, was administered during monitoring exams between January and December 2015 to a consecutive sample of 1,268 rescue workers, volunteers, and other responders who had aided in response, recovery, and cleanup efforts at the World Trade Center (WTC) in New York after the September 11, 2011 attacks. Data were linked with diagnostic and longitudinal data from the WTC monitoring study. Multivariable analyses were used to examine predictors of functional limitations. Prevalence estimates weighted to the general responder population revealed a relatively high prevalence of functional limitations, SPPB ≤ 9; 16.0%, 95% CI [13.7, 18.4]. Current PTSD was associated with a twofold increased risk of functional limitations after controlling for predisposing factors, trauma severity, behavioral factors, and WTC-related medical conditions, adjusted risk ratio (aRR) = 2.11, 95% CI [1.48, 3.01]. Exposure to ergonomic risk factors at the WTC also increased the risk of functional impairments, aRR = 1.34 95% CI [1.05, 1.70]. Longitudinal results suggest that individuals with current functional limitations experienced high baseline PTSD severity, B = 2.94, SE = 1.33, and increasing PTSD symptom severity, B = 0.29, SE = 0.10, since September 11, 2001. This study identified a cross-sectional relationship between functional limitations and PTSD and a worsening of PTSD symptoms in persons who eventually demonstrated functional limitations. Results highlight the potential role of chronic PTSD in functional limitations.

Clouston SAP, Shapira O, Kotov R, et al. 2017. Proton pump inhibitors and the risk of severe cognitive

impairment: The role of posttraumatic stress disorder. Alzheimer's & Dementia: Translational Research & Clinical Interventions. 3 (4):579–583.

HTTPS://DOI.ORG/10.1016/J.TRCI.2017.08.007

INTRODUCTION: Proton pump inhibitors (PPIs), a common treatment for gastroesophageal reflux disease (GERD), were recently associated with increased risk of dementia. However, severe or chronic stress including, for example, posttraumatic stress disorder (PTSD) was not accounted for. This study examined whether PPI use was associated with severe cognitive impairment (SCI) and whether PTSD explained this association in a cohort of World Trade Center (WTC) responders. Method: A prospective cohort study of 3779 WTC responders attending a university-based monitoring and treatment program. Prescriptions for PPIs and SCI determined using the Montreal Cognitive Assessment were the focus of the analysis. Results: Overall, 1451 (38.4%) responders were dispensed PPIs, and 83 (2.2%) had SCI. Bivariable analyses revealed significant associations between being-dispensed PPIs in relation to SCI. After adjusting for PTSD, major depressive disorder, WTC exposures, age, and sex, being-dispensed PPIs were significantly associated with odds of SCI (adjusted odds ratio = 1.67 95% confidence interval = 1.054-2.643). Conclusions: Being-dispensed PPIs were associated with SCI in this analysis of WTC responders. Results suggest that clinicians treating GERD seek to both understand patients' mental health history and monitor cognitive functioning when designing treatment routines. Overall, results confirmed that this is an important area of investigation with potential direct clinical implications.

Dasaro CR, Holden WL, Berman KD, et al. 2017. Cohort profile: World Trade Center Health Program general responder cohort. Int J Epidemiol. 46 (2):e9.

HTTPS://DOI.ORG/10.1093/IJE/DYV099

NO ABSTRACT AVAILABLE

Lucchini RG, Hashim D, Acquilla S, et al. 2017. A comparative assessment of major international disasters: The need for exposure assessment, systematic emergency preparedness, and lifetime health care. BMC Public Health. 17 (1):46.

HTTPS://DOI.ORG/10.1186/S12889-016-3939-3

BACKGROUND: The disasters at Seveso, Three Mile Island, Bhopal, Chernobyl, the World Trade Center (WTC) and Fukushima had historic health and economic sequelae for large populations of workers, responders and community members.

METHODS: Comparative data from these events were collected to derive indications for future preparedness. Information from the primary sources and a literature review addressed: i) exposure assessment; ii) exposed populations; iii) health surveillance; iv) follow-up and research outputs; v) observed physical and mental health effects; vi) treatment and benefits; and vii) outreach activities.

RESULTS: Exposure assessment was conducted in Seveso, Chernobyl and Fukushima, although none benefited from a timely or systematic strategy, yielding immediate and sequential measurements after the disaster. Identification of exposed subjects was overall underestimated. Health

surveillance, treatment and follow-up research were implemented in Seveso, Chernobyl, Fukushima, and at the WTC, mostly focusing on the workers and responders, and to a lesser extent on residents. Exposure-related physical and mental health consequences were identified, indicating the need for a long-term health care of the affected populations. Fukushima has generated the largest scientific output so far, followed by the WTCHP and Chernobyl. Benefits programs and active outreach figured prominently in only the WTC Health Program. The analysis of these programs yielded the following lessons: 1) Know who was there; 2) Have public health input to the disaster response; 3) Collect health and needs data rapidly; 4) Take care of the affected; 5) Emergency preparedness; 6) Data driven, needs assessment, advocacy.

CONCLUSIONS: Given the long-lasting health consequences of natural and man-made disasters, health surveillance and treatment programs are critical for management of health conditions, and emergency preparedness plans are needed to prevent or minimize the impact of future threats.

Mindlis I, Morales-Raveendran E, Goodman E, et al. 2017. Post-traumatic stress disorder dimensions and asthma morbidity in World Trade Center rescue and recovery workers. Journal of Asthma. 54 (7):723–731.

HTTPS://DOI.ORG/10.1080/02770903.2016.1263650

OBJECTIVE: Using data from a cohort of World Trade Center (WTC) rescue and recovery workers with asthma, we assessed whether meeting criteria for post-traumatic stress disorder (PTSD), sub-threshold PTSD, and for specific PTSD symptom dimensions are associated with increased asthma morbidity.

METHODS: Participants underwent a Structured Clinical Interview for Diagnostic and Statistical Manual to assess the presence of PTSD following DSM-IV criteria during in-person interviews between December 2013 and April 2015. We defined sub-threshold PTSD as meeting criteria for two of three symptom dimensions: re-experiencing, avoidance, or hyper-arousal. Asthma control, acute asthma-related healthcare utilization, and asthma-related quality of life data were collected using validated scales. Unadjusted and multiple regression analyses were performed to assess the relationship between sub-threshold PTSD and PTSD symptom domains with asthma morbidity measures.

RESULTS: Of the 181 WTC workers with asthma recruited into the study, 28% had PTSD and 25% had sub-threshold PTSD. Patients with PTSD showed worse asthma control, higher rates of inpatient healthcare utilization, and poorer asthma quality of life than those with sub-threshold or no PTSD. After adjusting for potential confounders, among patients not meeting the criteria for full PTSD, those presenting symptoms of re-experiencing exhibited poorer quality of life ($p = 0.003$). Avoidance was associated with increased acute healthcare use ($p = 0.05$). Sub-threshold PTSD was not associated with asthma morbidity ($p > 0.05$ for all comparisons). Conclusions: There may be benefit in assessing asthma control in patients with sub-threshold PTSD symptoms as well as those with full PTSD to more effectively identify ongoing asthma symptoms and target management strategies. Vossbrinck M,

Zeig-Owens R, Hall CB, et al. 2017. Post-9/11/2001 lung function trajectories by sex and race in World Trade Center-exposed New York City emergency medical service workers. Occupational and Environmental Medicine. 74 (3):200–203.

HTTPS://DOI.ORG/10.1136/OEMED-2016-103619

OBJECTIVE: To determine whether lung function trajectories after 9/11/2001 (9/11) differed by sex or race/ethnicity in World Trade Center-exposed Fire Department of the City of New York emergency medical service (EMS) workers.

METHOD: Serial cross-sectional study of pulmonary function tests (PFTs) taken between 9/11 and 9/10/2015. We used data from routine PFTs (forced expiratory volume in 1 s (FEV<inf>1</inf>) and FEV<inf>1</inf>% predicted), conducted at 12-18 month intervals. FEV<inf>1</inf> and FEV<inf>1</inf>% predicted were assessed over time, stratified by sex, and race/ethnicity. We also assessed FEV<inf>1</inf> and FEV<inf>1</inf>% predicted in current, former and never-smokers.

RESULTS: Among 1817 EMS workers, 334 (18.4%) were women, 979 (53.9%) self-identified as white and 939 (51.6%) were never-smokers. The median follow-up was 13.1 years (IQR 10.5-13.6), and the median number of PFTs per person was 11 (IQR 7-13). After large declines associated with 9/11, there was no discernible recovery in lung function. In analyses limited to never-smokers, the trajectory of decline in adjusted FEV<inf>1</inf> and FEV<inf>1</inf>% predicted was relatively parallel for men and women in the 3 racial/ethnic groups. Similarly, small differences in FEV<inf>1</inf> annual decline between groups were not clinically meaningful. Analyses including ever-smokers were essentially the same.

CONCLUSIONS: 14 years after 9/11, most EMS workers continued to demonstrate a lack of lung function recovery. The trajectories of lung function decline, however, were parallel by sex and by race/ethnicity. These findings support the use of routine, serial measures of lung function over time in first responders and demonstrate no sex or racial sensitivity to exposure-related lung function decline.

Year Published 2018 (4)

Bello GA, Lucchini RG, Teitelbaum SL, et al. 2018. Development of a physiological frailty index for the World Trade Center general responder cohort. Current Gerontology and Geriatrics Research. 2018:1–12.

HTTPS://DOI.ORG/10.1155/2018/3725926

Responders to the 9/11/2001 WTC attacks were exposed to multiple toxic pollutants. Since 2002, the health of the responder cohort has been continuously tracked by the WTC Health Monitoring Program. However, no assessments have been made of frailty, an important health metric given the current average age of the WTC responder cohort (55 years). In this study, we use laboratory test results and other physiological parameters to construct a physiological frailty in-

dex (FI-Lab) for this cohort. The study sample comprised responders aged 40 years or older who completed a health monitoring visit at Mount Sinai Center within the past 5 years. For each subject, FI-Lab was computed as the proportion of 20 physiological parameters (lab tests, pulmonary function, and blood pressure) on which the subject had abnormal values. Using negative binomial regression models, we tested FI-Lab's association with the SF-12 wellbeing score and various demographic characteristics. FI-Lab showed strong associations with the physical and mental components of the SF-12 as well as age, race, and smoking status. Using a cutoff of 0.25 to define presence of physiological/preclinical frailty, we found frailty prevalence in the study sample to be approximately 12%. This study demonstrates the feasibility of assessing preclinical frailty in the WTC responder cohort.

Bello GA, Teitelbaum SL, Lucchini RG, et al. 2018. Assessment of cumulative health risk in the World Trade Center general responder cohort. Am J Ind Med. 61 (1):63–76.

HTTPS://DOI.ORG/10.1002/AJIM.22786

BACKGROUND: Multiple comorbidities have been reported among rescue/recovery workers responding to the 9/11/2001 WTC disaster. In this study, we developed an index that quantifies the cumulative physiological burden of comorbidities and predicts life expectancy in this cohort.

METHODS: A machine learning approach (gradient boosting) was used to model the relationship between mortality and several clinical parameters (laboratory test results, blood pressure, pulmonary function measures). This model was used to construct a risk index, which was validated by assessing its association with a number of health outcomes within the WTC general responder cohort.

RESULTS: The risk index showed significant associations with mortality, self-assessed physical health, and onset of multiple chronic conditions, particularly COPD, hypertension, asthma, and sleep apnea.

CONCLUSION: As an aggregate of several clinical parameters, this index serves as a cumulative measure of physiological dysregulation and could be utilized as a prognostic indicator of life expectancy and morbidity risk.

Ciro D. 2018. Psychosocial correlates of post-traumatic stress disorder symptoms and well-being among hispanic World Trade Center rescue and recovery workers. PhD Thesis. The Graduate Center, City University of New York

Thousands of first responders are estimated to have endured extremely distressing experiences during their recovery efforts at the 9/11 World Trade Center (WTC) site. While the effects of 9/11 continue to be studied, few studies have examined how rescue and recovery workers have been coping since 9/11 and how their coping is associated with their psychological well-being. Moreover, we do not know how distinct coping patterns may be associated with post-traumatic growth, experiences of positive emotion, or quality of life among WTC responders. This study compared coping differences among Hispanic, Non-Hispanic White, and Non-; Hispanic Black first responders. In addition, it examined the relationship between their coping, Post- Traumatic Stress Disorder (PTSD)

symptoms, and psychological well-being. I also examined these associations in Hispanic responders by language preference and US nativity as proxies of acculturation.; ; Data from a cohort of 4,148 WTC responders who attended monitoring visits at the Mount Sinai WTC Health Program (WTC-HP) and who participated in a web-based survey administered by the Mount Sinai WTC Mental Health Program research team were used for secondary data analyses. More specifically, I utilized multiple regression analyses to compare differences in coping among Hispanics, Non-Hispanic Whites, and Non-Hispanic Blacks, while controlling for WTC-related trauma exposure, demographics, and clinical and psychosocial characteristics. Data were also used to examine the relationship between the responders' coping, PTSD symptoms, and psychological well-being. Further, I used the data to examine differences in coping and well-being (e.g., post-traumatic growth, positive affect, and quality of life) in Hispanic responders by language preference and US nativity. Last, I tested a moderation effect to examine the relationship between active coping, PTSD symptom levels, and wellbeing among Hispanic responders by their level of acculturation using language preference and US nativity as proxies.; ; Key findings suggested broad similarities in coping between Hispanic and Non-Hispanic Black first responders, significant differences in coping among Hispanics, and the prevalence of post-traumatic growth in Hispanic responders. Further, the results revealed a moderating effect of US nativity on the Hispanic responders' experiences of positive affect and quality of life. This study's results are consistent with other study findings that show Hispanic ethnicity is associated with higher PTSD symptom levels in 9/11 first responders. However, the study findings also show that positive religious coping and active coping are strongly associated with post-traumatic growth in Hispanic first responders. Further, positive religious coping and perceived social support are strongly associated with Hispanic responders experiencing positive affect and reporting a higher quality of life. ; ; Finally, the study findings demonstrate that US nativity among Hispanic responders moderates the relationship between active coping and positive affect and between active coping and quality of life, suggesting that Hispanic responders who are born abroad and use active coping report higher rates of positive affect and quality of life than those who are US born. Clinical and policy implications of these findings are of importance in designing programs for this population.

Hashim D, Boffetta P, Galsky M, et al. 2018. Prostate cancer characteristics in the World Trade Center cohort, 2002-2013. Eur J Cancer Prev. 27 (4):347–354.

HTTPS://DOI.ORG/10.1097/CEJ.0000000000000315

An increased incidence of prostate cancer was reported in three cohorts of World Trade Center (WTC) respondents. It is uncertain whether this increase is because of WTC-related exposures or enhanced surveillance. Prostate cancer cases (2002-2013) were obtained from the WTC Health Program. Age, race, and Gleason score distribution were compared with New York State Cancer Registry cases from the same time period. Multivariate models were adjusted for age and race. Analyses of clinical characteristics of prostate cancer cases within the cohort were also carried out, adjusting for age, race, and WTC exposure categories. WTC respondents

had a prostate cancer age-standardized rate ratio of 1.65 [95% confidence interval (CI): 1.37-1.93] compared with New York State; age-specific ratios were highest for ages 30-49 (2.28; 95% CI: 1.51-3.43), 70-74 (2.05; 95% CI: 1.03-4.10), and 80-84 years (5.65; 95% CI: 1.41-22.58). High WTC exposure was associated with advanced clinical stage (5.58; 95% CI: 1.05-29.76; Ptrend=0.03). WTC respondents continue to have a higher prostate cancer rate compared with New York State as a whole. Respondents with a higher WTC exposure level may have had more advanced clinical stage of prostate cancer.

Year Published 2019 (8)

Clouston SAP, Deri Y, Diminich E, et al. 2019. Posttraumatic stress disorder and total amyloid burden and amyloid-β 42/40 ratios in plasma: Results from a pilot study of World Trade Center responders. Alzheimer's and Dementia: Diagnosis, Assessment and Disease Monitoring. 11:216–220.

HTTPS://DOI.ORG/10.1016/J.DADM.2019.01.003

INTRODUCTION: Chronic posttraumatic stress disorder (PTSD) is associated with poor memory and increased burden of various degenerative cerebral neuropathologies. The goal of this pilot study was to determine whether PTSD was associated with changes in plasma-based neuropathological biomarkers of neurodegeneration among World Trade Center (WTC) responders.

METHODS: Thirty-four WTC responders had blood drawn and flash-frozen within 15 minutes of retrieval. PTSD symptoms were assessed at that time. Age, sex, and WTC exposure duration were obtained from medical records. Plasma was assayed in duplicate using an ultra-sensitive single-molecule enzyme-linked immunosorbent assay to examine the distribution of amyloid-β (Aβ) 42/40 ratios, total Aβ, total tau, and neurofilament light (NfL). The comparison group was drawn from a bank of healthy controls collected and assayed at the same facility.

RESULTS: The average age of WTC responders at blood draw was 53 years. Half were PTSD positive (PTSD+) as indicated by symptom severity. WTC responders had lower Aβ42/Aβ40 ratios but higher total tau and NfL levels in the plasma than healthy controls. PTSD+ status was associated with lower plasma Aβ load and higher Aβ42/Aβ40 ratios. Discussion: Findings suggest that PTSD may be associated with alterations in plasma markers related to Aβ, tau, and NfL, highlighting the potential association between PTSD status and neurodegenerative neuropathology in WTC responders.

Clouston SAP, Diminich ED, Kotov R, et al. 2019. Incidence of mild cognitive impairment in World Trade Center responders: Long-term consequences of re-experiencing the events on 9/11/2001. Alzheimer's and Dementia: Diagnosis, Assessment and Disease Monitoring. 11:628–636.

HTTPS://DOI.ORG/10.1016/J.DADM.2019.07.006

OBJECTIVE: This study examined whether World Trade Center (WTC) exposures and

chronic posttraumatic stress disorder (PTSD) were associated with incidence of mild cognitive impairment (MCI) in a longitudinal analysis of a prospective cohort study of WTC responders.

METHODS: Incidence of MCI was assessed in a clinical sample of WTC responders (N = 1800) who were cognitively intact at baseline assessment. Crude incidence rates were calculated and compared to population estimates using standardized incidence ratios. Multivariable analyses used Cox proportional-hazards regression.

RESULTS: Responders were 53.1 years old (SD = 7.9) at baseline. Among eligible cognitively intact responders, 255 (14.2%) developed MCI at follow-up. Incidence of MCI was higher than expected based on expectations from prior published research. Incidence was higher among those with increased PTSD symptom severity, and prolonged exposure was a risk factor in apolipoprotein-ε4 carriers.

CONCLUSIONS: PTSD and prolonged WTC exposures were associated with increased incidence of MCI in WTC responders, results that may portend future high rates of dementia in WTC-exposed responders.

Clouston SAP, Edelman NH, Abraham A, et al. 2019. Shortened leukocyte telomere length is associated with reduced pulmonary function and greater subsequent decline in function in a sample of World Trade Center responders. Scientific Reports (Nature Publisher Group). 9 (1):8148.

HTTPS://DOI.ORG/10.1038/S41598-019-44625-1

THE OBJECTIVE: of this study was to examine whether shorter leukocyte telomere length (LTL) is associated with more rapid pulmonary function decline in a longitudinal study of World Trade Center (WTC) responders. WTC responders (N = 284) participating in a monitoring study underwent blood sampling and were followed prospectively for spirometric outcomes. A single blood sample was taken to measure LTL using southern blotting.

OUTCOMES: included percent-predicted one-second forced expiratory volume (FEV1%), forced vital capacity (FVC%), and the FEV1/FVC ratio. In a subset, percent-predicted diffusing capacity (DLCO%) was also measured. Longitudinal modeling examined prospectively collected information over five years since blood was banked was used to examine the rate of change in pulmonary functioning over time. Severity of WTC exposure was assessed. Shorter LTL was associated with lower FEV1% and FVC% at baseline. For example, 29.9% of those with LTL <6.5 kbps had FEV1% <80% whereas only 12.4% of those with LTL ≥6.5 had FEV1% <80% (RR = 2.53, 95%CI = [1.70–3.76]). Lower DLCO% was also significantly associated with shorter LTL. Longitudinal models identified a prospective association between shorter LTL and greater yearly rates of decline in FEV1% (0.46%/year, 95%CI = [0.05–0.87]) and in the FEV1/FVC ratio (0.19%/year, 95%CI = [0.03–0.36]). There were no associations between severity of exposure and either LTL or pulmonary function. Longitudinal analyses revealed that shorter LTL, but not severity of WTC exposures, was associated with poorer pulmonary functioning and with greater subsequent decline in pulmonary functioning over time. These findings are

consistent with the idea that shortened LTL may act as a biomarker for enhanced pulmonary vulnerability in the face of acute severe toxic inhalation exposures.

Clouston SAP, Kuan P, Kotov R, et al. 2019. Risk factors for incident prostate cancer in a cohort of World Trade Center responders. BMC Psychiatry. 19 (1):389.

HTTPS://DOI.ORG/10.1186/S12888-019-2383-1

BACKGROUND: Despite a relatively young average age and no routine screening, prostate cancer is one of the most common cancers in men who worked at the World Trade Center (WTC) following the 9/11/2001 disaster. This study evaluated whether re-experiencing stressful memories of a traumatic event was associated with prostate cancer incidence.

METHODS: Participants were males from one clinical center that monitors the health of first-responders (N = 6857). Monitoring began in July 2002 and occurs annually but does not include prostate cancer screening. Severity of physical exposures and of re-experiencing memories and stress responses were measured at study enrollment using standardized and validated methods in all participants. The outcome was incidence of diagnosed prostate cancer after enrollment (n = 68). Bivariate analyses provided age-adjusted incidence rates (aIR). Cox proportional hazards modeling was used to calculate incidence; hazards ratios (HR) were reported.

RESULTS: The mean age of responders on 9/11/2001 was 37.9 years. Prostate cancer incidence was lowest in responders with no re-experiencing stress (aIR = 250.83/100,000 person-years, [233.41-268.25]) and highest in responders with severe re-experiencing stress (aIR = 818.49/100,000 person-years, [801.07-835.91]). Cox proportional hazards regression revealed that re-experiencing the stressful events of 9/11/2001 was associated with increased prostate cancer incidence (HR = 1.96 [1.26-3.05], P = 0.003), even upon adjusting for confounders.

CONCLUSIONS: This is the first study to identify a positive association between re-experiencing a traumatic event and prostate cancer incidence. Our results are consistent with recent rodent model evidence demonstrating a direct biological link between stress pathways and prostate tumorigenesis and offer new hypotheses in the causality of prostate cancer.

de la Hoz RE, Liu X, Celedón JC, et al. 2019. Association of obesity with quantitative chest ct measured airway wall thickness in WTC workers with lower airway disease. Lung. 197 (4):517–522.

HTTPS://DOI.ORG/10.1007/S00408-019-00246-Z

BACKGROUND: We previously reported that wall area percent (WAP), a quantitative CT (QCT) indicator of airway wall thickness and, presumably, inflammation, is associated with adverse longitudinal expiratory flow trajectories in WTC workers, but that obesity and weight gain also seemed to be independently predictive of the latter. Previous studies have reported no association between WAP and obesity, so we investigated that association in nonsmoking WTC-exposed individuals and healthy unexposed controls.

METHODS:We assessed WAP using the

Chest Imaging Platform QCT system in a segmental bronchus in 118 former WTC workers, and 89 COPDGene® WTC-unexposed and asymptomatic subjects. We used multiple regression to model WAP vs. body mass index (BMI) in the two groups, adjusting for important subject and CT image characteristics.

RESULTS: Unadjusted analyses revealed significant differences between the two groups with regards to WAP, age, gender, scan pixel spacing and slice interval, but not BMI or total lung capacity. In adjusted analysis, there was a significant interaction between BMI and WTC exposure on WAP. BMI was significantly and positively associated with WAP in the WTC group, but not in the COPDGene® group, but stratified analyses revealed that the effect was significant in WTC subjects with clinical evidence of lower airway disease (LAD).

DISCUSSION: Unlike non-diseased subjects, BMI was significantly associated with WAP in WTC workers and, in stratified analyses, the association was significant only among those with LAD. Our findings suggest that this adverse effect of obesity on airway structure and inflammation may be confined to already diseased individuals.

Hammock AC, Dreyer RE, Riaz M, et al. 2019. Trauma and relationship strain: Oral histories with World Trade Center disaster responders. Qual Health Res. 29 (12):1751–1765.

HTTPS://DOI.ORG/10.1177/1049732319837534

Existing models of couple functioning after trauma are primarily based on the experiences of returning military veterans. In this study, we conducted thematic analysis of a purposive sample of 49 oral histories of responders to the 9/11/01 terrorist attacks to understand how they navigated life with their spouses after the response experience. Use of multiple coders and analytic matrices increased analytic rigor. In the sample, 34.7% disclosed a posttraumatic stress disorder (PTSD) diagnosis and another 22.7% mentioned experiencing at least one trauma symptom. Most responders had not sought mental health intervention, relying instead on their spouses' caregiving. Responders reported limited disclosure to their spouses about the details of their 9/11/01 response work, which may have helped them cope emotionally with repeated 9/11/01 clean-up duties. Shared values regarding the common good and patriotism were important for maintaining an intimate relationship after 9/11/01, and helping partners understand and feel understood by each other.

Mukherjee S, Clouston S, Kotov R, et al. 2019. Handgrip strength of World Trade Center (WTC) responders: The role of re-experiencing posttraumatic stress disorder (PTSD) symptoms. International journal of environmental research and public health. 16 (7)

HTTPS://DOI.ORG/10.3390/IJERPH16071128

BACKGROUND: This study sought to examine whether handgrip strength (HGS), a measure of muscle strength and a biomarker of aging, was associated with post-traumatic stress disorder (PTSD) in a cohort of World Trade Center (WTC) responders at midlife.

METHODS: HGS was assessed utilizing a computer-assisted hand dynamometer administered to a consecutive sample

of men and women (n = 2016) who participated in rescue and recovery efforts following the World Trade Center (WTC) attacks and subsequently attended monitoring appointments in Long Island, NY. PTSD symptom severity and depressive symptoms were assessed using the PTSD specific-trauma checklist (PCL-S) and the Patient Health Questionnaire (PHQ-9). General linear models were used to examine the association of WTC-related PTSD with HGS after adjusting for confounders. Results: The sample was at midlife (mean age = 53.3) when assessed, and 91.3% were men. Nearly 10% of the sample had probable PTSD (PCL ≥ 44) with concomitant depression (PHQ ≥ 10), while 5.1% had probable PTSD without depression. Average HGS was 57.4 lbs. (95% confidence interval (95% CI): 56.6-58.1) among men and 36.1 lbs. (95% CI = 33.8-38.5) among women. Mean HGS of those with probable PTSD with concomitant depression was lower (45.9 lbs., 95% CI = 43.6-48.2) than responders with only PTSD (49.1 lbs., 95% CI = 46.0-52.4) and those without PTSD or depression (57.5 lbs., 95% CI = 56.2-57.8). Subdomain analyses of PTSD symptoms revealed that re-experiencing symptoms at enrollment (p = 0.003) was associated with lower HGS after adjusting for depressive symptoms and other confounders.

DISCUSSION: Results suggested that higher WTC-related PTSD symptom severity was associated with lower HGS. Results support ongoing work suggesting that PTSD may be associated with more rapid physical aging. The potential for developing interventions that might simultaneously improve physical and mental health in the aftermath of trauma may be considered.

Sunil VR, Radbel J, Hussain S, et al. 2019. Sarcoid-like granulomatous disease: Pathologic case series in World Trade Center dust exposed rescue and recovery workers. Int J Environ Res Public Health. 16 (5)

HTTPS://DOI.ORG/10.3390/IJERPH16050815

Sarcoid-like granulomatous diseases (SGD) have been previously identified in cohorts of World Trade Center (WTC) dust-exposed individuals. In the present studies, we analyzed lung and/or lymph node biopsies from patients referred to our clinic with suspected WTC dust-induced lung disease to evaluate potential pathophysiologic mechanisms. Histologic sections of lung and/or lymph node samples were analyzed for markers of injury, oxidative stress, inflammation, fibrosis, and epigenetic modifications. Out of seven patients examined, we diagnosed four with SGD and two with pulmonary fibrosis; one was diagnosed later with SGD at another medical facility. Patients with SGD were predominantly white, obese men, who were less than 50 years old and never smoked. Cytochrome b5, cytokeratin 17, heme oxygenase-1, lipocalin-2, inducible nitric oxide synthase, cyclooxygenase 2, tumor necrosis factor alpha, ADP-ribosylation factor-like GTPase 11, mannose receptor-1, galectin-3, transforming growth factor beta, histone-3 and methylated histone-3 were identified in lung and lymph nodes at varying levels in all samples examined. Three of the biopsy samples with granulomas displayed peri-granulomatous fibrosis. These findings are important and suggest the potential of WTC dust-induced fibrotic sarcoid. It is likely that patient demographics and/or genetic factors influence the response to WTC dust

injury and that these contribute to different pathological outcomes.

Year Published 2020 (13)

Bover Manderski MT, Black K, Udasin IG, et al. 2020. Retrospective assessment of risk factors for head and neck cancer among World Trade Center general responders. Front Public Health. 8:488057.

HTTPS://DOI.ORG/10.3389/FPUBH.2020.488057

OBJECTIVE: To assess the reliability of a questionnaire designed to reconstruct risk factors for head and neck cancer relative to the 9/11 World Trade Center (WTC) response and over the lifetime.

METHODS: As part of a nested case-control study, 200 WTC Health Program (WTCHP) General Responder Cohort (GRC) members completed a newly-developed study questionnaire via telephone (with a trained interviewer) or online (self-administered). We assessed agreement between measures of tobacco and alcohol use in our questionnaire results and data collected previously during WTCHP-GRC monitoring visits using Cohens Kappa (κ) and intraclass correlation coefficient (ICC) for categorical and continuous measures, respectively. We compared agreement by disease status, survey mode, and year of WTCHP enrollment. Results: We observed high agreement between measures of lifetime, pre-WTC, and post-WTC smoking prevalence (all $\kappa > 0.85$) and smoking duration (all ICC > 0.84). There was moderate agreement between measures of smoking frequency (ICC: 0.61-0.73). Agreement between measures of smoking frequency, but not duration, differed by disease status, and agreement between smoking measures was higher for participants who completed our survey by phone than by web. Among cases, there were no differences based on enrollment in the WTCHP before or after diagnosis.

CONCLUSION: Agreement between measures was generally high, although potential reporting bias and a mode effect that should be considered when interpreting analyses of self-reported data in this population; however differential misclassification appears to be minimal. Our questionnaire may be useful for future studies examining similar behavioral risk factors among disaster-exposed populations.

Chen C, Salim R, Rodriguez J, et al. 2020. The burden of subthreshold posttraumatic stress disorder in World Trade Center responders in the second decade after 9/11. J Clin Psychiatry. 81 (1)

HTTPS://DOI.ORG/10.4088/JCP.19M12881

OBJECTIVE: To characterize the prevalence, risk and protective correlates, and clinical characteristics associated with probable subthreshold posttraumatic stress disorder (PTSD) in police and nontraditional (eg, construction workers) World Trade Center (WTC) responders a median of 12.2 years after September 11, 2001.

METHODS: A total of 4,196 WTC responders, monitored via the WTC Health Program, completed a web-based survey between

2012 and 2014 assessing a range of variables, including demographics, WTC exposures, medical and psychiatric comorbidities, and mental health services use. The sample included 2,029 police responders and 2,167 nontraditional responders. Current (past-month) probable WTC-related PTSD level (none, subthreshold, or full PTSD) was assessed based on DSM-IV criteria using the PTSD Checklist-Specific Stressor version (PCL-S).

RESULTS: The prevalence of current probable full and subthreshold WTC-related PTSD in police responders was 9.3% and 17.5%, respectively, and in nontraditional responders was 21.9% and 24.1%, respectively. Risk and protective correlates for subthreshold PTSD included post-9/11 medical comorbidities and traumatic events (odds ratios [ORs] = 1.1-1.2). Clinical characteristics included elevated rates of comorbid depression (OR = 3.2 and 3.9 for subthreshold PTSD and 17.2 and 30.3 for full PTSD for nontraditional and police responders, respectively). Among responders with subthreshold PTSD, police were more likely to have accessed mental health services and utilized a greater variety of treatments than nontraditional responders.

CONCLUSIONS: Overall, 26.8% of police and 46.0% of nontraditional responders met criteria for probable WTC-related full or subthreshold PTSD an average of 12 years after 9/11. Probable subthreshold PTSD, which is not typically assessed in clinical settings, was more prevalent than probable full PTSD and was associated with significantly elevated rates of psychiatric comorbidities, functional impairment, and reduced quality of life. These findings underscore the importance of assessing, monitoring, and possibly treating subthreshold PTSD in WTC and other disaster responders.

Chen X, Ma T, Yip R, et al. 2020. Elevated prevalence of moderate-to-severe hepatic steatosis in World Trade Center general responder cohort in a program of ct lung screening. Clin Imaging. 60 (2):237–243.

HTTPS://DOI.ORG/10.1016/J.CLINIMAG.2019.12.009

BACKGROUND AND AIMS: To determine the prevalence of moderate-to-severe hepatic steatosis (HS) and associated risk factors in members of the World Trade Center (WTC) General Responder Cohort (GRC) who qualify for low-dose non-contrast computed tomography for lung cancer screening and compare them to non-WTC participants in the same screening program.

METHODS: All participants gave written informed consent before participating in this IRB-approved study. Clinical variables and laboratory values were recorded. Hepatic attenuation measurement (Hounsfield unit; HU) was measured on low-dose computed tomography (LDCT) and a threshold attenuation value <40HU indicated moderate-to-severe HS. Bivariate and multivariable linear and logistic regression analyses were performed. Propensity scores (PS) were calculated and inverse probability weighting (IPW) was used to adjust for potential confounders when comparing the WTC with non-WTC participants.

RESULTS: The prevalence of moderate-to-severe HS was 16.2% among 154 WTC participants compared to 5.3% among 170

non-WTC participants. In WTC members, moderate-to-severe HS was associated with higher BMI, higher laboratory liver function tests, and former smoking status. Using PS analysis and IPW to account for potential confounders, the odds ratio for moderate-to-severe HS was 3.4-fold higher (95% confidence interval: 1.7-6.7) in the WTC participants compared with non-WTC participants. Moderate-to-severe HS was also associated with higher BMI and former smoker status.

CONCLUSION: Prevalence of moderate-to-severe HS was >3-fold higher in the WTC-GRC group than in other participants.

Clouston SAP, Deri Y, Horton M, et al. 2020. Reduced cortical thickness in World Trade Center responders with cognitive impairment. Alzheimers Dement (Amst). 12 (1):e12059.

HTTPS://DOI.ORG/10.1002/DAD2.12059

INTRODUCTION: This study examined cortical thickness (CTX) in World Trade Center (WTC) responders with cognitive impairment (CI).

METHODS: WTC responders (N = 99) with/without CI, recruited from an epidemiologic study, completed a T1-MPRAGE protocol. CTX was automatically computed in 34 regions of interest. Region-based and surface-based morphometry examined CTX in CI versus unimpaired responders. CTX was automatically computed in 34 regions of interest. Region-based measures were also compared to published norms.

RESULTS: Participants were 55.8 (SD = 0.52) years old; 48 had CI. Compared to unimpaired responders, global mean CTX was reduced in CI and across 21/34 cortical subregions. Surface-based analyses revealed reduced CTX across frontal, temporal, and parietal lobes when adjusting for multiple comparisons. Both CI and unimpaired WTC groups had reduced CTX in the entorhinal and temporal cortices compared to published normative data. Discussion: Results from the first structural magnetic resonance imaging study in WTC responders identified reduced CTX consistent with a neurodegenerative disease of unknown etiology.

de la Hoz RE, Shapiro M, Nolan A, et al. 2020. Association of low fvc spirometric pattern with WTC occupational exposures. Respiratory Medicine. 170:106058.

HTTPS://DOI.ORG/10.1016/J.RMED.2020.106058

BACKGROUND: A reduced forced vital capacity without obstruction (low FVC) is the predominant spirometric abnormality reported in workers and volunteers exposed to dust, gases, and fumes at the World Trade Center (WTC) disaster site in 2001-2002. While low FVC has been associated with obesity and metabolic syndrome, its association with WTC occupational exposures has not been demonstrated. We estimated the prevalence of this abnormality and examined its association with WTC exposure level.

METHODS: Longitudinal study of the relation between arrival at the WTC site within 48 h and FVC below the lower limit of normal (FVC < LLN, with normal FEV1/FVC ratio) at any time in 10,284 workers with at least two spirometries between 2002 and 2018. Logistic regression and linear mixed models were used for the multivariable analyses.

RESULTS: The prevalence of low FVC increased from 17.0% (95% CI 15.4%, 18.5%) in June 2003, to 26.4% (95% CI 24.8%, 28.1%) in June 2018, and exceeded at both times that of obstruction. The rate of FVC decline was -43.7 ml/year during the study period. In a multivariable analysis adjusting for obesity, metabolic syndrome indicators, and other factors, early arrival at the WTC disaster site was significantly associated with low FVC, but only among men (ORadj = 1.29, 95% CI 1.17, 1.43). Longitudinal FVC rate of decline did not differ by WTC site arrival time.

CONCLUSIONS: Among WTC workers, the prevalence of low FVC increased over a 16-year period. Early arrival to the WTC disaster site was significantly associated with low FVC in males.

DePierro J, Lowe S, and Katz C. 2020. Lessons learned from 9/11: Mental health perspectives on the COVID-19 pandemic. Psychiatry Research. 288:113024.

HTTPS://DOI.ORG/10.1016/J.PSYCHRES.2020.113024

The COVID-19 pandemic will likely lead to high rates of PTSD, depression, and substance misuse among survivors, victims' families, medical workers, and other essential personnel. The mental health response to the 9/11/01 terrorist attacks, culminating in a federally-funded health program, provides a template for how providers may serve affected individuals. Drawing on the 9/11 experience, we highlight elective prevention measures, likely short and long-term treatment needs, vulnerable subgroups, and important points of divergence between 9/11 and the COVID-19 pandemic. Mental health monitoring, early identification of at-risk individuals, and treatment irrespective of financial barriers are essential for minimizing chronic distress.

Depierro J, Lowe SM, Haugen PT, et al. 2020. Mental health stigma and barriers to care in World Trade Center responders: Results from a large, population-based health monitoring cohort. American Journal of Industrial Medicine. 64 (3):208–216.

HTTPS://DOI.ORG/10.1002/AJIM.23204

BACKGROUND: Nearly 20 years after the terrorist attacks of September 11, 2001, multiple studies have documented the adverse mental consequences among World Trade Center (WTC) rescue, recovery, and clean-up workers. However, scarce research has examined mental health stigma and barriers to care in WTC-exposed individuals, and no known study has examined whether rates of endorsement may differ between police and "nontraditional" responders, the latter comprising a heterogeneous group of workers and volunteers.

OBJECTIVE: To identify the prevalence and correlates of mental health stigma and barriers to care in WTC responders. Methods: Mental health stigma and barriers to care and their correlates were examined in 6,777 police and 6,272 nontraditional WTC responders. Results: Nontraditional responders endorsed more stigma or barriers to care concerns than police responders. Within a subsample who screened positive for a psychiatric disorder, police were more likely than nontraditional responders to endorse "concerns that negative job consequences might result" (17.9% vs. 9.1%), while non-

traditional responders were more likely to endorse "I don't know where to go to find counseling services" (18.4% vs.6.6%). Within this subsample, mental health service need and more severe WTC-related posttraumatic stress disorder symptoms were associated with increased likelihood of endorsing stigma or barriers; pre-9/11 psychiatric history and non-Hispanic Black race/ethnicity were associated with lower likelihood of endorsing stigma or barriers.

CONCLUSIONS: Results of this study underscore the burden of mental health stigma and barriers to care in WTC responders, and highlight the need for targeted interventions to address these concerns and promote mental healthcare utilization in this population.

Factor S, Desai V, and Crane MA. 2020. Prevalence of and risk factors for hepatitis c virus infection in the World Trade Center general responder cohort. pending acceptance.

Hepatitis C virus (HCV) infection can lead to cirrhosis and hepatocellular carcinoma. At least 20% of HCV-infected persons do not have a recognized HCV risk factor. The World Trade Center (WTC) General Responder Cohort (GRC) includes over 28,000 persons who worked/volunteered during the WTC response, are followed annually, and completed questionnaires about exposure to human remains, blood/bodily fluids, and sewage during the WTC activities. The WTC-GRC offers an unprecedented opportunity to study the risk of HCV infection in emergency response workers exposed to these three agents.

Masterson-Duva M, Haugen P, Werth A, et al. 2020. Adapting meaning-centered psychotherapy for World Trade Center responders. Palliative & supportive care. 18 (6):636–643.

HTTPS://DOI.ORG/10.1017/S1478951520000061

OBJECTIVE: To date, nearly 10,000 World Trade Center (WTC) responders have been diagnosed with at least one type of WTC-related cancer, and over 70 types of cancer have been related to WTC occupational exposure. Due to the observed latency period for malignancies, the WTC Health Program anticipates increases in rates of new cancer diagnoses. Given the growing number of cancer diagnoses in this population, there is an urgent need to develop a novel intervention to address the psychosocial needs of WTC responders with cancer. Meaning-centered psychotherapy (MCP) is a structured psychotherapeutic intervention originally developed to help patients with advanced cancer find and sustain meaning in life despite illness-related limitations. Existential distress and loss of meaning are critical and understudied elements of psychological health that have been widely overlooked among WTC responders with cancer.

METHOD: We have adapted MCP for WTC responders (MCP-WTC) for the treatment of WTC responders who have been diagnosed with WTC-certified cancers. MCP-WTC aims to target the complex crisis in meaning faced by those responders who responded to the 9/11 attacks and subsequently were diagnosed with cancer as a result of their service.

RESULTS: We describe the adaptation of MCP-WTC and the application of this in-

tervention to meet the unique needs of those exposed to the terrorist attacks of September 11, 2001 (9/11), participated in the rescue, recovery, and clean-up effort at Ground Zero, and were diagnosed with WTC-related cancer. We highlight the novel aspects of this intervention which have been designed to facilitate meaning-making in the context of the patient's response to 9/11 and subsequent diagnosis of cancer.

SIGNIFICANCE OF RESULTS: This work provides a rationale for MCP-WTC and the potential for this intervention to improve the quality of life of WTC responders and help these patients navigate life after 9/11 and cancer.

Mukherjee S, Clouston S, Bromet E, et al. 2020. Past experiences of getting bullied and assaulted and posttraumatic stress disorder (PTSD) after a severe traumatic event in adulthood: A study of World Trade Center (WTC) responders. Journal of Aggression, Maltreatment and Trauma. 29 (2):167–185.

HTTPS://DOI.ORG/10.1080/10926771.2018.1555873

Although experiencing bullying and other forms of assault is associated with adverse physical, emotional, and psychological consequences, the long-term consequences, especially in the aftermath of a severe trauma in adulthood, is not known. This study examined the relationship between history of being bullied and/or assaulted and posttraumatic stress disorder (PTSD) symptoms among responders to the World Trade Center (WTC) disaster. During 2015–2016, a modified life events checklist was administered to responders at Stony Brook WTC Health Program. WTC-related PTSD symptoms were assessed by PTSD checklist (PCL). Longitudinal mixed models examined associations between bullying, other forms of assault, and severity and chronicity of PTSD symptoms. Approximately, 13% of 920 responders had probable WTC-PTSD (PCL≥44). Being bullied in childhood was associated with increased odds of WTC-PTSD (adjusted odds ratio [aOR] = 7.34; 95% confidence interval [CI] = 2.12–25.34), adjusted for demographics, other stressors, and WTC exposures. PTSD odds decreased over time among those not bullied (aOR 0.82; 95% CI: 0.73–0.92), but not among victims. Experiencing physical, sexual, or verbal assaults during adulthood also had a significant association with WTC-PTSD (aOR 4.64; 95% CI: 1.98–10.92). Findings suggest being bullied in childhood and/or assaulted in adulthood can increase PTSD risk and progression after mass trauma.

Shapiro MZ, Wallenstein SR, Dasaro CR, et al. 2020. Cancer in general responders participating in World Trade Center Health Programs, 2003–2013. JNCI Cancer Spectrum. 4 (1):pkz090.

HTTPS://DOI.ORG/10.1093/JNCICS/PKZ090

Following the September 11, 2001, attacks on the World Trade Center (WTC), thousands of workers were exposed to an array of toxins known to cause adverse health effects, including cancer. This study evaluates cancer incidence in the WTC Health Program General Responder Cohort occurring within 12 years post exposure.The study population consisted of 28 729 members of the General Responder Cohort enrolled from cohort inception, July 2002 to December 31, 2013. Standardized incidence ratios (SIRs) were calculated with cancer case inclusion and follow-up starting post September 11,

2001 (unrestricted) and, alternatively, to account for selection bias, with case inclusion and follow-up starting 6 months after enrollment in the WTC Health Program (restricted). Case ascertainment was based on linkage with six state cancer registries. Under the restricted criterion, hazard ratios were estimated using multivariable Cox proportional hazards models for all cancer sites combined and for prostate cancer.Restricted analyses identified 1072 cancers in 999 responders, with elevations in cancer incidence for all cancer sites combined (SIR = 1.09, 95% confidence interval [CI] = 1.02 to 1.16), prostate cancer (SIR = 1.25, 95% CI = 1.11 to 1.40), thyroid cancer (SIR = 2.19, 95% CI = 1.71 to 2.75), and leukemia (SIR = 1.41, 95% CI = 1.01 to 1.92). Cancer incidence was not associated with any WTC exposure index (composite or individual) for all cancer sites combined or for prostate cancer.Our analyses show statistically significant elevations in cancer incidence for all cancer sites combined and for prostate and thyroid cancers and leukemia. Multivariable analyses show no association with magnitude or type of exposure.

Waszczuk MA, Docherty AR, Shabalin AA, et al. 2020. Polygenic prediction of PTSD trajectories in 9/11 responders. Psychol Med. :1–9.

HTTPS://DOI.ORG/10.1017/S0033291720003839

BACKGROUND: Genetics hold promise of predicting long-term post-traumatic stress disorder (PTSD) outcomes following trauma. The aim of the current study was to test whether six hypothesized polygenic risk scores (PRSs) developed to capture genetic vulnerability to psychiatric conditions prospectively predict PTSD onset, severity, and 18-year course after trauma exposure.

METHODS: Participants were 1490 responders to the World Trade Center (WTC) disaster (mean age at 9/11 = 38.81 years, s.d. = 8.20; 93.5% male; 23.8% lifetime WTC-related PTSD diagnosis). Prospective longitudinal data on WTC-related PTSD symptoms were obtained from electronic medical records and modelled as PTSD trajectories using growth mixture model analysis. Independent regression models tested whether six hypothesized psychiatric PRSs (PTSD-PRS, Re-experiencing-PRS, Generalized Anxiety-PRS, Schizophrenia-PRS, Depression-PRS, and Neuroticism-PRS) are predictive of WTC-PTSD outcomes: lifetime diagnoses, average symptom severity, and 18-year symptom trajectory. All analyses were adjusted for population stratification, 9/11 exposure severity, and multiple testing.

RESULTS: Depression-PRS predicted PTSD diagnostic status (OR 1.37, CI 1.17-1.61, adjusted p = 0.001). All PRSs, except PTSD-PRS, significantly predicted average PTSD symptoms (beta = 0.06-0.10, adjusted $p < 0.05$). Re-experiencing-PRS, Generalized Anxiety-PRS and Schizophrenia-PRS predicted the high severity PTSD trajectory class (ORs 1.21-1.28, adjusted $p < 0.05$). Finally, PRSs prediction was independent of 9/11 exposure severity and jointly accounted for 3.7 times more variance in PTSD symptoms than the exposure severity.

CONCLUSIONS: Psychiatric PRSs prospectively predicted WTC-related PTSD lifetime diagnosis, average symptom severity, and 18-year trajectory in responders to

9/11 disaster. Jointly, PRSs were more predictive of subsequent PTSD than the exposure severity. In the future, PRSs may help identify at-risk responders who might benefit from targeted prevention approaches.

Weber J, Reeves AP, Doucette JT, et al. 2020. Quantitative ct evidence of airway inflammation in WTC workers and volunteers with low fvc spirometric pattern. Lung. 198 (3):555–563.

HTTPS://DOI.ORG/10.1007/S00408-020-00350-5

BACKGROUND: The most common abnormal spirometric pattern reported in WTC worker and volunteer cohorts has consistently been that of a nonobstructive reduced forced vital capacity (low FVC). Low FVC is associated with obesity, which is highly prevalent in these cohorts. We used quantitative CT (QCT) to investigate proximal and distal airway inflammation and emphysema in participants with stable low FVC pattern.

METHODS: We selected study participants with at least two available longitudinal surveillance spirometries, and a chest CT with QCT measurements of proximal airway inflammation (wall area percent, WAP), end-expiratory air trapping, suggestive of distal airway obstruction (expiratory to inspiratory mean lung attenuation ratio, MLAEI), and emphysema (percentage of lung volume with attenuation below –950 HU, LAV%). The comparison groups in multinomial logistic regression models were participants with consistently normal spirometries, and participants with stable fixed obstruction (COPD).

RESULTS: Compared to normal spirometry participants, and after adjusting for age, sex, race/ethnicity, BMI, smoking, and early arrival at the WTC disaster site, low FVC participants had higher WAP (ORadj 1.24, 95% CI 1.06, 1.45, per 5% unit), suggestive of proximal airway inflammation, but did not differ in MLAEI, or LAV%. COPD participants did not differ in WAP with the low FVC ones and were more likely to have higher MLAEI or LAV% than the other two subgroups.

DISCUSSION: WTC workers with spirometric low FVC have higher QCT-measured WAP compared to those with normal spirometries, but did not differ in distal airway and emphysema measurements, independently of obesity, smoking, and other covariates.

Year Published 2021 (26)

Bello GA, Ornstein KA, Lucchini RG, et al. 2021. Development and validation of a clinical frailty index for the World Trade Center general responder cohort. Journal of Aging and Health. 33 (44750):531–544.

HTTPS://DOI.ORG/10.1177/0898264321997675

OBJECTIVES: To develop and validate a clinical frailty index to characterize aging among responders to the 9/11 World Trade Center (WTC) attacks. Methods: This study was conducted on health monitoring data on a sample of 6197 responders. A clinical frailty index, WTC FI-Clinical, was developed according to the cumulative deficit model of frailty. The validity of the resulting index was assessed using all-cause mortality as an endpoint. Its association with various cohort characteristics was evaluated.

RESULTS: The sample's median age was 51 years. Thirty items were selected for inclusion in the index. It showed a strong correlation with age, as well as significant adjusted associations with mortality, 9/11 exposure severity, sex, race, pre-9/11 occupation, education, and smoking status. Discussion: The WTC FI-Clinical highlights effects of certain risk factors on aging within the 9/11 responder cohort. It will serve as a useful instrument for monitoring and tracking frailty within this cohort.

Brackbill RM, Kahn AR, Li J, et al. 2021. Combining three cohorts of World Trade Center rescue/recovery workers for assessing cancer incidence and mortality. International Journal of Environmental Research and Public Health. 18 (4):1386.

HTTPS://DOI.ORG/10.3390/IJERPH18041386

Three cohorts including the Fire Department of the City of New York (FDNY), the World Trade Center Health Registry (WTCHR), and the General Responder Cohort (GRC), each funded by the World Trade Center Health Program have reported associations between WTC-exposures and cancer. Results have generally been consistent with effect estimates for excess incidence for all cancers ranging from 6 to 14% above background rates. Pooling would increase sample size and de-duplicate cases between the cohorts. However, pooling required time consuming steps: obtaining Institutional Review Board (IRB) approvals and legal agreements from entities involved; establishing an honest broker for managing the data; de-duplicating the pooled cohort files; applying to State Cancer Registries (SCRs) for matched cancer cases; and finalizing analysis data files. Obtaining SCR data use agreements ranged from 6.5 to 114.5 weeks with six states requiring >20 weeks. Records from FDNY (n = 16,221), WTCHR (n = 29,372), and GRC (n = 33,427) were combined de-duplicated resulting in 69,102 unique individuals. Overall, 7894 cancer tumors were matched to the pooled cohort, increasing the number cancers by as much as 58% compared to previous analyses. Pooling resulted in a coherent resource for future research for studies on rare cancers and mortality, with more representative of occupations and WTC- exposure. Note--This paper describes the processes involved with combining data across the three WTC-exposed cohorts and linking the pooled data with state cancer registries;

and the strategies for overcoming administrative challenges. To our knowledge, studies that use pooled data do not typically provide a detailed description of their combining process. The transparency of this approach is important for a fuller understanding of the findings derived from analyses of WTC-exposure and health in our case, as well as, other endeavors that also use information combined from multiple sources.

Chen APF, Clouston SAP, Kritikos M, et al. 2021. A deep learning approach for monitoring parietal-dominant alzheimer's disease in World Trade Center responders at midlife. Brain Commun. 3 (3):fcab145.

HTTPS://DOI.ORG/10.1093/BRAINCOMMS/FCAB145

Little is known about the characteristics and causes of early-onset cognitive impairment. Responders to the 2001 New York World Trade Center disaster represent an ageing population that was recently shown to have an excess prevalence of cognitive impairment. Neuroimaging and molecular data demonstrate that a subgroup of affected responders may have a unique form of parietal-dominant Alzheimer's Disease. Recent neuropsychological testing and artificial intelligence approaches have emerged as methods that can be used to identify and monitor subtypes of cognitive impairment. We utilized data from World Trade Center responders participating in a health monitoring program and applied a deep learning approach to evaluate neuropsychological and neuroimaging data to generate a cortical atrophy risk score. We examined risk factors associated with the prevalence and incidence of high risk for brain atrophy in responders who are now at midlife. Training was conducted in a randomly selected two-thirds sample (N = 99) enrolled using of the results of a structural neuroimaging study. Testing accuracy was estimated for each training cycle in the remaining third subsample. After training was completed, the scoring methodology that was generated was applied to longitudinal data from 1441 World Trade Center responders. The artificial neural network provided accurate classifications of these responders in both the testing (Area Under the Receiver Operating Curve, 0.91) and validation samples (Area Under the Receiver Operating Curve, 0.87). At baseline and follow-up, responders identified as having a high risk of atrophy (n = 378) showed poorer cognitive functioning, most notably in domains that included memory, throughput, and variability as compared to their counterparts at low risk for atrophy (n = 1063). Factors associated with atrophy risk included older age [adjusted hazard ratio, 1.045 (95% confidence interval = 1.027-1.065)], increased duration of exposure at the WTC site [adjusted hazard ratio, 2.815 (1.781-4.449)], and a higher prevalence of post-traumatic stress disorder [aHR, 2.072 (1.408-3.050)]. High atrophy risk was associated with an increased risk of all-cause mortality [adjusted risk ratio, 3.19 (1.13-9.00)]. In sum, the high atrophy risk group displayed higher levels of previously identified risk factors and characteristics of cognitive impairment, including advanced age, symptoms of post-traumatic stress disorder, and prolonged duration of exposure to particulate matter. Thus, this study suggests that a high risk of brain atrophy may be accurately monitored using cognitive data.

Ciro D, Pietrzak RH, Lee RJ, et al. 2021. Acculturation, coping, and PTSD in hispanic 9/11 rescue and recovery

workers. Psychol Trauma. 13 (1):84–93.

HTTPS://DOI.ORG/10.1037/TRA0000624

OBJECTIVE: Research examining the responders of the World Trade Center terrorist attacks of 9/11 has found that Hispanic responders are at greater risk for posttraumatic stress disorder (PTSD) than non-Hispanic White responders. However, no studies have examined how acculturation may influence the relationship between coping and PTSD in Hispanic 9/11 responders. This novel study is the first to examine differences in coping and PTSD among Hispanic responders by level of acculturation.

METHODS: The sample is composed of 845 Hispanic 9/11 responders who were seen at the World Trade Center Health Program and participated in a web-based survey. Using logistic and multiple linear regression, we examined how acculturation is related to their coping strategies and risk for PTSD. We also tested for interaction to examine whether level of acculturation moderated the relationship between coping and PTSD symptom severity.

RESULTS: Key findings revealed that higher acculturation is associated with the use of substances, venting, and humor to cope, while lower acculturation is associated with the use of active coping and self-distraction in this sample. We also found that less acculturated responders were more likely to experience more severe PTSD. Lastly, our findings revealed that Hispanics who are more acculturated and used substances to cope had more severe PTSD than less acculturated responders.

CONCLUSION: These findings highlight the need to consider the role of acculturation in Hispanic responders' coping and PTSD.

Crowley G, Caraher E, Veerappan A, et al. 2021. Metabolomics at the intersection of murine WTC-pm exposure and high fat diet: A machine learning assessment. Journal. (0)

HTTPS://DOI.ORG/10.1164/AJRCCM-CONFERENCE.2021.203.1_MEETINGABSTRACTS.A4337

TP112 PROTEOMICS/GENOMICS/METABOLOMICS IN LUNG DISEASE: Corresponding

RATIONALE: We have previously reported that high fat diet-particulate matter (HFD-PM) co-exposure can induce airway hypereactivity (AHR) in a murine model similar to what is clinically seen in the WTC-exposed firefighter cohort. LPA, a potential pathway that links MetSyn and pulmonary disease, is increased in HFD-PM co-exposure. Echocardiography results indicate that PM exposure in obesity causes subsequent cardiopulmonary dysfunction.;To further our understanding of potential pathways involved in vascular and pulmonary remodeling, we assayed the metabolome of HFD and PM co-exposure. ;;

METHODS: Murine HFD PM Exposure Model. C57Bl/6 wild type (WT) mice (n=8/group), aged 6-8 weeks were fed HFD (60% of calories from lard; D12492i; Research Diets) or normal diet (ND) with 13% of calories from fat. After 12-weeks of HFD and ≥20% weight gain when compared to age matched ND controls, oropharyngeal aspiration of 200µg WTC-PM53 or an equal volume of PBS was administered.;Metabolomics. 24-hrs after exposure, 100-mg

of lung was snap frozen and underwent metabolomics assessment (Metabolon); 3 mice/Group. Qualified/curated metabolites subjected to random forests(RF; randomForest package R3.4.3, R-Project). Refined metabolite profile (top 5% based on mean decrease accuracy) was developed and included in a second model to assess classification performance. Unsupervised, agglomerative, two-way hierarchical clustering (Spearman correlation, average linkage; MATLAB-R2018a) performed for data visualization on refined profile. ;;

RESULTS: The refined profile of metabolites (n=22) are shown, Figure 1A. Hierarchical clustering;of the refined profile revealed differential expression in 2 clusters, Figure 1B. Random forests of the refined profile had 0% estimated classification error. Cluster 1, elevated in PBS-exposed mice, contained metabolites related to dietary protein. Meanwhile, Cluster 2, elevated in PM-exposed mice, included fatty acid metabolites that play a role in inflammation, as well as metabolites of amino acids. ;;

CONCLUSIONS: Similar to our human population, we observe that fatty acids and acetylated lysine residues are differentially expressed. These metabolites may play a;role in WTC-PM-related pathology and implicate epigenetic modulation as a potential result of WTC-exposure and a mechanism of WTC-AHR. Furthermore, elevations in metabolites related to dietary protein have been linked to resistance to WTC-related lung disease, and are seen here to be decreased in response to PM-exposure. Future work will investigate cardiovascular and respiratory remodeling that occurs after PM exposure in the context of high fat diets.

Deri Y, Clouston SAP, DeLorenzo C, et al. 2021. Selective hippocampal subfield volume reductions in World Trade Center responders with cognitive impairment. Alzheimer's & Dementia: Diagnosis, Assessment & Disease Monitoring. 13 (1):e12165.

HTTPS://DOI.ORG/10.1002/DAD2.12165

ABSTRACT INTRODUCTION: The objective of this study was to investigate associations between dementia in World Trade Center (WTC) responders and in vivo volumetric measures of hippocampal subfield volumes in WTC responders at midlife.

METHODS: A sample of 99 WTC responders was divided into dementia and unimpaired groups. Participants underwent structural T1-weighted magnetic resonance imaging. Volumetric measures included the overall hippocampus and eight subfields. Regression models examined volumetric measure of interest adjusting for confounders including intracranial volume.

RESULTS: Dementia was associated with smaller hippocampal volume and with reductions across hippocampal subfields. Smaller hippocampal subfield volumes were associated with longer cumulative time worked at the WTC. Domain-specific cognitive performance was associated with lower volumetric measures across hippocampal subregions.

CONCLUSIONS: This is the first study to investigate hippocampal subfield volumes in a sample of WTC responders at midlife. Selective hippocampal subfield volume reductions suggested abnormal cognition that were associated with WTC exposure duration.

Deri Y, Clouston SAP, DeLorenzo C, et al. 2021. Neuroinflammation in World Trade Center responders at midlife: A pilot study using [(18)f]-feppa pet imaging. Brain Behav Immun Health. 16:100287.

HTTPS://DOI.ORG/10.1016/J.BBIH.2021.100287

BACKGROUND: Neuroinflammation has long been theorized to arise from exposures to fine particulate matter and to be modulated when individuals experience chronic stress, both of which are also though to cause cognitive decline in part as a result of neuroinflammation.

OBJECTIVES: Hypothesizing that neuroinflammation might be linked to experiences at the World Trade Center (WTC) events, this study explored associations between glial activation and neuropsychological measures including post-traumatic stress disorder (PTSD) symptom severity and WTC exposure duration.

METHODS: Translocator protein 18-kDa (TSPO) is overexpressed by activated glial cells, predominantly microglia and astrocytes, making TSPO distribution a putative biomarker for neuroinflammation. Twenty WTC responders completed neuropsychological assessments and in vivo PET brain scan with [(18)F]-FEPPA. Generalized linear modeling was used to test associations between PTSD, and WTC exposure duration as the predictor and both global and regional [(18)F]-FEPPA total distribution volumes as the outcomes.

RESULT: Responders were 56.0 ± 4.7 years-old, and 75% were police officers on 9/11/2001, and all had at least a high school education. Higher PTSD symptom severity was associated with global and regional elevations in [(18)F]-FEPPA binding predominantly in the hippocampus (d = 0.72, P = 0.001) and frontal cortex (d = 0.64, P = 0.004). Longer exposure duration to WTC sites was associated with higher [(18)F]-FEPPA binding in the parietal cortex.

CONCLUSION: Findings from this study of WTC responders at midlife suggest that glial activation is associated with PTSD symptoms, and WTC exposure duration. Future investigation is needed to understand the important role of neuroinflammation in highly exposed WTC responders.

Deri Y, Clouston SAP, DeLorenzo C, et al. 2021. Neuroinflammation and mild cognitive impairment in World Trade Center responders at midlife: A pilot study using [18f]-feppa pet imaging. Brain, Behavior, & Immunity - Health. 16:100287.

HTTPS://DOI.ORG/10.1016/J.BBIH.2021.100287

BACKGROUND: Neuroinflammation has long been theorized to arise from exposures to fine particulate matter and to be modulated when individuals experience chronic stress, both of which are also though to cause cognitive decline in part as a result of neuroinflammation. Objectives Hypothesizing that neuroinflammation might provide a mechanism linking experiences at the WTC events with evidence of cognitive impairment, this study explored associations between glial activation and neuropsychological measures including post-traumatic stress disorder (PTSD) symptom severity and WTC exposure duration.

METHODS: Translocator protein 18-kDa (TSPO) is overexpressed by activated glial cells, predominantly microglia and astro-

cytes, making TSPO distribution a putative biomarker for neuroinflammation in neurodegenerative conditions including MCI. WTC responders with MCI (n=10) and a matched-set of cognitively unimpaired responders (n=10) completed in vivo PET brain scan with [18F]-FEPPA. Generalized linear modeling was used to test associations between MCI as the predictor and both global and regional [18F]-FEPPA total distribution volumes as the outcomes. Neuropsychological measures and time worked on WTC site were used as predictors in secondary exploratory analyses.

RESULT(S): Responders were 56.0 ± 4.7 years-old, and 75% were police officers on 9/11/2001, and all had at least a high school education. Higher PTSD symptom severity was associated with global and regional elevations in [18F]-FEPPA binding predominantly in the hippocampus (d = 0.72, P = 0.001) and frontal cortex (d = 0.64, P = 0.004). Longer exposure duration to WTC sites was associated with higher [18F]-FEPPA binding in the parietal cortex.

CONCLUSION: Findings suggest that glial activation is associated with visual memory, PTSD symptoms, and time worked on the WTC sites in a pilot study of WTC responders. Future investigations are needed to understand the important role of neuroinflammation in highly exposed WTC responders.

Goldfarb DG, Zeig-Owens R, Kristjansson D, et al. 2021. Cancer survival among World Trade Center rescue and recovery workers: A collaborative cohort study. Am J Ind Med. 64 (10):815–826.

HTTPS://DOI.ORG/10.1002/AJIM.23278

BACKGROUND: World Trade Center (WTC)-exposed responders may be eligible to receive no-cost medical monitoring and treatment for certified conditions, including cancer. The survival of responders with cancer has not previously been investigated.

METHODS: This study compared the estimated relative survival of WTC-exposed responders who developed cancer while enrolled in two WTC medical monitoring and treatment programs in New York City (WTC-MMTP responders) and WTC-exposed responders not enrolled (WTC-non-MMTP responders) to non-responders from New York State (NYS-non-responders), all restricted to the 11-southernmost NYS counties, where most responders resided. Parametric survival models estimated cancer-specific and all-cause mortality. Follow-up ended at death or on December 31, 2016.

RESULTS: From January 1, 2005 to December 31, 2016, there were 2,037 cancer cases and 303 deaths (248 cancer-related deaths) among WTC-MMTP responders, 564 cancer cases, and 143 deaths (106 cancer-related deaths) among WTC-non-MMTP responders, and 574,075 cancer cases and 224,040 deaths (158,645 cancer-related deaths) among the NYS-non-responder population. Comparing WTC-MMTP responders with NYS-non-responders, the cancer-specific mortality hazard ratio (HR) was 0.72 (95% confidence interval [CI] = 0.64-0.82), and all-cause mortality HR was 0.64 (95% CI = 0.58-0.72). The cancer-specific HR was 0.94 (95% CI = 0.78-1.14), and all-cause mortality HR was 0.93 (95% CI = 0.79-1.10) comparing WTC-non-MMTP responders to the NYS-non-responder population.

CONCLUSIONS: WTC-MMTP responders had lower mortality compared with NYS-non-responders, after controlling for demographic factors and temporal trends. There may be survival benefits from no-out-of-pocket-cost medical care which could have important implications for healthcare policy, however, other occupational and socioeconomic factors could have contributed to some of the observed survival advantage.

Huang C, Kritikos M, Clouston SAP, et al. 2021. White matter connectivity in incident mild cognitive impairment: A diffusion spectrum imaging study of World Trade Center responders at midlife. Journal of Alzheimer's Disease. 80 (3):1–11.

HTTPS://DOI.ORG/10.3233/JAD-201237

BACKGROUND: Individuals who participated in response efforts at the World Trade Center (WTC) following 9/11/2001 are experiencing elevated incidence of mild cognitive impairment (MCI) at midlife.

OBJECTIVE: We hypothesized that white matter connectivity measured using diffusion spectrum imaging (DSI) would be restructured in WTC responders with MCI versus cognitively unimpaired responders.

METHODS: Twenty responders (mean age 56; 10 MCI/10 unimpaired) recruited from an epidemiological study were characterized using NIA-AA criteria alongside controls matched on demographics (age/sex/occupation/race/education). Axial DSI was acquired on a 3T Siemen's Biograph mMR scanner (12-channel head coil) using a multi-band diffusion sequence. Connectometry examined whole-brain tract-level differences in white matter integrity. Fractional anisotropy (FA), mean diffusivity (MD), and quantified anisotropy were extracted for region of interest (ROI) analyses using the Desikan-Killiany atlas.

RESULTS: Connectometry identified both increased and decreased connectivity within regions of the brains of responders with MCI identified in the corticothalamic pathway and cortico-striatal pathway that survived adjustment for multiple comparisons. MCI was also associated with higher FA values in five ROIs including in the rostral anterior cingulate; lower MD values in four ROIs including the left rostral anterior cingulate; and higher MD values in the right inferior circular insula. Analyses by cognitive domain revealed nominal associations in domains of response speed, verbal learning, verbal retention, and visuospatial learning.

CONCLUSIONS: WTC responders with MCI at midlife showed early signs of neurodegeneration characterized by both increased and decreased white matter diffusivity in regions commonly affected by early-onset Alzheimer's disease.

Huckins LM, Johnson JS, Cancelmo L, et al. 2021. Polygenic regulation of PTSD severity and outcomes among World Trade Center responders. medRxiv. :2020.2012.2006.20244772.

HTTPS://DOI.ORG/10.1101/2020.12.06.20244772

Post-traumatic stress disorder (PTSD) is a debilitating psychiatric condition triggered by exposure to trauma. The study of PTSD is complicated by highly heterogeneous presentations and experiences of trauma between individuals. Capitalizing on the existence of the World Trade Center General

Responder Cohort (WTC-GRC) of rescue, recovery and clean-up workers who responded during and in the aftermath of the World Trade Center (WTC) 9/11/2001 attacks, we studied genetic correlates of PTSD in a sample of 371 WTC responders, selected from the WTC-GRC utilizing stratified random sampling. This deeply phenotyped sample of WTC responders – ranging from no/low PTSD symptom levels to severe PTSD– provide a unique opportunity to study genetic risk factors for PTSD severity and chronicity following a single, shared, well-documented trauma, also incorporating measures of childhood and other lifetime traumas. We examined associations of polygenic risk scores (PRS) –derived from a range of genome-wide association studies (GWAS) of behavioral traits, psychiatric disorders, and brain volumetric phenotypes– with PTSD severity and chronicity among these 371 individuals. Our results demonstrate significant genetic regulation of lifetime PTSD severity, assessed with the lifetime version Clinician-Administered PTSD Scale (CAPS), and chronicity, assessed with the past-month CAPS. PRS derived from GWAS of attention deficit-hyperactivity disorder (ADHD), autism spectrum disorder (ASD), and brain imaging phenotypes (amygdala and putamen volumes) were associated with several PTSD symptom dimensions. Interestingly, we found greater genetic contribution to PTSD among cases compared to our full sample. In addition, we tested for associations between exposures to traumatic stressors, including WTC-related exposures, childhood trauma, and other lifetime traumatic life events in our full sample. Together, polygenic risk and exposures to traumatic stress explained ~45% of variance in lifetime CAPS (R2=0.454), and ~48% of variance in past-month CAPS (R2=0.480) in the full sample. These participants represent a highly vulnerable population, with exposures to severe trauma during 9/11 and the following days and months. These novel identified associations between PTSD and PRS of behavioral traits and brain volume phenotypes, as well as replicated associations with PRS of other psychiatric disorders, may contribute to understanding the biological factors associated with risk for and chronicity of PTSD. In particular, the identification of neuroimaging phenotypes indicates that coupling of neuroimaging with genetic risk score calculations may predict PTSD outcomes.

Karasick AS, Udasin IG, Gusmano MK, et al. 2021. An assessment of healthcare access and utilization in the World Trade Center Health Program. Journal of Occupational and Environmental Medicine. 63 (2):166–171.

HTTPS://DOI.ORG/10.1097/JOM.0000000000002110

OBJECTIVE: Access to healthcare, a national priority, may be better understood through medical surveillance programs like the World Trade Center Health Program (WTCHP).

METHODS: Measures of healthcare access and utilization for 1159 9/11 rescue and recovery workers ("responders") at the Rutgers Clinical Center of Excellence (CCE) were assessed using negative binomial modeling of the Benefits Eligibility Assessment Screening Tool and compared with 174 9/11 responders in the 2017 New York City Community Health Survey (NYCCHS) using z-testing.

RESULTS: Approximately 10.8% of Rutgers CCE respondents lacked at least one aspect of healthcare access. Problems ac-

cessing healthcare and basic needs were positively associated with CCE utilization and differed between Rutgers CCE and NYCCHS respondents.

CONCLUSIONS: Some 9/11 responders bridge healthcare access gaps via participation in the WTCHP. Surveillance survey tools may help to identify healthcare disparities.

Khan NZ, Gur HD, and Hartley-Brown MA. 2021. World trade center survivor with post solid-organ transplant plasma cell neoplasm. Current Problems in Cancer: Case Reports. 4:100094.

HTTPS://DOI.ORG/10.1016/J.CPCCR.2021.100094

Plasma cell neoplasms (PCNs) in post solid organ transplant is a rare occurrence. To date, there is no standardized protocol for treatment. Management is further complicated in World Trade Center (WTC) survivors who present with post- solid organ transplant PCNs. This poses a challenge in management in order to reconcile the use of necessary immunosuppressive therapy (IST) with chemotherapy or immunotherapy and the potential toxic side effects. We report a case of a 59 year old WTC survivor with a history of orthotopic liver transplant (2015) for NASH cirrhosis on IST who was diagnosed with IgG lambda multiple myeloma (MM) in June 2019. The induction regimen of cyclophosphamide, bortezomib and dexamethasone (CyBorD) was initiated. Labs and clinical evaluation showed a very good partial response (VGPR). In January 2020, the patient presented with transaminitis and hyperbilirubinemia. CT abdomen and pelvis indicated multiple low-attenuation hepatic lesions. Ultrasound-guided core liver biopsy revealed malignant plasma cell neoplasm. The patient underwent endoscopic retrograde cholaniopancreatography (ERCP) with intraductal biliary stent placement in an attempt to alleviate the extrinsic obstruction from the hepatic lesions. The procedure was unsuccessful and the patient subsequently developed overt jaundice and progressive ascites. He was started on modified dexamethasone, cyclophosphamide, etoposide and cisplatin (DCEP). Unfortunately, liver failure progressed with enlarging liver lesions, at which point the patient elected hospice and died. This case highlights the fulminant course of PCNs post solid organ transplant. This is an area of unmet need for standardized treatment regimen in these poor prognostic cases. In addition, the case illustrates the complexity involved with management of such patients. A multidisciplinary medical team is needed to manage such patients' complicated disease course.

Koraishy FM, Coca SG, Cohen BE, et al. 2021. The association of post-traumatic stress disorder with longitudinal change in glomerular filtration rate in World Trade Center responders. Psychosom Med. 83 (9):978–986.

HTTPS://DOI.ORG/10.1097/PSY.0000000000000968

OBJECTIVE: High levels of psychological distress increase the risk of a wide range of medical diseases. We investigated the association between posttraumatic stress disorder (PTSD) and kidney disease in this study.

METHODS: World Trade Center (WTC) responders were included if they had ≥2 measures of estimated glomerular filtration rate (eGFR). The PTSD checklist (PCL) was used to define no PTSD (PCL < 40), 'mild' PTSD (40 ≤ PCL <50) and 'severe' PTSD (PCL ≥50). Subtypes of PTSD by

symptom clusters were analyzed.. Multinomial logistic regression was used to estimate the association of PTSD with two GFR change outcomes (decline or increase) compared to the stable GFR outcome.

RESULTS: In 2,266 participants, the mean age was 53.1 years, 8.2% female, and 89.1% were White. Individuals with PTSD (N = 373; 16.5%) did not differ in mean baseline GFR from individuals without PTSD (89.73 vs. 90.56 ml/min/1.73 m2); p = 0.29). Over a 2.01 years mean follow-up,a mean GFR decline of -1.51 ml/min/1.73m2 per year was noted. In multivariable-adjusted models, PTSD was associated with GFR decline (aRR = 1.74 [1.32-2.30], p < 0.001) compared to stable GFR, with 'Hyperarousal' symptoms showing the strongest association aRR =2.11 [1.40-3.19]; p < 0.001).. Dose-response effects were evident when comparing mild to severe PTSD and comparing PTSD with versus without depression. PTSD was also associated with GFR rise (aRR = 1.47 [1.10-1.97], p < 0.009). The association between PTSD and GFR change was stronger in participants <50 years of age.

CONCLUSIONS: PTSD may be a novel risk factor for exaggerated longitudinal GFR change in young, healthy adults. These findings need to be validated in other cohorts.

Kritikos M, Clouston SAP, Huang C, et al. 2021. Cortical complexity in world trade center responders with chronic posttraumatic stress disorder. Translational Psychiatry. 11 (1):597.

HTTPS://DOI.ORG/10.1038/S41398-021-01719-7

Approximately 23% of World Trade Center (WTC) responders are experiencing chronic posttraumatic stress disorder (PTSD) associated with their exposures at the WTC following the terrorist attacks of 9/11/2001, which has been demonstrated to be a risk factor for cognitive impairment raising concerns regarding their brain health. Cortical complexity, as measured by analyzing Fractal Dimension (FD) from T1 MRI brain images, has been reported to be reduced in a variety of psychiatric and neurological conditions. In this report, we hypothesized that FD would be also reduced in a case-control sample of 99 WTC responders as a result of WTC-related PTSD. The results of our surface-based morphometry cluster analysis found alterations in vertex clusters of complexity in WTC responders with PTSD, with marked reductions in regions within the frontal, parietal, and temporal cortices, in addition to whole-brain absolute bilateral and unilateral complexity. Furthermore, region of interest analysis identified that the magnitude of changes in regional FD severity was associated with increased PTSD symptoms (reexperiencing, avoidance, hyperarousal, negative affect) severity. This study confirms prior findings on FD and psychiatric disorders and extends our understanding of FD associations with posttraumatic symptom severity. The complex and traumatic experiences that led to WTC-related PTSD were associated with reductions in cortical complexity. Future work is needed to determine whether reduced cortical complexity arose prior to, or concurrently with, onset of PTSD.

Liu X, Reeves AP, Antoniak K, et al. 2021. Association of quantitative ct lung density measurements and lung function decline in World Trade Center workers. Clinical

Respiratory Journal. 15 (6):613–621.

HTTPS://DOI.ORG/10.1111/CRJ.13313

BACKGROUND: Occupational exposures at the WTC site after 11 September 2001 have been associated with presumably inflammatory chronic lower airway diseases. Aims: In this study, we describe the trajectories of expiratory air flow decline, identify subgroups with adverse progression, and investigate the association of those trajectories with quantitative computed tomography (QCT) imaging measurement of increased and decreased lung density.

METHODS: We examined the trajectories of expiratory air flow decline in a group of 1,321 former WTC workers and volunteers with at least three periodic spirometries, and using QCT-measured low (LAV%, –950 HU) and high (HAV%, from –600 to –250 HU) attenuation volume percent. We calculated the individual regression line slopes for first-second forced expiratory volume (FEV1slope), identified subjects with rapidly declining ("accelerated decliners") and increasing ("improved"), and compared them to subjects with "intermediate" (0 to –66.5 mL/year) FEV1slope. We then used multinomial logistic regression to model those three trajectories, and the two lung attenuation metrics.

RESULTS: The mean longitudinal FEV1 slopes for the entire study population, and its intermediate, decliner, and improved subgroups were, respectively, –40.4, –34.3, –106.5, and 37.6 mL/year. In unadjusted and adjusted analyses, LAV% and HAV% were both associated with "accelerated decliner" status (ORadj, 95% CI 2.37, 1.41–3.97, and 1.77, 1.08–2.89, respectively), compared to the intermediate decline.

CONCLUSIONS: Longitudinal FEV1 decline in this cohort, known to be associated with QCT proximal airway inflammation metric, is also associated with QCT indicators of increased and decreased lung density. The improved FEV1 trajectory did not seem to be associated with lung density metrics.

Maura F, Diamond B, Maclachlan KH, et al. 2021. Initial whole-genome sequencing of plasma cell neoplasms in first responders and recovery workers exposed to the world trade center attack of September 11, 2001. Clinical Cancer Research. 27 (7):2111–2118.

HTTPS://DOI.ORG/10.1158/1078-0432.CCR-20-2245

PURPOSE: The World Trade Center (WTC) attack of September 11, 2001 created an unprecedented environmental exposure to known and suspected carcinogens. High incidence of multiple myeloma and precursor conditions has been reported among first responders to the WTC disaster. To expand on our prior screening studies, and to characterize the genomic impact of the exposure to known and potential carcinogens in the WTC debris, we were motivated to perform whole-genome sequencing (WGS) of WTC first responders and recovery workers who developed a plasma cell disorder after the attack.

EXPERIMENTAL DESIGN: We performed WGS of nine CD138- positive bone marrow mononuclear samples from patients who were diagnosed with plasma cell disorders after the WTC disaster.

RESULTS: No significant differences were observed in comparing the post-WTC driver and mutational signature landscapes with 110 previously published WGSs from 56 patients with multiple myeloma and the CoMMpass WGS cohort (n = 752). Leveraging constant activity of the single-base substitution mutational signatures 1 and 5 over time, we estimated that tumor-initiating chromosomal gains were windowed to both pre- and post-WTC exposure.

CONCLUSIONS: Although limitations in sample size preclude any definitive conclusions, our findings suggest that the observed increased incidence of plasma cell neoplasms in this population is due to complex and heterogeneous effects of theWTCexposure that may have initiated or contributed to progression of malignancy.

Moline J. 2021. World Trade Center disaster: Reflections after twenty years. Archives of Environmental and Occupational Health. 76 (7):361–362.

HTTPS://DOI.ORG/10.1080/19338244.2021.1996684

NO ABSTRACT AVAILABLE

Morozova O, Clouston SA, Valentine J, et al. 2021. COVID-19 cumulative incidence, asymptomatic infections, and fatality in long island, ny, january-august 2020: A cohort of World Trade Center responders. PLoS One. 16 (7):e0254713.

HTTPS://DOI.ORG/10.1371/JOURNAL.PONE.0254713

BACKGROUND: New York City and Long Island, NY were early foci of the COVID-19 epidemic in the US. The effects of COVID-19 on different sub-populations, and its key epidemiologic parameters remain unknown or highly uncertain. We investigated the epidemiology of COVID-19 from January to August of 2020 in an established academic monitoring cohort of N = 9,697 middle-aged World Trade Center responders residing in Long Island, NY.

METHODS: A seroprevalence survey and a series of cross-sectional surveys were nested in a prospective cohort study. Measures included IgG antibody testing, SARS-CoV-2 polymerase chain reaction (PCR) testing, review of electronic medical records, and surveys of symptoms. Correlates of infection were analyzed with multivariable logistic regression.

RESULTS: The cohort was predominantly men in their mid-fifties; 6,597 cohort members were successfully contacted (68%); 1,042 (11%) individuals participated in the seroprevalence survey; and 369 individuals (5.6% of 6,597 study participants) underwent PCR testing. The estimated standardized cumulative incidence was 21.9% (95%CI: 20.1-23.9%), the asymptomatic proportion was 16.4% (36/219; 95%CI: 11.8-22.0%), the case hospitalization ratio was 9.4% (36/385; 95%CI: 6.6-12.7%), the case fatality ratio was 1.8% (7/385; 95%CI: 0.7-3.7%), and the hospitalization fatality ratio was 8.3% (3/36; 95%CI: 1.8-22.5%). Confirmed SARS-CoV-2 infection was associated with younger age, race/ethnicity, and being currently employed.

CONCLUSIONS: The results of the present study suggest a high cumulative incidence of ***SARS-CoV-2*** among WTC responders in the spring and summer of 2020 and contribute to narrowing the plausible range of the proportion of infections that

exhibit no symptoms. An increased risk of infection among younger employed individuals is likely to reflect a higher probability of exposure to the virus, and the racial disparities in the infection risk warrant further investigation.

Mueller AK, Singh A, Webber MP, et al. 2021. PTSD symptoms, depressive symptoms, and subjective cognitive concerns in WTC-exposed and non-WTC-exposed firefighters. American Journal of Industrial Medicine. 0 (0):803–814.

HTTPS://DOI.ORG/10.1002/AJIM.23285

ABSTRACT BACKGROUND: Firefighting has been associated with posttraumatic stress disorder (PTSD) and other mental health conditions. We previously found that among Fire Department of the City of New York (FDNY) responders to the World Trade Center (WTC) disaster, higher-intensity WTC-exposure predicted PTSD symptoms, depressive symptoms, and subjective cognitive concerns. The present study aims to compare these symptoms in the FDNY WTC-exposed cohort versus a comparison cohort of non-FDNY, non-WTC-exposed firefighters.

METHODS: The study population included WTC-exposed male firefighters from FDNY (N= 8466) and non-WTC-exposed male firefighters from Chicago (N =1195), Philadelphia (N =770), and San Francisco (N = 650) fire departments who were employed on 9/11/2001 and completed a health questionnaire between 3/1/2018 and 12/31/2020. Current PTSD symptoms, depressive symptoms, and subjective cognitive concerns were assessed via validated screening instruments. Multivariable linear regression analyses stratified by fire department estimated the impact of covariates on each outcome. Results Adjusted mean PTSD symptom scores ranged from 23.5 ± 0.6 in Chicago firefighters to 25.8 ± 0.2 in ***FDNY,*** and adjusted mean depressive symptom scores ranged from 7.3 ± 0.5 in Chicago to 9.4 ± 0.6 in Philadelphia. WTC-exposure was associated with fewer subjective cognitive concerns ($\beta = 0.69 \pm 0.05$, $p < .001$) after controlling for covariates. Across cohorts, older age was associated with more cognitive concerns, but fewer PTSD and depressive symptoms.

CONCLUSIONS: WTC-exposed firefighters had fewer cognitive concerns compared with non-WTC-exposed firefighters. We were unable to estimate associations between WTC exposure and PTSD symptoms or depressive symptoms due to variability between non-WTC-exposed cohorts. Longitudinal follow-up is needed to assess PTSD, depressive, and cognitive symptom trajectories in firefighter populations as they age.

Senay E, Byrne D, Mattson C, et al. 2021. Telehealth for COVID-19 in World Trade Center responders: Meeting the needs of this unique population. J Occup Environ Med. 63 (11):e834–e837.

HTTPS://DOI.ORG/10.1097/JOM.0000000000002385

NO ABSTRACT AVAILABLE

Sloan NL, Shapiro MZ, Sabra A, et al. 2021. Cardiovascular disease in the World Trade Center Health Program general responder cohort. American Journal of Industrial Medicine. 64 (2):97–107.

HTTPS://DOI.ORG/10.1002/AJIM.23207

BACKGROUND: Over 90,000 rescue and recovery responders to the September 2001 World Trade Center (WTC) attacks were exposed to toxic materials that can impair cardiac function and increase cardiovascular disease (CVD) risk. We examined WTC-related exposures association with annual and cumulative CVD incidence and risk over 17 years in the WTC Health Program (HP) General Responder Cohort (GRC).

METHODS: Post 9/11 first occurrence of CVD was assessed in 37,725 responders from self-reported physician diagnosis of, or current treatment for, coronary artery disease, myocardial infarction, stroke and/or congestive heart failure from WTCHP GRC monitoring visits. Kaplan-Meier estimates of CVD incidence used the generalized Wilcoxon test statistic to account for censored data. Cox proportional hazards regression analyses estimated the CVD hazard ratio associated with 9/11/2001 arrival in responders with and without dust cloud exposure, compared with arrival on or after 9/12/2001. Additional analyses adjusted for comorbidities.

RESULTS: To date, 6.3% reported new CVD. In covariate-adjusted analyses, men's CVD 9/11/2001 arrival risks were 1.40 (95% confidence interval [CI] = 1.26, 1.56) and 1.43 (95% CI = 1.29, 1.58) and women's were 2.16 (95% CI = 1.49, 3.11) and 1.59 (95% CI = 1.11, 2.27) with and without dust cloud exposure, respectively. Protective service employment on 9/11 had higher CVD risk.

CONCLUSIONS: WTCHP GRC members with 9/11/2001 exposures had substantially higher CVD risk than those initiating work afterward, consistent with observations among WTC-exposed New York City firefighters. Women's risk was greater than that of men's. GRC-elevated CVD risk may also be occurring at a younger age than in the general population.

Son Y, Clouston SA, Kotov R, et al. 2021. World trade center responders in their own words: Predicting PTSD symptom trajectories with ai-based language analyses of interviews. Psychological Medicine. :1–9.

HTTPS://DOI.ORG/10.1017/S0033291721002294

BACKGROUND: Oral histories from 9/11 responders to the World Trade Center (WTC) attacks provide rich narratives about distress and resilience. Artificial Intelligence (AI) models promise to detect psychopathology in natural language, but they have been evaluated primarily in non-clinical settings using social media. This study sought to test the ability of AI-based language assessments to predict PTSD symptom trajectories among responders.

METHODS: Participants were 124 responders whose health was monitored at the Stony Brook WTC Health and Wellness Program who completed oral history interviews about their initial WTC experiences. PTSD symptom severity was measured longitudinally using the PTSD Checklist (PCL) for up to 7 years post-interview. AI-based indicators were computed for depression, anxiety, neuroticism, and extraversion along with dictionary-based measures of linguistic and interpersonal style. Linear regression and multilevel models estimated associations of AI indicators with concurrent and subsequent PTSD symptom severity (significance adjusted by false discovery rate). Results Cross-sectionally,

greater depressive language (β = 0.32; p = 0.049) and first-person singular usage (β = 0.31; p = 0.049) were associated with increased symptom severity. Longitudinally, anxious language predicted future worsening in PCL scores (β = 0.30; p = 0.049), whereas first-person plural usage (β = -0.36; p = 0.014) and longer words usage (β = -0.35; p = 0.014) predicted improvement.

CONCLUSIONS: This is the first study to demonstrate the value of AI in understanding PTSD in a vulnerable population. Future studies should extend this application to other trauma exposures and to other demographic groups, especially under-represented minorities.

Stein CR, Cooney ML, Frank B, et al. 2021. Mental health mediators of subjective cognitive concerns among World Trade Center responders. J Psychiatr Res. 140:187–196.

HTTPS://DOI.ORG/10.1016/J.JPSYCHIRES.2021.05.081

Decline in cognitive functioning among rescue and recovery workers who responded in the aftermath of the September 11, 2001, World Trade Center (WTC) attacks is of emerging interest. Responders are vulnerable to cognitive decline from exposure to airborne toxins present at the WTC site, as well as from WTC-related mental and physical health conditions. To better understand the relationship between occupational WTC exposure, mental health, physical health and subjective cognitive functioning, we examined the mediating role of health status in the association between exposure and subjective cognitive concerns in a multi-site, longitudinal investigation of the WTC General Responder cohort (n = 16,380 responders; n = 58,575 visits) for the period 2002-2015. Through latent class analyses, we identified a four-level marker of cognitive concerns based on information from a Self-Administered Mental Health Questionnaire. Using generalized linear mixed models with random intercepts, we observed that a higher intensity WTC exposure composite was associated with greater cognitive concerns, and that this association was operating almost entirely through mental health comorbidities, not physical health comorbidities. In fully adjusted models, the inclusion of probable depression, anxiety, PTSD and use of psychotropic medications attenuated the association between highest WTC exposure and greatest cognitive concerns. Physical health did not appear to be on the pathway between WTC exposure and cognitive concerns. Understanding the underlying sources of cognitive concerns may help identify vulnerable members of the General Responder cohort and potentially aid clinical decision-making, such as treatment choice and enhanced screening options. Earlier diagnosis and symptom treatment may help preserve functional independence.

Sunderram J, Ayappa I, Lu S-E, et al. 2021. Pap adherence and nasal resistance: A randomized control trial of cpapflex vs cpap. Annals of the American Thoracic Society. 18 (4):668–677.

HTTPS://DOI.ORG/10.1513/ANNALSATS.202009-1161OC

RATIONALE: Continuous Positive Airway Pressure (CPAP) adherence is often poor in obstructive sleep apnea (OSA) and may be influenced by nasal resistance. CPAP with reduction of expiratory pressure

(CPAPFlex) may reduce discomfort in those with high nasal resistance and improve adherence in this subgroup. Objectives: To evaluate the association of PAP adherence to nasal resistance and examine if CPAPFlex improves adherence over CPAP in subjects with high nasal resistance.

METHODS: A randomized double-blind control cross-over trial of 4 weeks each of CPAPFlex versus CPAP in World Trade Center dust-exposed subjects with OSA stratified by nasal resistance measured by 4-Phase Rhinomanometry.

RESULTS: 317 subjects with OSA (mean AHI4%=17±14/hr) were randomized. Overall, PAP adherence was poor, but adherence to CPAP (n=239, mean hours per night (95% CI)) = 1.97h (1.68, 2.26) was greater than to CPAPFlex (n=249, 1.65h (1.39, 1.91); difference 0.31h (0.03, 0.6); p<0.05). Contrary to our hypothesis there was no correlation between nasal resistance and adherence to CPAP (r=0.098, p=NS) or CPAPFlex(r=0.056, p=NS). There was no difference in adherence between CPAP and CPAPFlex (mean Δ hours (95% CI)) in subjects with low resistance (0.33h (-0.10, 0.76)) or high nasal resistance (0.26h (-0.14, 0.66)). No significant differences were observed in any of the secondary outcomes between PAP modes.

CONCLUSIONS: Contrary to expectations, our data do not show better adherence to CPAPFlex than to CPAP in subjects with high or low nasal resistance, and, show clinically insignificant better adherence overall with CPAP. Clinical Trial registered with ***CLINICALTRIALS.GOV*** (NCT01753999)Page 3 of 43

Wisnivesky J, Markowitz SB, James S, et al. 2021. Comorbid post-traumatic stress disorder and major depression disorder associated with asthma morbidity among WTC workers. Annals of Allergy, Asthma & Immunology. 126 (3):278–283.

HTTPS://DOI.ORG/10.1016/J.ANAI.2020.10.007

BACKGROUND: World Trade Center (WTC) rescue and recovery workers suffer a high burden of asthma, comorbid post-traumatic stress disorder (PTSD) ,and depression. PTSD is associated with worse asthma outcomes. Objective In this study, we evaluated whether the relationship between PTSD and asthma morbidity is modified by depression.

METHODS: We used data from a cohort of WTC workers with asthma. Asthma control (ACQ), resource utilization, and quality of life (AQLQ) were evaluated. We used regression analyses to evaluate the adjusted association of PTSD and depression with asthma control, resource utilization and quality of life.

RESULTS: Of the study cohort of 293 WTC workers with asthma, 19% had PTSD alone, 2% had MDD alone and 12% had PTSD and MDD. Adjusted mean differences (95% CI) in ACQ scores were 1.32 (0.85 to 1.80) for WTC workers with PTSD and MDD, 0.44 (0.03 to 0.84) for those with PTSD alone, and 0.50 (-0.38 to 1.38) for workers with MDD alone compared to those without depression or PTSD. WTC workers with PTSD and depression, PTSD alone, and depression alone had mean (95% CI) adjusted differences in AQLQ scores of -1.67 (-2.22 to -1.12), -0.56 (-2.23 to -1.12), and -1.21 (-2.23 to -0.18) compared to workers

without depression or PTSD. Similar patterns were observed for acute resource utilization.

CONCLUSION: PTSD and depression appear to have a synergistic effect that worsens asthma control and quality of life. Efforts to improve asthma outcomes in this population should address the negative impacts of these common mental health conditions.

Year Published 2022 (16)

Baba RY, Zhang Y, Shao Y, et al. 2022. COPD in smoking and non-smoking community members exposed to the World Trade Center dust and fumes. International Journal of Environmental Research and Public Health. 19 (7):4249.

HTTPS://DOI.ORG/10.3390/IJERPH19074249

BACKGROUND: The characteristics of community members exposed to World Trade Center (WTC) dust and fumes with Chronic Obstructive Pulmonary Disease (COPD) can provide insight into mechanisms of airflow obstruction in response to an environmental insult, with potential implications for interventions.

METHODS: We performed a baseline assessment of respiratory symptoms, spirometry, small airway lung function measures using respiratory impulse oscillometry (IOS), and blood biomarkers. COPD was defined by the 2019 GOLD criteria for COPD. Patients in the WTC Environmental Health Center with <5 or >/=5 pack year smoking history were classified as nonsmoker-COPD (ns-COPD) or smoker-COPD (sm-COPD), respectively.

MAIN RESULTS: Between August 2005 and March 2018, 467 of the 3430 evaluated patients (13.6%) fit criteria for COPD. Among patients with COPD, 248 (53.1%) were ns-COPD. Patients with ns-COPD had measures of large airway function (FEV1) and small airway measures (R5-20, AX) that were less abnormal than those with sm-COPD. More ns-COPD compared to sm-COPD had a bronchodilator (BD) response measured by spirometry (24 vs. 14%, p = 0.008) or by IOS (36 vs. 21%, p = 0.002). Blood eosinophils did not differ between ns-COPD and sm-COPD, but blood neutrophils were higher in sm-COPD compared to ns-COPD (p < 0.001). Those with sm-COPD were more likely to be WTC local residents than ns-COPD (p = 0.007).

CONCLUSIONS: Spirometry findings and small airway measures, as well as inflammatory markers, differed between patients with ns-COPD and sm-COPD. These findings suggest potential for differing mechanisms of airway injury in patients with WTC environmental exposures and have potential therapeutic implications.

Clouston SAP, Hall CB, Kritikos M, et al. 2022. Cognitive impairment and world trade centre-related exposures. Nat Rev Neurol. 18 (2):103–116.

HTTPS://DOI.ORG/10.1038/S41582-021-00576-8

On 11 September 2001 the World Trade Center (WTC) in New York was attacked by

terrorists, causing the collapse of multiple buildings including the iconic 110-story 'Twin Towers'. Thousands of people died that day from the collapse of the buildings, fires, falling from the buildings, falling debris, or other related accidents. Survivors of the attacks, those who worked in search and rescue during and after the buildings collapsed, and those working in recovery and clean-up operations were exposed to severe psychological stressors. Concurrently, these 'WTC-affected' individuals breathed and ingested a mixture of organic and particulate neurotoxins and pro-inflammogens generated as a result of the attack and building collapse. Twenty years later, researchers have documented neurocognitive and motor dysfunctions that resemble the typical features of neurodegenerative disease in some WTC responders at midlife. Cortical atrophy, which usually manifests later in life, has also been observed in this population. Evidence indicates that neurocognitive symptoms and corresponding brain atrophy are associated with both physical exposures at the WTC and chronic post-traumatic stress disorder, including regularly re-experiencing traumatic memories of the events while awake or during sleep. Despite these findings, little is understood about the long-term effects of these physical and mental exposures on the brain health of WTC-affected individuals, and the potential for neurocognitive disorders. Here, we review the existing evidence concerning neurological outcomes in WTC-affected individuals, with the aim of contextualizing this research for policymakers, researchers and clinicians and educating WTC-affected individuals and their friends and families. We conclude by providing a rationale and recommendations for monitoring the neurological health of WTC-affected individuals.

Clouston SAP, Kritikos M, Huang C, et al. 2022. Reduced cerebellar cortical thickness in World Trade Center responders with cognitive impairment. Transl Psychiatry. 12 (1):107.

HTTPS://DOI.ORG/10.1038/S41398-022-01873-6

Prior research has demonstrated high levels of cognitive and physical functional impairments in World Trade Center (WTC) responders. A follow-up neuroimaging study identified changes to white matter connectivity within the cerebellum in responders with cognitive impairment (CI). In the first study to examine cerebellar cortical thickness in WTC responders with CI, we fielded a structural magnetic resonance imaging protocol. WTC responders (N = 99) participated in a structural magnetic resonance imaging (MRI) study, of whom 48 had CI. Participants with CI did not differ demographically or by intracranial volume when compared to cognitively unimpaired participants. MRIs were processed using the CERES imaging pipeline; bilateral cortical thickness in 12 cerebellar lobules was reported. Analyses were completed comparing mean cerebellar cortical thickness across groups. Lobules were examined to determine the location and functional correlates of reduced cerebellar cortical thickness. Multivariable-adjusted analyses accounted for the false discovery rate. Mean cerebellar cortical thickness was reduced by 0.17 mm in responders with CI. Decrements in cerebellar cortical thickness were symmetric and located in the Cerebellar Crus (I and II), and in Lobules IV, VI, VIIb, VIIIa, VIIIb, and IX. Cerebellar cortical thickness was associated with episodic memory, response speed, and tandem balance. WTC

responders with CI had evidence of reduced cerebellar cortical thickness that was present across lobules in a pattern unique to this cohort.

Gibson R, Whealin JM, Dasaro CR, et al. 2022. Prevalence and correlates of suicidal ideation in World Trade Center responders: Results from a population-based health monitoring cohort. Journal of Affective Disorders. 306:62–70.

HTTPS://DOI.ORG/10.1016/J.JAD.2022.03.011

BACKGROUND: Suicidal ideation (SI) is an early risk factor for suicide among disaster responders. To date, however, no known study has examined the prevalence, and pre-, peri-, and post-disaster risk correlates of SI in World Trade Center (WTC) responders, one of the largest disaster response populations in U.S. history.

METHODS: The prevalence, and pre-, peri- and post-event correlates of SI were assessed in a population-based health monitoring cohort of 14,314 police responders and 16,389 non-traditional responders (e.g., construction workers) who engaged in response, recovery, and clean-up efforts following the 9/11/2001 terrorist attacks on the WTC. Multivariable analyses were conducted to identify correlates and individual psychiatric symptoms associated with SI in each group.

RESULTS: A total 12.5% of non-traditional and 2.2% of police WTC responders reported SI. Depression, functional impairment, alcohol use problems, and lower family support while working at the WTC site were associated with SI in both groups of responders. Symptom-level analyses revealed that three symptoms accounted for approximately half of the variance in SI for both groups—feeling bad about oneself, or that one has let down oneself or family; feeling down, depressed, or hopeless; and sense of foreshortened future (44.7% in non-traditional and 71% in police). Limitations: Use of self-report measures and potentially limited generalizability.

CONCLUSIONS: SI is prevalent in WTC disaster responders, particularly non-traditional responders. Post-9/11 psychiatric symptoms reflecting guilt, shame, hopelessness, and associated functional impairment are most strongly linked to SI, suggesting that interventions targeting these factors may help mitigate suicide risk in this population.

Hernandez M, Vaughan J, Gordon T, et al. 2022. World Trade Center dust induces nasal and neurological tissue injury while propagating reduced olfaction capabilities and increased anxiety behaviors. Inhal Toxicol. :1–14.

HTTPS://DOI.ORG/10.1080/08958378.2022.2072027

OBJECTIVE: Previous in vitro and in vivo World Trade Center particulate matter (WTC(PM)) exposure studies have provided evidence of exposure-driven oxidative/nitrative stress and inflammation on respiratory tract and aortic tissues. What remains to be fully understood are secondary organ impacts due to WTC(PM) exposure. This study was designed to test if WTC particle-induced nasal and neurologic tissue injury may result in unforeseen functional and behavioral outcomes.Material and Methods: WTC(PM) was intranasally administered in mice, evaluating genotypic, histopathologic, and olfaction latency endpoints.

RESULTS: WTC(PM) exposure was found to incite neurologic injury and olfaction latency in intranasally (IN) exposed mice. Single high-dose and repeat low-dose nasal cavity insults from WTC(PM) dust resulted in significant olfaction delays and enduring olfaction deficits. Anxiety-dependent behaviors also occurred in mice experiencing olfaction loss including significant body weight loss, increased incidence and time spent in hind stretch postures, as well as increased stationary time and decreased exploratory time. Additionally, WTC(PM) exposure resulted in increased whole brain wet/dry ratios and wet whole brain to body mass ratios that were correlated with exposure and increased exposure dose ($p<0.05$).

DISCUSSION: The potential molecular drivers of WTC(PM)-driven tissue injury and olfaction latency may be linked to oxidative/nitrative stress and inflammatory cascades in both upper respiratory nasal and brain tissues.Conclusion: Cumulatively, these data provide evidence of WTC(PM) exposure in relation to tissue damage related to oxidative stress-driven inflammation identified in the nasal cavity, propagated to olfactory bulb tissues and, potentially, over extended periods, to other CNS tissues.

Imbriano G, Waszczuk M, Rajaram S, et al. 2022. Association of attention and memory biases for negative stimuli with post-traumatic stress disorder symptoms. Journal of Anxiety Disorders. 85:102509.

HTTPS://DOI.ORG/10.1016/J.JANXDIS.2021.102509

Cognitive models have highlighted attentional and memory biases to negatively valenced emotional stimuli, and their association, in the development and maintenance of post-traumatic stress disorder (PTSD). However, research has focused mainly on attentional biases towards distracting (not task-relevant) negative stimuli and the links of attentional biases with memory remain underexplored. We manipulated attention during encoding of trauma-irrelevant negative and neutral words andexamined the differential relationship of their encoding and recall with PTSD symptoms. Responders to the World Trade Center disaster performed tasks in which they read negative and neural words (full attention, FA) and reported the color of another set of such words (divided-attention, DA). Subsequently, participants used word stems to aid retrieval of words shown in both tasks. PTSD symptoms were associated with slower performance for negative vs neutral words in FA but not DA tasks.Furthermore, greater PTSD symptoms severity was associated with more accurate recall of negative vs neutral words, irrespective of whether words were presented on FA or DA tasks. These findings suggest that PTSD symptoms in a trauma-exposed population are related to encoding of trauma-irrelevant negative information when attention is fully deployed and subsequent recall of negative information, irrespective of whether attention was fully deployed.

Iyengar-Kapuganti RL, Maceda CS, Croft LB, et al. 2022. Obstructive sleep apnoea and left ventricular diastolic dysfunction among first responders to the 9/11 World Trade Center terrorist attack: A cross-sectional study. BMJ Open. 12 (4):e058366.

HTTPS://DOI.ORG/10.1136/BMJOPEN-2021-058366

OBJECTIVES: Obstructive sleep apnoea

(OSA) is often linked to cardiovascular disease. A limited number of studies have reported an association between OSA and left ventricular diastolic dysfunction (LVDD). However, prior studies were performed on small patient populations. Studies have shown a high prevalence of OSA among first responders to the 9/11 World Trade Center (WTC) terrorist attack. We investigated the relationship between OSA and LVDD in a large population of WTC responders.

DESIGN: Cross-sectional study.

SETTING: One-time screening programme as part of the WTC-CHEST Study (NCT10466218), performed at a quaternary medical centre in New York City, from November 2011 to June 2014.

PARTICIPANTS: A total of 1007 participants with mean age of 51 years of mostly non-Hispanic white men were evaluated. Patients from the WTC Health Program-Clinical Center of Excellence, who were over the age of 39 years, were eligible to participate.

RESULTS: Evaluation of those without OSA diagnosis showed no significant association with LVDD when comparing those screened (Berlin Questionnaire) as OSA high risk versus OSA low risk (p=0.101). Among those diagnosed with LVDD, there was a significant association when comparing those with and without patient-reported OSA (OR 1.50, 95% CI 1.13 to 2.00, p=0.005), but the significance was not maintained after adjusting for pertinent variables (OR 1.3, 0.94 to 1.75, p=0.119). Notably, comparing those with OSA diagnosis and those low risk of OSA, the OR for LVDD was significant (1.69, 1.24 to 2.31, p=0.001), and after adjusting for waist-hip ratio, diabetes and coronary artery calcium score percentile, the relationship remained significant (OR 1.45, 1.03 to 2.04, p=0.032).

CONCLUSION: The strong association of OSA with LVDD in this population may inform future guidelines to recommend screening for LVDD in high-risk asymptomatic patients with OSA.

Kuan PF, Yang X, Kotov R, et al. 2022. Metabolomics analysis of post-traumatic stress disorder symptoms in World Trade Center responders. Transl Psychiatry. 12 (1):174.

HTTPS://DOI.ORG/10.1038/S41398-022-01940-Y

Metabolomics has yielded promising insights into the pathophysiology of post-traumatic stress disorder (PTSD). The current study expands understanding of the systems-level effects of metabolites by using global metabolomics and complex lipid profiling in plasma samples from 124 World Trade Center responders (56 PTSD, 68 control) on 1628 metabolites. Differential metabolomics analysis identified hexosylceramide HCER(26:1) associated with PTSD at FDR < 0.1. The multi-metabolite composite score achieved an AUC of 0.839 for PTSD versus unaffected control classification. Independent component analysis identified three metabolomic modules significantly associated with PTSD. These modules were significantly enriched in bile acid metabolism, fatty acid metabolism and pregnenolone steroids, which are involved in innate immunity, inflammatory process and neuronal excitability, respectively. Integrative analysis of metabolomics and

our prior proteomics datasets on subsample of 96 responders identified seven proteomic modules significantly correlated with metabolic modules. Overall, our findings shed light on the molecular alterations and identify metabolomic-proteomic signatures associated with PTSD by using machine learning and network approaches to enhance understanding of the pathways implicated in PTSD. If present results are confirmed in follow-up studies, they may inform development of novel treatments.

Li J, Yung J, Qiao B, et al. 2022. Cancer incidence in World Trade Center rescue and recovery workers: 14 years of follow-up. J Natl Cancer Inst. 114 (2):210–219.

HTTPS://DOI.ORG/10.1093/JNCI/DJAB165

BACKGROUND: Statistically significantly increased cancer incidence has been reported from 3 cohorts of World Trade Center (WTC) disaster rescue and recovery workers. We pooled data across these cohorts to address ongoing public concerns regarding cancer risk 14 years after WTC exposure.

METHODS: From a combined deduplicated cohort of 69 102 WTC rescue and recovery workers, a sample of 57 402 workers enrolled before 2009 and followed through 2015 was studied. Invasive cancers diagnosed in 2002-2015 were identified from 13 state cancer registries. Standardized incidence ratios (SIRs) were used to assess cancer incidence. Adjusted hazard ratios (aHRs) were estimated from Cox regression to examine associations between WTC exposures and cancer risk.

RESULTS: Of the 3611 incident cancers identified, 3236 were reported as first-time primary (FP) cancers, with an accumulated 649 724 and 624 620 person-years of follow-up, respectively. Incidence for combined FP cancers was below expectation (SIR = 0.96, 95% confidence interval [CI] = 0.93 to 0.99). Statistically significantly elevated SIRs were observed for melanoma-skin (SIR = 1.43, 95% CI = 1.24 to 1.64), prostate (SIR = 1.19, 95% CI = 1.11 to 1.26), thyroid (SIR = 1.81, 95% CI = 1.57 to 2.09), and tonsil (SIR = 1.40, 95% CI = 1.00 to 1.91) cancer. Those arriving on September 11 had statistically significantly higher aHRs than those arriving after September 17, 2001, for prostate (aHR = 1.61, 95% CI = 1.33 to 1.95) and thyroid (aHR = 1.77, 95% CI = 1.11 to 2.81) cancers, with a statistically significant exposure-response trend for both.

CONCLUSIONS: In the largest cohort of 9/11 rescue and recovery workers ever studied, overall cancer incidence was lower than expected, and intensity of WTC exposure was associated with increased risk for specific cancer sites, demonstrating the value of long-term follow-up studies after environmental disasters.

Lin NW and Maier LA. 2022. Occupational exposures and sarcoidosis: Current understanding and knowledge gaps. Curr Opin Pulm Med. 28 (2):144–151.

HTTPS://DOI.ORG/10.1097/MCP.0000000000000835

PURPOSE OF REVIEW: Sarcoidosis is an idiopathic granulomatous disease that primarily affects the lungs. Several lines of evidence suggest that occupational exposures are associated with disease risk. This review critically evaluates studies using the Bradford Hill criteria for causation to determine if a causal relationship can

be established between occupational exposure and sarcoidosis.

RECENT FINDINGS: Large epidemiological studies have proposed multiple occupational exposures associated with sarcoidosis but lack consistency of results. Many convincing studies demonstrate an association between World Trade Center (WTC) dust and sarcoidosis, which illustrates a causal relationship based on the fulfillment of the Bradford Hill criteria. Studies describing an association between silica/metals and sarcoidosis are intriguing but fulfill a limited number of the Bradford Hill criteria and warrant further investigation before a causal relationship can be determined. Finally, we also discuss preliminary studies associating sarcoidosis phenotypes with specific occupational exposures.

SUMMARY: Using the Bradford Hill criteria for causation, we demonstrate that WTC dust has a causative relationship with sarcoidosis, which reinforces the theory that sarcoidosis is an exposure-related disease. More research is needed to determine other specific occupational exposures causing disease.

Lowe SM, Haugen PT, Marrone K, et al. 2022. The COVID-19 pandemic and the five essential elements in mass trauma intervention: Perspectives from World Trade Center Health Program mental health clinicians. Psychiatry. 84 (4):386–392.

HTTPS://DOI.ORG/10.1080/00332747.2021.2005443

NO ABSTRACT AVAILABLE

Marchese S, Cancelmo L, Diab O, et al. 2022. Altered gene expression and PTSD symptom dimensions in World Trade Center responders. Mol Psychiatry. :2021.2003.2005.21252989.

HTTPS://DOI.ORG/10.1038/S41380-022-01457-2

Despite experiencing a significant trauma, only a subset of World Trade Center (WTC) rescue and recovery workers developed posttraumatic stress disorder (PTSD). Identification of biomarkers is critical to the development of targeted interventions for treating disaster responders and potentially preventing the development of PTSD in this population. Analysis of gene expression from these individuals can help in identifying biomarkers of PTSD. We established a well-phenotyped sample of 371 WTC responders, recruited from a longitudinal WTC responder cohort, by obtaining blood, self-reported and clinical interview data. Using bulk RNA-sequencing from whole blood, we examined the association between gene expression and WTC-related PTSD symptom severity on (i) highest lifetime Clinician-Administered PTSD Scale (CAPS) score, (ii) past-month CAPS score, and (iii) PTSD symptom dimensions using a 5-factor model of re-experiencing, avoidance, emotional numbing, dysphoric arousal and anxious arousal symptoms. We corrected for sex, age, genotype-derived principal components and surrogate variables. Finally, we performed a meta-analysis with existing PTSD studies (total N=1,016), using case/control status as the predictor and correcting for these variables. We identified 66 genes significantly associated with highest lifetime CAPS score (FDR-corrected $p<0.05$), and 31 genes associated with past-month CAPS. Our more granular analyses of PTSD symptom dimensions identified additional genes that did not reach statistical significance in our

overall analysis. In particular, we identified 82 genes significantly associated with lifetime anxious arousal symptoms. Several genes significantly associated with multiple PTSD symptom dimensions and lifetime CAPS score (SERPINA1, RPS6KA1, and STAT3) have been previously associated with PTSD. Geneset enrichment of these findings has identified pathways significant in metabolism, immune signaling, other psychiatric disorders, neurological signaling, and cellular structure. Our meta-analysis revealed 10 genes that reached genome-wide significance, all of which were down-regulated in cases compared to controls (CIRBP, TMSB10, FCGRT, CLIC1, RPS6KB2, HNRNPUL1, ALDOA, NACA, ZNF429 and COPE). Additionally, cellular deconvolution highlighted an enrichment in CD4 T cells and eosinophils in responders with PTSD compared to controls. The distinction in significant genes between lifetime CAPS score and the anxious arousal symptom dimension of PTSD highlights a potential biological difference in the mechanism underlying the heterogeneity of the PTSD phenotype. Future studies should be clear about methods used to analyze PTSD status, as phenotypes based on PTSD symptom dimensions may yield different gene sets than combined CAPS score analysis. Potential biomarkers implicated from our meta-analysis may help improve therapeutic target development for PTSD.

Sacks HS, Smirnoff M, Carson D, et al. 2022. Autoimmune conditions in the World Trade Center general responder cohort: A nested case-control and standardized incidence ratio analysis. Am J Ind Med. 65 (2):117–131.

HTTPS://DOI.ORG/10.1002/AJIM.23313

BACKGROUND: The World Trade Center (WTC) general responder cohort (GRC) was exposed to environmental toxins possibly associated with increased risk of developing autoimmune conditions.

OBJECTIVES: Two study designs were used to assess incidence and risks of autoimmune conditions in the GRC.

METHODS: Three clinically trained professionals established the status of possible GRC cases of autoimmune disorders adhering to diagnostic criteria, supplemented, as needed, by specialists' review of consenting responders' medical records. Nested case-control analyses using conditional logistic regression estimated the risk associated with high WTC exposure (being in the 9/11/2001 dust cloud or ≥median days' response worked) compared with low WTC exposure (all other GRC members'). Four controls were matched to each case on age at case diagnosis (±2 years), sex, race/ethnicity, and year of program enrollment. Sex-specific and sensitivity analyses were performed. GRC age- and sex-adjusted standardized incidence ratios (SIRs) were compared with the Rochester Epidemiology Project (REP). Complete REP inpatient and outpatient medical records were reviewed by specialists. Conditions meeting standardized criteria on ≥2 visits were classified as REP confirmed cases.

RESULTS: Six hundred and twenty-eight responders were diagnosed with autoimmune conditions between 2002 and 2017. In the nested case-control analyses, high WTC exposure was not associated with autoimmune domains and conditions (rheumatologic domain odds ratio [OR] = 1.03, 95% confidence inter-

val [CI] = 0.77, 1.37; rheumatoid arthritis OR = 1.12, 95% CI = 0.70, 1.77). GRC members had lower SIR than REP. Women's risks were generally greater than men's.

CONCLUSIONS: The study found no statistically significant increased risk of autoimmune conditions with WTC exposures.

Sigel K, de la Hoz RE, Markowitz SB, et al. 2022. Lung cancer incidence among World Trade Center rescue and recovery workers. Cancer Med.

HTTPS://DOI.ORG/10.1002/CAM4.4672

BACKGROUND: Many World Trade Center disaster (WTC) rescue and recovery workers (WTC RRWV)were exposed to toxic inhalable particles. The impact of WTC exposures on lung cancer risk is unclear.

METHODS: Data from the WTC Health Program General Responders Cohort (WTC-GRC) were linked to health information from a large New York City health system to identify incident lung cancer cases. Incidence rates for lung cancer were then calculated. As a comparison group, we created a microsimulation model that generated expected lung cancer incidence rates for a WTC- and occupationally-unexposed cohort with similar characteristics. We also fitted a Poisson regression model to determine specific lung cancer risk factors for WTC RRWV.

RESULTS: The incidence of lung cancer for WTC RRWV was 39.5 (95% confidence interval [CI]: 30.7-49.9) per 100,000 person-years. When compared to the simulated unexposed cohort, no significant elevation in incidence was found among WTC RRWV (incidence rate ratio [IRR] 1.34; 95% CI: 0.92-1.96). Predictors of lung cancer incidence included age, smoking intensity, and years since quitting for former smokers. In adjusted models evaluating airway obstruction and individual pre-WTC occupational exposures, only mineral dust work was associated with lung cancer risk (IRR: 2.03; 95% CI: 1.07-3.86).

DISCUSSION: In a sample from a large, prospective cohort of WTC RRWV we found a lung cancer incidence rate that was similar to that expected of a **WTC**- and occupationally-unexposed cohort with similar individual risk profiles. Guideline-concordant lung cancer surveillance and periodic evaluations of population-level lung cancer risk should continue in this group.

Whealin JM, Ciro D, Dasaro CR, et al. 2022. Race/ethnic differences in prevalence and correlates of posttraumatic stress disorder in World Trade Center responders: Results from a population-based, health monitoring cohort. Psychol Trauma. 14 (2):199–208.

HTTPS://DOI.ORG/10.1037/TRA0001081

OBJECTIVE: This study evaluated race/ethnic differences in the prevalence and correlates of World Trade Center ***(WTC)*** related posttraumatic stress disorder ***(PTSD)*** in WTC responders.

METHOD: Data were analyzed from a population-based, health monitoring cohort of 15,440 nontraditional (i.e., construction workers) and 13,403 police WTC responders.

RESULTS: Among nontraditional responders, the prevalence of WTC-related PTSD was highest in Latino/a ***(40.4%)*** versus Black ***(27.3%)*** and White ***(26.5%)*** respond-

ers; among police responders, Latino/a ***(10.4%)*** responders also had higher prevalence of PTSD relative to Black ***(9.8%)*** and White ***(8.7%)*** responders. However, multivariable analyses revealed that prior psychiatric diagnosis, greater severity of WTC-related exposures, post-9/11 stressful life events, (in police responders only) older age, and (in nontraditional responders only) lower income and education levels accounted for substantially higher prevalence of WTC-related **PTSD** across ethnic/racial groups. Additionally, among nontraditional responders, subgroups with added risk included responders who were: Latino/a or White had high ***post-911*** stressful events; Latino/a or Black and had pre-9/11 psychiatric history; and Latinas. Among police responders, subgroups with added risk were Latino/a or Black police with a low annual income.

CONCLUSIONS: Collectively, results of this study underscore the burden of differential vulnerability that can contribute to higher prevalence of **PTSD** in certain cultural subgroups following large magnitude traumatic events.

Wisnivesky JP, Becker JH, Ankam J, et al. 2022. The relationship between post traumatic stress disorder and self-management behaviors in World Trade Center workers with asthma. The Journal of Allergy and Clinical Immunology: In Practice. 10 (1):242–249.

HTTPS://DOI.ORG/10.1016/J.JAIP.2021.08.035

BACKGROUND: Comorbid post-traumatic stress disorder ***(PTSD)*** is highly prevalent and associated with increased morbidity among World Trade Center (WTC) rescue and recovery workers with asthma. However, the potential behavioral pathways underlying this relationship remain unclear. Objective To evaluate if **PTSD** is associated with lower adherence to asthma self-management behaviors among WTC workers with asthma.

METHODS: We used data from a prospective cohort of **WTC** workers with a physician diagnosis of asthma who were prescribed controller medications. Presence of comorbid **PTSD** was determined based on structured clinical interviews. Asthma self-management behaviors included medication adherence, inhaler technique, use of action plans, and trigger avoidance. We conducted unadjusted and multiple regression analyses to evaluate the association of **PTSD** with asthma self-management.

RESULTS: Overall, 30% of 276 WTC workers with asthma had comorbid **PTSD. PTSD** was associated with worse asthma control and poorer quality of life. However, **PTSD** was not significantly associated with medication adherence ***(odds ratio [OR]: -0.15, 95% confidence interval [CI]: -0.5-0.2)***, inhaler technique ***(OR: -0.12, 95% CI: -0.7-0.5)***, use of action plans ***(OR: 0.8, 95% CI: 0.4-1.8)***, or trigger avoidance **(OR: 0.9, 95% CI: 0.4-1.8)**.

CONCLUSIONS: P We did not find significant differences in key asthma self-management behaviors between **WTC** workers with and without PTSD. These results suggest that other mechanisms, such as differences in symptom perception or inflammatory pathways, may explain the association between **PTSD** and increased asthma morbidity.

Appendix 2, Section 5

WTC Survivors Data Center• Research Publications

WTC Survivors Data Center Research Publications

Year Published 2005 (2)

Lin S, Reibman J, Bowers JA, et al. 2005. Upper respiratory symptoms and other health effects among residents living near the World Trade Center site after September 11, 2001. Am J Epidemiol. 162 (6):499–507.

HTTPS://DOI.ORG/10.1093/AJE/KWI233

The authors investigated changes in respiratory health after September 11, 2001 ("9/11") among residents of the area near the World Trade Center (WTC) site in New York City as compared with residents of a control area. In 2002, self-administered questionnaires requesting information on the presence and persistence of respiratory symptoms, unplanned medical visits, and medication use were sent to 9,200 households (22.3% responded) within 1.5 km of the WTC site (affected area) and approximately 1,000 residences (23.3% responded) in Upper Manhattan, more than 9 km from the site (control area). Residents of the affected area reported higher rates of new-onset upper respiratory symptoms after 9/11 (cumulative incidence ratio = 2.22, 95% confidence interval (CI): 1.88, 2.63). Most of these symptoms persisted 1 year after 9/11 in the affected area. Previously healthy residents of the affected area had more respiratory-related unplanned medical visits (prevalence ratio = 1.73, 95% CI: 1.13, 2.64) and more new medication use (prevalence ratio = 2.89, 95% CI: 1.75, 4.76) after 9/11. Greater impacts on respiratory functional limitations were also found in the affected area. Although bias may have contributed to these increases, other analyses of WTC-related pollutants support their biologic plausibility. Further analyses are needed to examine whether these increases were related to environmental exposures and to monitor long-term health effects.

Reibman J, Lin S, Hwang SA, et al. 2005. The World Trade Center residents' respiratory health study: New-onset respiratory symptoms and pulmonary function. Environ Health Perspect. 113 (4):406–411.

HTTPS://DOI.ORG/10.1289/EHP.7375

The destruction of the World Trade Center (WTC) on 11 September 2001 in New York City resulted in the massive release of pulverized dust and combustion products. The dust and smoke settled in the surrounding area, which encompassed a large residential community. We hypothesized that previously normal residents in the community surrounding the former WTC would have

an increased incidence of persistent respiratory symptoms and abnormalities in screening spirometry. A hybrid cross-sectional and retrospective cohort study using a symptom-based questionnaire and onsite screening spirometry in residents in an exposed area and in a control area was performed 12 +/- 4 months after the collapse. Surveys were analyzed from 2,812 residents. New-onset respiratory symptoms were described by 55.8% of residents in the exposed area, compared with 20.1% in the control area after the event. Persistent new-onset symptoms were identified in 26.4 versus 7.5% of residents in the exposed area versus control area, respectively. No differences in screening spirometry between the groups were detected. A small pilot study suggested the possibility of an increase in bronchial hyperresponsiveness in exposed participants with persistent symptoms. The data demonstrate an increased rate of new-onset and persistent respiratory health effects in residents near the former WTC compared with a control population.

Year Published 2007 (2)

Lin S, Jones R, Reibman J, et al. 2007. Reported respiratory symptoms and adverse home conditions after 9/11 among residents living near the World Trade Center. J Asthma. 44 (4):325–332.

HTTPS://DOI.ORG/10.1080/02770900701344181

This study investigated whether self-reported damage, dust, and odors in homes near the World Trade Center (WTC) after September 11, 2001, were related to increased rates of respiratory symptoms among residents and if multiple sources of exposure were associated with greater health risk. We mailed questionnaires to homes within 1.5 km of the WTC site (affected area) and in upper Manhattan (control area). Surveys asked about respiratory symptoms, unplanned medical visits, physician diagnoses, medication use, and conditions in the home after 9/11. Adverse home conditions were associated with new-onset (i.e., began after 9/11) and persistent (i.e., remained 1 year after 9/11) upper and lower respiratory symptoms in the affected area (Cumulative Incidence Ratios [CIRs] 1.20-1.71). Residents reporting longer duration of dust/odors or multiple sources of exposure had greater risk for symptoms compared to those reporting shorter duration and fewer sources. These data suggest that WTC-related contamination in the home after 9/11 was associated with new and persistent respiratory symptoms among residents living near the site. While we cannot eliminate potential biases related to self-reported data, we took strategies to minimize their impact, and the observed effects are biologically plausible.

Oppenheimer BW, Goldring RM, Herberg ME, et al. 2007. Distal airway function in symptomatic subjects with normal spirometry following World Trade Center dust exposure. Chest. 132 (4):1275–1282.

HTTPS://DOI.ORG/10.1378/CHEST.07-0913

RATIONALE: Following collapse of the World Trade Center (WTC), individuals reported

new-onset respiratory symptoms. Despite symptoms, spirometry often revealed normal airway function. However, bronchial wall thickening and air trapping were seen radiographically in some subjects. We hypothesized that symptomatic individuals following exposure to WTC dust may have functional abnormalities in distal airways not detectable with routine spirometry.

METHODS: One hundred seventy-four subjects with respiratory symptoms and normal spirometry results were evaluated. Impedance oscillometry (IOS) was performed to determine resistance at 5 Hz, 5 to 20 Hz, and reactance area. Forty-three subjects were also tested for frequency dependence of compliance (FDC). Testing was repeated after bronchodilation.

RESULTS: Predominant symptoms included cough (67%) and dyspnea (65%). Despite normal spirometry results, mean resistance at 5 Hz, 5 to 20 Hz, and reactance area were elevated (4.36 +/- 0.12 cm H(2)O/L/s, 0.86 +/- 0.05 cm H(2)O/L/s, and 6.12 +/- 0.50 cm H(2)O/L, respectively) [mean +/- SE]. Resistance and reactance normalized after bronchodilation. FDC was present in 37 of 43 individuals with improvement after bronchodilation.

CONCLUSIONS: Symptomatic individuals with presumed WTC dust/fume exposure and normal spirometry results displayed airway dysfunction based on the following: (1) elevated airway resistance and frequency dependence of resistance determined by IOS; (2) heterogeneity of distal airway function demonstrated by elevated reactance area on oscillometry and FDC; and (3) reversibility of these functional abnormalities to or toward normal following administration of a bronchodilator. Since spirometry results were normal in all subjects, these abnormalities likely reflect dysfunction in airways more distal to those evaluated by spirometry. Examination of distal airway function when spirometry results are normal may be important in the evaluation of subjects exposed to occupational and environmental hazards.

Year Published 2009 (1)

Reibman J, Liu M, Cheng Q, et al. 2009. Characteristics of a residential and working community with diverse exposure to World Trade Center dust, gas, and fumes. J Occup Environ Med. 51 (5):534–541.

HTTPS://DOI.ORG/10.1097/JOM.0B013E3181A0365B

OBJECTIVE: To describe physical symptoms in those local residents, local workers, and cleanup workers who were enrolled in a treatment program and had reported symptoms and exposure to the dust, gas, and fumes released with the destruction of the World Trade Center (WTC) on September 11, 2001.

METHODS: Symptomatic individuals underwent standardized evaluation and subsequent treatment.

RESULTS: One thousand eight hundred ninety-eight individuals participated in the WTC Environmental Health Center between

September 2005 and May 2008. Upper and lower respiratory symptoms that began after September 11, 2001 and persisted at the time of examination were common in each exposure population. Many (31%) had spirometry measurements below the lower limit of normal.

CONCLUSIONS: Residents and local workers as well as those with work-associated exposure to WTC dust have new and persistent respiratory symptoms with lung function abnormalities 5 or more years after the WTC destruction.

Year Published 2010 (2)

Lin S, Jones R, Reibman J, et al. 2010. Lower respiratory symptoms among residents living near the World Trade Center, two and four years after 9/11. Int J Occup Environ Health. 16 (1):44–52.

HTTPS://DOI.ORG/10.1179/OEH.2010.16.1.44

We investigated whether residents living near the World Trade Center (WTC) continued to experience respiratory problems several years after September 11, 2001 (9/11). Residents living within one mile of the WTC surveyed after 9/11 responded two and four years later to follow-up surveys that asked about lower respiratory symptoms (LRS), medical history, psychological stress, and indoor environmental characteristics. There were declines in the proportion of residents reporting LRS, new lower respiratory diagnoses, unplanned medical visits, and asthma medication use. However, the proportion of residents reporting any LRS in the affected area at follow-up remained higher than the original proportion in the control area; residents with multiple sources of potential 9/11-related exposures were at greatest risk for LRS at follow-up. Psychological stress, dust/odors, and moisture were significantly associated with LRS at follow-up. These data demonstrate that LRS continue to burden residents living in the areas affected by the WTC disaster.

Rom WN, Reibman J, Rogers L, et al. 2010. Emerging exposures and respiratory health: World Trade Center dust. Proc Am Thorac Soc. 7 (2):142–145.

HTTPS://DOI.ORG/10.1513/PATS.200908-092RM

The attack on the World Trade Center (WTC) on 9/11/2001 produced a massive dust cloud with acute exposure, and the rubble pile burning over 3 months exposed more than 300,000 residents, rescue workers, and clean-up workers. Firefighters in the New York City Fire Department had significant respiratory symptoms characterized by cough, dyspnea, gastroesophageal reflux, and nasal stuffiness with a significant 1-year decline in FVC and FEV(1). Bronchial hyperreactivity measured by methacholine challenge correlated with bronchial wall thickening on CT scans. Compared with the NHANES III data for FVC and FEV(1), 32% of 2,000 WTC dust-exposed residents and clean-up workers were below the lower 5th percentile. The most common abnormality was a low FVC pattern, a finding similar to that also described for individuals in rescue and recovery activities. Among those complaining of respiratory symptoms and normal spirom-

etry, almost half had abnormalities detected with impedance oscillometry consistent with distal airways' disease. Follow-up with the WTC Health Registry and the WTC Environmental Health Center will help discern whether treatment with anti-inflammatory medications or bronchodilators in those with respiratory symptoms may prevent the development of chronic obstructive pulmonary disease.

Year Published 2011 (2)

Caplan-Shaw CE, Yee H, Rogers L, et al. 2011. Lung pathologic findings in a local residential and working community exposed to World Trade Center dust, gas, and fumes. J Occup Environ Med. 53 (9):981–991.

HTTPS://DOI.ORG/10.1097/JOM.0B013E31822FFF60

OBJECTIVE: To describe pathologic findings in symptomatic World Trade Center-exposed local workers, residents, and cleanup workers enrolled in a treatment program. METHODS: Twelve patients underwent surgical lung biopsy for suspected interstitial lung disease (group 1, n = 6) or abnormal pulmonary function tests (group 2, n = 6). High-resolution computed axial tomography and pathologic findings were coded. Scanning electron microscopy with energy-dispersive x-ray spectroscopy was performed.

RESULTS: High-resolution computed axial tomography showed reticular findings (group 1) or normal or airway-related findings (group 2). Pulmonary function tests were predominantly restrictive. Interstitial fibrosis, emphysematous change, and small airway abnormalities were seen. All cases had opaque and birefringent particles within macrophages, and examined particles contained silica, aluminum silicates, titanium dioxide, talc, and metals.

CONCLUSIONS: In symptomatic World Trade Center-exposed individuals, pathologic findings suggest a common exposure resulting in alveolar loss and a diverse response to injury.

Friedman SM, Maslow CB, Reibman J, et al. 2011. Case-control study of lung function in World Trade Center Health Registry area residents and workers. Am J Respir Crit Care Med. 184 (5):582–589.

HTTPS://DOI.ORG/10.1164/RCCM.201011-1909OC

RATIONALE: Residents and area workers who inhaled dust and fumes from the World Trade Center disaster reported lower respiratory symptoms in two World Trade Center Health Registry surveys (2003-2004 and 2006-2007), but lung function data were lacking.

OBJECTIVES: To examine the relationship between persistent respiratory symptoms and pulmonary function in a nested case-control study of exposed adult residents and area workers 7-8 years after September 11, 2001.

METHODS: Registrants reporting post September 11th onset of a lower respiratory symptom in the first survey and the same symptom in the second survey were solicited as potential cases. Registrants without lower respiratory symptoms in either Registry survey were solicited as potential

control subjects. Final case-control status was determined by lower respiratory symptoms at a third interview (the study), when spirometry and impulse oscillometry were also performed.

MEASUREMENTS AND MAIN RESULTS: We identified 180 cases and 473 control subjects. Cases were more likely than control subjects to have abnormal spirometry (19% vs. 11%; $P < 0.05$), and impulse oscillometry measurements of elevated airway resistance (R5; 68% vs. 27%; $P < 0.0001$) and frequency dependence of resistance (R(5)(-)(2)(0); 36% vs. 7%; $P < 0.0001$). When spirometry was normal, cases were more likely than control subjects to have elevated R(5) and R(5)(-)(2)(0) (62% vs. 25% and 27% vs. 6%, respectively; both $P < 0.0001$). Associations between symptoms and oscillometry held when factors significant in bivariate comparisons (body mass index, spirometry, and exposures) were analyzed using logistic regression.

CONCLUSIONS: This study links persistent respiratory symptoms and oscillometric abnormalities in World Trade Center-exposed residents and area workers. Elevated R(5) and R(5)(-)(2)(0) in cases despite normal spirometry suggested distal airway dysfunction as a mechanism for symptoms.

Year Published 2012 (2)

Liu M, Qian M, Cheng Q, et al. 2012. Longitudinal spirometry among patients in a treatment program for community members with World Trade Center-related illness. J Occup Environ Med. 54 (10):1208–1213.

HTTPS://DOI.ORG/10.1097/JOM.0B013E31826BB78E

OBJECTIVE: The course of lung function in community members exposed to World Trade Center (WTC) dust and fumes remains undefined. We studied longitudinal spirometry among patients in the WTC Environmental Health Center (WTCEHC) treatment program.

METHODS: Observational study of 946 WTCEHC patients with repeated spirometry measures analyzed on the population as a whole and stratified by smoking status, initial spirometry pattern, and WTC-related exposure category.

RESULTS: Improvement in forced vital capacity (54.4 mL/yr; 95% confidence interval, 45.0 to 63.8) and forced expiratory volume in 1 second (36.8 mL/yr; 95% confidence interval, 29.3 to 44.3) was noted for the population as a whole. Heavy smokers did not improve. Spirometry changes differed depending on initial spirometry pattern and exposure category.

CONCLUSION: These data demonstrate spirometry improvement in select populations suggesting reversibility in airway injury and reinforcing the importance of continued treatment.

Maslow CB, Friedman SM, Pillai PS, et al. 2012. Chronic and acute exposures to the World Trade Center disaster and lower respiratory symptoms: Area residents and workers. Am J Public Health. 102 (6):1186–1194.

HTTPS://DOI.ORG/10.2105/AJPH.2011.300561

OBJECTIVES: We assessed associations be-

tween new-onset (post-September 11, 2001 [9/11]) lower respiratory symptoms reported on 2 surveys, administered 3 years apart, and acute and chronic 9/11-related exposures among New York City World Trade Center-area residents and workers enrolled in the World Trade Center Health Registry.

METHODS: World Trade Center-area residents and workers were categorized as case participants or control participants on the basis of lower respiratory symptoms reported in surveys administered 2 to 3 and 5 to 6 years after 9/11. We created composite exposure scales after principal components analyses of detailed exposure histories obtained during face-to-face interviews. We used multivariate logistic regression models to determine associations between lower respiratory symptoms and composite exposure scales.

RESULTS: Both acute and chronic exposures to the events of 9/11 were independently associated, often in a dose-dependent manner, with lower respiratory symptoms among individuals who lived and worked in the area of the World Trade Center.

CONCLUSIONS: Study findings argue for detailed assessments of exposure during and after events in the future from which potentially toxic materials may be released and for rapid interventions to minimize exposures and screen for potential adverse health effects.

Year Published 2013 (3)

Berger KI, Reibman J, Oppenheimer BW, et al. 2013. Lessons from the World Trade Center disaster: Airway disease presenting as restrictive dysfunction. Chest. 144 (1):249–257.

HTTPS://DOI.ORG/10.1378/CHEST.12-1411

BACKGROUND: The present study (1) characterizes a physiologic phenotype of restrictive dysfunction due to airway injury and (2) compares this phenotype to the phenotype of interstitial lung disease (ILD).

METHODS: This is a retrospective study of 54 persistently symptomatic subjects following World Trade Center (WTC) dust exposure. Inclusion criteria were reduced vital capacity (VC), FEV1/VC>77%, and normal chest roentgenogram. Measurements included spirometry, plethysmography, diffusing capacity of lung for carbon monoxide (Dlco), impulse oscillometry (IOS), inspiratory/expiratory CT scan, and lung compliance (n=16).

RESULTS: VC was reduced (46% to 83% predicted) because of the reduction of expiratory reserve volume (43%+/-26% predicted) with preservation of inspiratory capacity (IC) (85%+/-16% predicted). Total lung capacity (TLC) was reduced, confirming restriction (73%+/-8% predicted); however, elevated residual volume to TLC ratio (0.35+/-0.08) suggested air trapping (AT). Dlco was reduced (78%+/-15% predicted) with elevated Dlco/alveolar volume (5.3+/-0.8 [mL/mm Hg/min]/L). IOS demonstrated abnormalities in resistance and/or reactance in 50 of 54 subjects. CT scan demonstrated bronchial wall thickening and/or AT in 40 of 54 subjects; parenchymal disease

was not evident in any subject. Specific compliance at functional residual capacity (FRC) (0.07+/-0.02 [L/cm H2O]/L) and recoil pressure (Pel) at TLC (27+/-7 cm H2O) were normal. In contrast to patients with ILD, lung expansion was not limited, since IC, Pel, and inspiratory muscle pressure were normal. Reduced TLC was attributable to reduced FRC, compatible with airway closure in the tidal range.

CONCLUSIONS: This study describes a distinct physiologic phenotype of restriction due to airway dysfunction. This pattern was observed following WTC dust exposure, has been reported in other clinical settings (eg, asthma), and should be incorporated into the definition of restrictive dysfunction.

Kazeros A, Maa MT, Patrawalla P, et al. 2013. Elevated peripheral eosinophils are associated with new-onset and persistent wheeze and airflow obstruction in World Trade Center-exposed individuals. J Asthma. 50 (1):25–32.

HTTPS://DOI.ORG/10.3109/02770903.2012.743149

BACKGROUND: Exposure to World Trade Center (WTC) dust and fumes is associated with the onset of asthma-like respiratory symptoms in rescue and recovery workers and exposed community members. Eosinophilic inflammation with increased lung and peripheral eosinophils has been described in subpopulations with asthma. We hypothesized that persistent asthma-like symptoms in WTC-exposed individuals would be associated with systemic inflammation characterized by peripheral eosinophils.

METHODS: The WTC Environmental Health Center (WTC EHC) is a treatment program for local residents, local workers, and cleanup workers with presumed WTC-related symptoms. Patients undergo a standardized evaluation including questionnaires and complete blood count. Between September 2005 and March 2009, 2462 individuals enrolled in the program and were available for analysis. Individuals with preexisting respiratory symptoms or lung disease diagnoses prior to September 2001 and current or significant tobacco use were excluded,

RESULTS: One thousand five hundred and seventeen individuals met the inclusion criteria. Patients had a mean age of 47 years, were mostly female (51%), and had a diverse race/ethnicity. Respiratory symptoms that developed after WTC dust/fume exposure and remained persistent included dyspnea on exertion (68%), cough (57%), chest tightness (47%), and wheeze (33%). A larger percentage of patients with wheeze had elevated peripheral eosinophils compared with those without wheeze (21% vs. 13%, $p < .0001$). Individuals with elevated peripheral eosinophils were more likely to have airflow obstruction on spirometry (16% vs. 7%, $p = .0003$).

CONCLUSION: Peripheral eosinophils were associated with wheeze and airflow obstruction in a diverse WTC-exposed population. These data suggest that eosinophils may participate in lung inflammation in this population with symptoms consistent with WTC-related asthma.Trasande L, Fiorino EK, Attina T, et al. 2013. Associations of World Trade Center exposures with pulmonary and cardiometabolic outcomes among children seeking care for health concerns. Sci Total Environ. 444:320–326.

HTTPS://DOI.ORG/10.1016/J.SCITOTENV.2012.11.097

OBJECTIVE: Prior research on the physical health of children exposed to the World Trade Center (WTC) attacks has largely relied on parental report via questionnaire. We examined the impact of clinically-reported exposures on the physical health of children who lived and/or attended school in downtown Manhattan on September 11, 2001.

STUDY DESIGN: We performed a cross-sectional study of 148 patients who presented to the WTC Environmental Health Center/ Survivors Health Program, and were </= 18 years old on September 11, 2001.

RESULTS: 38.5% were caught in the dust cloud from the collapsing buildings on September 11; over 80% spent >/= 1 day in their home between September 11 and 18, 2001; and 25.7% reported home dust exposure. New-onset nasal/sinus congestion was reported in 52.7%, while nearly one-third reported new gastroesophageal reflux (GERD) symptoms. Prehypertension or hypertension was identified in 45.5%. Multivariable regression with exposure variables, body mass index category, and age as covariates identified strongest associations of dust cloud with spirometry (17.1% decrease in maximum midexpiratory flow). Younger children experienced increased peripheral eosinophils (+0.098% per year, p=0.023), while older children experienced more new-onset GERD (OR 1.17, p=0.004), headaches (OR 1.10, p=0.011), and prehypertension (OR 1.09, p=0.024). Home dust exposure was associated with reduced high-density lipoprotein (-10.3mg/dL, p=0.027) and elevated triglycerides (+36.3mg/dL, p=0.033).

CONCLUSIONS: While these findings cannot be assumed to generalize to all children exposed to the WTC attacks, they strongly suggest the need for more extensive study of respiratory, metabolic, and cardiovascular consequences.

Year Published 2014 (1)

Crane MA, Levy-Carrick NC, Crowley L, et al. 2014. The response to September 11: A disaster case study. Ann Glob Health. 80 (4):320–331.

HTTPS://DOI.ORG/10.1016/J.AOGH.2014.08.215

BACKGROUND: The response to 9/11 continues into its 14th year. The World Trade Center Health Program (WTCHP), a long-term monitoring and treatment program now funded by the Zadroga Act of 2010, includes >60,000 World Trade Center (WTC) disaster responders and community members ("survivors"). The aim of this review is to identify several elements that have had a critical impact on the evolution of the WTC response and, directly or indirectly, the health of the WTC-exposed population. It further explores post-disaster monitoring efforts, recent scientific findings from the WTCHP, and some implications of this experience for ongoing and future environmental disaster response.

FINDINGS: Transparency and responsiveness,

site safety and worker training, assessment of acute and chronic exposure, and development of clinical expertise are interconnected elements determining efficacy of disaster response.

CONCLUSION: Even in a relatively well-resourced environment, challenges regarding allocation of appropriate attention to vulnerable populations and integration of treatment response to significant medical and mental health comorbidities remain areas of ongoing programmatic development.

Year Published 2015 (5)

Berger KI, Goldring RM, and Oppenheimer BW. 2015. Point: Should oscillometry be used to screen for airway disease? Yes. Chest. 148 (5):1131–1135.

HTTPS://DOI.ORG/10.1378/CHEST.15-0106

NO ABSTRACT AVAILABLE

Berger KI, Goldring RM, and Oppenheimer BW. 2015. Rebuttal from Dr Berger et al. Chest. 148 (5):1137–1138.

HTTPS://DOI.ORG/10.1378/CHEST.15-1037

We agree that the "holy grail" of pulmonary physiologists is a test that detects early chronic airway disease. While Dr. Enright remains "cautiously optimistic" that FOT can serve this purpose, there are sufficient data to mitigate his caution.

Jordan HT, Stellman SD, Reibman J, et al. 2015. Factors associated with poor control of 9/11-related asthma 10-11 years after the 2001 World Trade Center terrorist attacks. J Asthma. 52 (6):630–637.

HTTPS://DOI.ORG/10.3109/02770903.2014.999083

OBJECTIVE: To identify key factors associated with poor asthma control among adults in the World Trade Center (WTC) Health Registry, a longitudinal study of rescue/recovery workers and community members who were directly exposed to the 2001 WTC terrorist attacks and their aftermath.

METHODS: We studied incident asthma diagnosed by a physician from 12 September 2001 through 31 December 2003 among participants aged >/=18 on 11 September 2001, as reported on an enrollment (2003-2004) or follow-up questionnaire. Based on modified National Asthma Education and Prevention Program criteria, asthma was considered controlled, poorly-controlled, or very poorly-controlled at the time of a 2011-2012 follow-up questionnaire. Probable post-traumatic stress disorder, depression, and generalized anxiety disorder were defined using validated scales. Self-reported gastroesophageal reflux symptoms (GERS) and obstructive sleep apnea (OSA) were obtained from questionnaire responses. Multinomial logistic regression was used to examine factors associated with poor or very poor asthma control.

RESULTS: Among 2445 participants, 33.7% had poorly-controlled symptoms and 34.6% had very poorly-controlled symptoms in 2011-2012. Accounting for factors including age, education, body mass index, and smoking, there was a dose-response relationship between the number of mental

health conditions and poorer asthma control. Participants with three mental health conditions had five times the odds of poor control and 13 times the odds of very poor control compared to participants without mental health comorbidities. GERS and OSA were significantly associated with poor or very poor control.

CONCLUSIONS: Rates of poor asthma control were very high in this group with post-9/11 diagnosed asthma. Comprehensive care of 9/11-related asthma should include management of mental and physical health comorbidities.

Kazeros A, Zhang E, Cheng X, et al. 2015. Systemic inflammation associated with World Trade Center dust exposures and airway abnormalities in the local community. J Occup Environ Med. 57 (6):610–616.

HTTPS://DOI.ORG/10.1097/JOM.0000000000000458

BACKGROUND: Destruction of the World Trade Center (WTC) towers on September 11, 2001, released massive dust, gas, and fumes with environmental exposures for community members. Many community members have lower respiratory symptoms (LRSs) that began after September 11, 2001, and remain persistent. We evaluated whether systemic inflammation measured by C-reactive protein was associated with WTC dust exposures, persistent LRS, and lung function.

METHODS: Community members self-referred for the treatment of symptoms related to September 11, 2001. C-reactive protein and lung function measurements, including spirometry and forced oscillation tests (impulse oscillometry system), were included as routine analyses in patients (2007 to 2012).

RESULTS: Increased C-reactive protein levels were associated with the type of WTC dust exposure, LRS, reduced spirometry, and increased forced oscillation measurements (n = 724).

CONCLUSIONS: Ongoing systemic inflammation measured years after the event was associated with WTC dust exposures, persistent LRS, and abnormal lung function in a community cohort. These findings have implications for treatment and surveillance.

Rom WN and Reibman J. 2015. The history of the bellevue hospital chest service (1903-2015). Annals of the American Thoracic Society. 12 (10):1438–1446.

HTTPS://DOI.ORG/10.1513/ANNALSATS.201506-370PS

For more than 100 years, the Bellevue Hospital Chest Service in New York City has contributed major advances in our understanding of pulmonary disease. Research from the cardiopulmonary laboratory of the Chest Service by Drs. Cournand and Richards resulted in the shared Nobel Prize in Physiology or Medicine in 1956 for the development of human cardiac catheterization. In more recent years, continuing its mission to serve the underserved and respond to health crises, the Bellevue Chest Service has served as a leader in the management of HIV infections, multiple drug-resistant tuberculosis epidemics, early detection of lung cancer, and management of urban asthma. Members of the Chest Service founded the World Trade Center Environmental Health Center shortly after collapse of the towers in 2001. The Chest Service became New York's infectious isolation unit caring for the first

patient in New York infected with Ebola virus. Recent research has focused on disease management, with the first in-house Directly Observed Therapy Clinic for treatment of tuberculosis, clinical trials of aerosolized IFN-gamma, and translational research on host defense against tuberculosis infection. Studies of the airway mucosa have revealed mechanisms by which ambient pollutants promote asthma. Studies on the World Trade Center firefighters and community populations have promoted understanding of systemic inflammation and small airways function. Today, the partnership between a public hospital and an academic institution promotes the synergy that leads to cost-effective and state-of-the art care for an underserved population as well as cutting-edge training and research.

Year Published 2016 (8)

Arie S. 2016. Health effects of 9/11 terror attacks continue to grow. BMJ. 354:i4979.

HTTPS://DOI.ORG/10.1136/BMJ.I4979

Some 15 years after the terrorist attack on New York on 11; September 2001, at least 1000 people, including many; emergency responders, are known to have died from illnesses; related to their exposure to toxic dust, and 37 000 people are; officially recognised as sick.; In the next five years, the death toll from health problems related; to the New York attacks is likely to exceed the 2753 deaths on; the day that two hijacked passenger jets were flown into the; twin towers of the World Trade Center, according to Jim Melius,; a doctor who also advises the White House on worker health; and chairs the steering committee overseeing the US; government's health programme for 9/11 responders.; "There are a lot of people who are very, very ill with lung; disease who will see at least 10 years taken from their normal; life span," he told the Guardian. "We are already seeing many; more premature deaths occurring, and among younger people,; from the cancers."; The dust and debris around the World Trade Center contained; asbestos, lead, glass, heavy metals, concrete, and poisonous; gases as well as exploding jet fuel and fragments of dead bodies.; The World Trade Center Health Program provides monitoring; and treatment for a list of conditions that are officially; recognised as 9/11 related, including airway and digestive; disorders, mental health conditions, musculoskeletal disorders,; and cancers ***WWW.CDC.GOV/WTC/CONDITIONS.HTML***).; This year, Christine Todd Whitman, the head of the; Environmental Protection Agency in 2001, admitted for the first; time that she was wrong to assure people after the attack that; the air was safe.; "We did the very best we could at the time with the knowledge; we had," she said.

Berger KI, Kalish S, Shao Y, et al. 2016. Isolated small airway reactivity during bronchoprovocation as a mechanism for respiratory symptoms in WTC dust-exposed community members. Am J Ind Med. 59 (9):767–776.

HTTPS://DOI.ORG/10.1002/AJIM.22639

INTRODUCTION: Small airway dysfunction occurs following WTC dust exposure, but

its role in producing symptoms is unclear.

METHODS: Methacholine challenge (MCT) was used to assess the relationship between onset of respiratory symptoms and small airway abnormalities in 166 symptomatic WTC dust-exposed patients. Forced oscillation testing (FOT) and respiratory symptoms were assessed during MCT. FOT parameters included resistance at 5 and 20 Hz (R5 and R20) and the R5 minus R20 (R5-20).

RESULTS: Baseline spirometry was normal in all (mean FEV1 100 + 13% predicted, mean FEV1 /FVC 80 + 4%). MCT revealed bronchial hyperreactivity by spirometry in 67 patients. An additional 24 patients became symptomatic despite minimal FEV1 change (<5%); symptom onset coincided with increased R5 and R5-20 ($P > 0.001$ vs. baseline). The dose-response of FOT (reactivity) was greater compared with subjects that remained asymptomatic ($P < 0.05$).

CONCLUSIONS: FOT during MCT uncovered reactivity in small airways as a mechanism for respiratory symptoms in subjects with inhalational lung injury.

Caplan-Shaw C, Kazeros A, Pradhan D, et al. 2016. Improvement in severe lower respiratory symptoms and small airway function in World Trade Center dust exposed community members. Am J Ind Med. 59 (9):777–787.

HTTPS://DOI.ORG/10.1002/AJIM.22642

OBJECTIVE: Longitudinal assessment of lower respiratory symptoms (LRS) in community members with World Trade Center (WTC) exposures.

METHODS: Adult members of a treatment program with complete standardized visits were evaluated (n = 798). Association of demographic characteristics, mental health symptoms and lung function with trajectory of LRS between initial and monitoring visit was evaluated.

RESULTS: Severe LRS were present in 70% at initial and 63% at monitoring visit. Initial severe LRS were associated with WTC dust cloud exposure and mental health symptoms. Spirometry measures were not associated with LRS severity or trajectory; improvement in LRS was associated with improved lung function measured with forced oscillometry techniques.

CONCLUSION: Many community patients in a WTC treatment program had severe LRS associated with exposures and mental health symptoms. Improvement in LRS was associated with improvement in measures of small airway function.

Currie J and Schwandt H. 2016. The 9/11 dust cloud and pregnancy outcomes: A reconsideration. J Hum Resour. 51 (4):805–831.

HTTPS://DOI.ORG/10.3368/JHR.51.4.0714-6533R

The events of 9/11 released a million tons of toxic dust into lower Manhattan, an unparalleled environmental disaster. It is puzzling then that the literature has shown little effect of fetal exposure to the dust. However, inference is complicated by pre-existing differences between the affected mothers and other NYC mothers as well as heterogeneity in effects on boys and girls. Using all births in utero on 9/11 in NYC and comparing them to their siblings, we show that residence in

the affected area increased prematurity and low birth weight, especially for boys.

Farris SG, Paulus DJ, Gonzalez A, et al. 2016. Posttraumatic stress symptoms and body mass index among World Trade Center disaster-exposed smokers: A preliminary examination of the role of anxiety sensitivity. Psychiatry Research. 241:135–140.

HTTPS://DOI.ORG/10.1016/J.PSYCHRES.2016.04.074

Survivors

Among individuals exposed to the World Trade Center (WTC) disaster on September 11, 2001, posttraumatic stress disorder (PTSD) and symptoms are both common and associated with increased cigarette smoking and body mass. However, there is little information on the specific processes underlying the relationship of PTSD symptoms with body mass. The current study is an initial exploratory test of anxiety sensitivity, the fear of internal bodily sensations, as a possible mechanism linking PTSD symptom severity and body mass index (BMI). Participants were 147 adult daily smokers (34.0% female) exposed to the WTC disaster (via rescue/recovery work or direct witness). The direct and indirect associations between PTSD symptom severity and BMI via anxiety sensitivity (total score and subscales of physical, cognitive, and social concerns) were examined. PTSD symptom severity was related to BMI indirectly via anxiety sensitivity; this effect was specific to physical concerns about the meaning of bodily sensations. Interventions focusing on anxiety sensitivity reduction (specifically addressing physical concerns about bodily sensations) may be useful in addressing elevated BMI among trauma-exposed persons.

Icitovic N, Onyebeke LC, Wallenstein S, et al. 2016. The association between body mass index and gastroesophageal reflux disease in the World Trade Center Health Program general responder cohort. Am J Ind Med. 59 (9):761–766.

HTTPS://DOI.ORG/10.1002/AJIM.22637

BACKGROUND: There is increasing concern about the obesity epidemic in the United States. Obesity is a potential risk factor for a number of chronic diseases, including gastroesophageal reflux disease (GERD). This analysis examined whether body mass index (BMI) was associated with physician-diagnosed GERD in World Trade Center (WTC) general responders.

METHODS: 19,819 WTC general responders were included in the study. Cox proportional hazards regression models were used to compare time to GERD diagnosis among three BMI groups (normal (<25 kg/m(2)), overweight (>/=25 and <30 kg/m(2)), and obese (>/=30 kg/m(2))).

RESULTS: Among the responders, 43% were overweight and 42% were obese. The hazard ratio for normal versus overweight was 0.81 (95% Confidence Interval (CI), 0.75-0.88); normal versus obese 0.71 (95%CI, 0.66, 0.77); and overweight versus obese 0.88 (95%CI, 0.83-0.92).

CONCLUSION: GERD diagnoses rates were higher in overweight and obese WTC responders. Am. J. Ind. Med. 59:761–766, 2016.

Reibman J, Levy-Carrick N, Miles T, et al. 2016. Destruction of the World Trade Center towers. Lessons learned from an environmental health disaster. Ann Am Thorac Soc. 13 (5):577–583.

HTTPS://DOI.ORG/10.1513/ANNALSATS.201509-572PS

The assault and subsequent collapse of the World Trade Center towers in New York City on September 11, 2001 (9/11), released more than a million tons of debris and dust into the surrounding area, engulfing rescue workers as they rushed to aid those who worked in the towers, and the thousands of nearby civilians and children who were forced to flee. In December 2015, almost 15 years after the attack, and 5 years after first enactment, Congress reauthorized the James Zadroga 9/11 Health and Compensation Act, a law designed to respond to the adverse health effects of the disaster. This reauthorization affords an opportunity to review human inhalation exposure science in relation to the World Trade Center collapse. In this Special Article, we compile observations regarding the collective medical response to the environmental health disaster with a focus on efforts to address the adverse health effects experienced by nearby community members including local residents and workers. We also analyze approaches to understanding the potential for health risk, characterization of hazardous materials, identification of populations at risk, and shortfalls in the medical response on behalf of the local community. Our overarching goal is to communicate lessons learned from the World Trade Center experience that may be applicable to communities affected by future environmental health disasters. The World Trade Center story demonstrates that communities lacking advocacy and preexisting health infrastructures are uniquely vulnerable to health disasters. Medical and public health personnel need to compensate for these vulnerabilities to mitigate long-term illness and suffering.

Weiden MD, Kwon S, Caraher E, et al. 2016. Biomarkers of World Trade Center particulate matter exposure: Physiology of distal airway and blood biomarkers that predict fev(1) decline. Semin Respir Crit Care Med. 36 (3):323–333.

HTTPS://DOI.ORG/10.1055/S-0035-1547349

Biomarkers can be important predictors of disease severity and progression. The intense exposure to particulates and other toxins from the destruction of the World Trade Center (WTC) overwhelmed the lung's normal protective barriers. The Fire Department of New York (FDNY) cohort not only had baseline pre-exposure lung function measures but also had serum samples banked soon after their WTC exposure. This well-phenotyped group of highly exposed first responders is an ideal cohort for biomarker discovery and eventual validation. Disease progression was heterogeneous in this group in that some individuals subsequently developed abnormal lung function while others recovered. Airflow obstruction predominated in WTC-exposed patients who were symptomatic. Multiple independent disease pathways may cause this abnormal FEV1 after irritant exposure. WTC exposure activates one or more of these pathways causing abnormal FEV1 in an individual. Our hypothesis was that serum biomarkers expressed within 6 months after WTC exposure reflect active disease pathways and predict subsequent development or protection from abnormal FEV1 below the lower limit of normal known as WTC-Lung Injury (WTC-

LI). We utilized a nested case-cohort control design of previously healthy never smokers who sought subspecialty pulmonary evaluation to explore predictive biomarkers of WTC-LI. We have identified biomarkers of inflammation, metabolic derangement, protease/antiprotease balance, and vascular injury expressed in serum within 6 months of WTC exposure that were predictive of their FEV1 up to 7 years after their WTC exposure. Predicting future risk of airway injury after particulate exposures can focus monitoring and early treatment on a subset of patients in greatest need of these services.

Year Published 2017 (2)

Haugen PT, McCrillis AM, Smid GE, et al. 2017. Mental health stigma and barriers to mental health care for first responders: A systematic review and meta-analysis. J Psychiatr Res. 94:218–229.

HTTPS://DOI.ORG/10.1016/J.JPSYCHIRES.2017.08.001

OBJECTIVE: It is unclear how many first responders experience barriers to care and stigma regarding mental health care, and how this influences their help-seeking. A systematic review and meta-analysis was conducted on barriers to care and mental health stigma in first responders and their empirical relationship with psychosocial and psychiatric variables.

METHODS: The databases Medline, Embase PsycINFO, CINAHL, PILOTS, LILACS, Sociological Abstracts, SocINDEX, and Social Citation Index were searched to identify relevant studies. A quality assessment and meta-analysis was performed.

RESULTS: Fourteen articles met inclusion criteria, from which data from 12 samples were extracted for meta-analyses. All studies measured stigma regarding mental health care and 33.1% of first responders (95% CI 26.7-40.1; 12 individual samples) endorsed stigma items. The systematic review revealed that the most frequently endorsed items were fears regarding confidentiality and negative career impact. Five of 14 studies measured barriers to mental health care and 9.3% of first responders (95% CI 7.0-12.3; 4 individual samples) endorsed barriers to care items. The most frequently endorsed barriers were scheduling concerns and not knowing where to get help. Indications were found for more stigma and barriers in individuals with mental health problems.

CONCLUSIONS: Stigma and barriers to care are experienced by a significant proportion of firs responders, which can potentially lead to delayed presentation in mental health care and therefore, increased risk of chronicity of post-trauma psychopathology for these groups. The current systematic review draws attention to the paucity of research in this area, particularly in non-Western samples.

Haugen PT, Werth, A.S., Foster, A.L., Owen, J.. 2017. Are rupture–repair episodes related to outcome in the treatment of trauma-exposed World Trade Center responders?. Counselling and Psychotherapy Research. 17 (4):276–282.

HTTPS://DOI.ORG/10.1002/CAPR.12138

OBJECTIVE: This study aimed to examine rupture–repair (R–R) episodes in a sample of adult World Trade Center responders (N = 32) who engaged in integrative psychotherapy for the treatment of posttraumatic stress; disorder (PTSD) in an outpatient clinic.;

METHOD: Participants rated therapeutic alliance after each session, and presence of R–R episodes was calculated throughout the course of treatment. We predicted that patients who experienced R–R episodes would have significantly better treatment outcomes than those who did not. ;

RESULTS: ANCOVA analyses indicated that the presence or absence of R–R episodes was not meaningfully related to treatment outcome, with the exception of the Goals & Task domain of alliance, which was meaningfully related to improved outcome. ;

CONCLUSIONS: Attending to disagreements regarding treatment Goals & Task may be uniquely important for individuals with PTSD.

Year Published 2018 (1)

Ahuja S, Zhu Z, Shao Y, et al. 2018. Obstructive sleep apnea in community members exposed to World Trade Center dust and fumes. Journal of Clinical Sleep Medicine. 14 (5):735–743.

HTTPS://DOI.ORG/10.5664/JCSM.7094

STUDY OBJECTIVES: A relationship between obstructive sleep apnea (OSA) and exposure to the World Trade Center (WTC) dust and fumes has been suggested in responders but little is known about a possible relationship in community members. We characterized sleep studies performed in community members with WTC dust exposure to improve our understanding of the relationship between the diagnosis and severity of OSA and WTC dust exposure in this population.

METHODS: Single-center, retrospective study of patients enrolled in a clinical treatment program for community members with WTC dust exposure. Patients were included if they had undergone sleep studies for evaluation of possible OSA through September 2016 and provided written informed consent.

RESULTS: The total number of patients included in the analysis was 143. Patients were predominantly male (61%), never smokers (59%) and had a median body mass index of 31 kg/m². Most reported upper and lower respiratory symptoms. An apnea-hypopnea index (AHI) >= 5 events/h was measured in 66% of the patients, and respiratory disturbance index was = 5 events/h in 97%. The proportion of patients with moderate-severe OSA (defned by the AHI 4% criteria) was 50%. Multivariate logistic regression revealed that acute WTC dust cloud exposure was associated with severity but not diagnosis of OSA.

CONCLUSIONS: We identifed a high rate of OSA in the WTC community cohort who were referred for sleep studies. Exposure

to the massive WTC dust cloud caused by the WTC collapse was independently associated with the severity of OSA in this population. This fnding highlights the role that environmental exposures may play in the development of OSA.

Year Published 2019 (4)

Hena KM, Murphy S, Zhang Y, et al. 2019. Clinical evaluation of sarcoidosis in community members with World Trade Center dust exposure. International journal of environmental research and public health. 16 (7)

HTTPS://DOI.ORG/10.3390/IJERPH16071291

BACKGROUND: Sarcoidosis is a granulomatous disease involving intrathoracic and extrathoracic organs. Genetic and environmental factors, such as exposure to World-Trade Center (WTC) dust after 9/11, may play a role in clinical presentation. Characterization of sarcoidosis in community members with exposure to the WTC dust can provide further insight into the relationship between environmental exposure and sarcoidosis.

METHOD(S): Patients with documented sarcoidosis were identified in the WTC Environmental Health Center (EHC), a treatment program for community members. Demographic and clinical data were collected from standardized questionnaires and chart review. Organ involvement was assessed with a standard instrument. Result(s): Among patients in the WTC EHC, 87 were identified with sarcoidosis after 9/11. Sarcoidosis cases were more likely African-American, local workers, and had more respiratory symptoms, compared with non-sarcoidosis WTC EHC patients. Many (46%) had >= Scadding stage 3 on chest imaging, and had reduced lung function measures. Extrathoracic involvement was identified in 33/87 (38%) with a diversity of organs involved.

CONCLUSION(S): WTC-exposed sarcoidosis in community members is often characterized by severe pulmonary disease and a high rate of diverse extrathoracic involvement. Further analysis is required to characterize the course of disease progression or resolution.

Pradhan D, Xu N, Reibman J, et al. 2019. Bronchodilator response predicts longitudinal improvement in small airway function in World Trade Center dust exposed community members. Int J Environ Res Public Health. 16 (8)

HTTPS://DOI.ORG/10.3390/IJERPH16081421

The evolution of lung function, including assessment of small airways, was assessed in individuals enrolled in the World Trade Center Environmental Health Center (WTC-EHC). We hypothesized that a bronchodilator response at initial evaluation shown by spirometry or in small airways, as measured by forced oscillation technique (FOT), would be associated with improvement in large and small airway function over time. Standardized longitudinal assessment included pre and post bronchodilator (BD) spirometry (forced vital capacity, FVC; forced expiratory volume in 1 second, FEV1) and FOT (resistance at 5 Hz, R5; resistance at 5 minus 20

Hz, R5-20). Longitudinal changes were assessed using linear mixed-effects modelling with adjustment for potential confounders (median follow-up 2.86 years; 95% measurements within 4.9 years). Data demonstrated: (1) parallel improvement in airflow and volume measured by spirometry and small airway function (R5 and R5-20) measured by FOT; (2) the magnitude of longitudinal improvement was tightly linked to the initial BD response; and (3) longitudinal values for small airway function on FOT were similar to residual abnormality observed post BD at initial visit. These findings suggest presence of reversible and irreversible components of small airway injury that are identifiable at initial presentation. These results have implications for treatment of isolated small airway abnormalities that can be identified by non-invasive effort independent FOT particularly in symptomatic individuals with normal spirometry indices. This study underscores the need to study small airway function to understand physiologic changes over time following environmental and occupational lung injury.

Rosen R, Zhu Z, Shao Y, et al. 2019. Longitudinal change of PTSD symptoms in community members after the World Trade Center destruction. Int J Environ Res Public Health. 16 (7)

HTTPS://DOI.ORG/10.3390/IJERPH16071215

The World Trade Center (WTC) Environmental Health Center (EHC) is a treatment program for community members with exposure to the 9/11 terrorist attack and its physical and emotional aftermath. Compared to the general responders program, the WTC EHC is diverse with equal gender distribution, representation of many races and ethnicities, and a wide range of social economic status. Patients in the WTC EHC were initially enrolled for physical symptoms, most of which were respiratory, however a large portion of the enrollees scored positive for probable posttraumatic stress disorder (PTSD). In this paper we identify patient characteristics associated with probable PTSD. We also determine the characteristics associated with the longitudinal change of PTSD symptoms, including persistence and remittance, using the widely used Posttraumatic Check List-17 (PCL) cut-off value of 44, as well as changes in PCL total score and symptom cluster scores in patients of Low and High PTSD symptom severity. Few patients with elevated scores achieved a score below 44. However, longitudinal improvement in PCL score at follow-up was identified for patients with High PTSD scores (PCL > 57.5). Changes in PCL symptom clusters differed between those with High and Low PCL scores. These data suggest improvement over time in PCL score that differs depending on the severity of the score and variable responses in the PCL symptom clusters.

Thawani S, Wang B, Shao Y, et al. 2019. Time to onset of paresthesia among community members exposed to the World Trade Center disaster. Int J Environ Res Public Health. 16 (8)

HTTPS://DOI.ORG/10.3390/IJERPH16081429

We examined whether time to onset of paresthesia was associated with indicators of severity of World Trade Center (WTC) exposure. We analyzed data from 3411 patients from the Bellevue Hospital-WTC Environmental Health Center. Paresthesia was defined as present if the symptom occurred in the lower extremities with frequency "often"

or "almost continuous." We plotted hazard functions and used the log-rank test to compare time to onset of paresthesia between different exposure groups. We also used Cox regression analysis to examine risk factors for time-to-paresthesia after 9/11/2001 and calculate hazard ratios adjusted for potential confounders. We found significantly elevated hazard ratios for paresthesia for (a) working in a job that required cleaning of WTC dust in the workplace; and (b) being heavily exposed to WTC dust on September 11, 2001, after adjusting for age, race/ethnicity, depression, anxiety, post-traumatic stress disorder, and body mass index. These observational data are consistent with the hypothesis that exposure to WTC dust or some other aspect of cleaning WTC dust in the workplace, is associated with neuropathy and paresthesia. Further neurological evaluations of this and other WTC-exposed populations is warranted.

Year Published 2020 (3)

Durmus N, Shao Y, Arslan AA, et al. 2020. Characteristics of cancer patients in the World Trade Center Environmental Health Center. Int J Environ Res Public Health. 17 (19):7190.

HTTPS://DOI.ORG/10.3390/IJERPH17197190

The destruction of the World Trade Center (WTC) towers on 11 September 2001 released many tons of aerosolized dust and smoke with potential for carcinogenic exposures to community members as well as responders. The WTC Environmental Health Center (WTC EHC) is a surveillance and treatment program for a diverse population of community members ("Survivors"), including local residents and workers, present in the NYC disaster area on 9/11 or in the days or weeks following. We report a case series of cancers identified in the WTC EHC as of 31 December 2019. Descriptive characteristics are presented for 2561 cancer patients (excluding non-melanoma skin cancer) and 5377 non-cancer WTC-EHC participants who signed informed consent. We identified a total of 2999 cancer diagnoses in 2561 patients: 2534 solid tumors (84.5%) and 465 lymphoid and hematopoietic tissue cancers (15.5%) with forty-one different cancer types. We describe the distribution, frequency, median age of cancer diagnosis and median latency from 9/11 by cancer site. In addition to common cancer types, rare cancers, including male breast cancers and mesotheliomas have been identified. The current study is the first report on cancer characteristics of enrollees at WTC EHC, a federally designated treatment and surveillance program for local community members affected by the 9/11 terrorist attack on the WTC.

Marmor M, Thawani S, Cotrina ML, et al. 2020. Case-control study of paresthesia among World Trade Center-exposed community members. J Occup Environ Med. 62 (4):307–316.

HTTPS://DOI.ORG/10.1097/JOM.0000000000001828

OBJECTIVE: To investigate whether paresthesia of the lower extremities following exposure to the World Trade Center (WTC)

disaster was associated with signs of neuropathy, metabolic abnormalities, or neurotoxin exposures.

METHODS: Case-control study comparing WTC-exposed paresthesia cases with "clinic controls" (WTC-exposed subjects without paresthesias), and "community controls" (WTC-unexposed persons).

RESULTS: Neurological histories and examination findings were significantly worse in cases than controls. Intraepidermal nerve fiber densities were below normal in 47% of cases and sural to radial sensory nerve amplitude ratios were less than 0.4 in 29.4%. Neurologic abnormalities were uncommon among WTC-unexposed community controls. Metabolic conditions and neurotoxin exposures did not differ among groups.

CONCLUSIONS: Paresthesias among WTC-exposed individuals were associated with signs of neuropathy, small and large fiber disease. The data support WTC-related exposures as risk factors for neuropathy, and do not support non-WTC etiologies.

Reibman J, Caplan-Shaw C, Wu Y, et al. 2020. Characterization of persistent uncontrolled asthma symptoms in community members exposed to World Trade Center dust and fumes. Int. J. Environ. Res. Public Health. 17 (18):6645.

HTTPS://DOI.ORG/10.3390/IJERPH17186645

The destruction of the World Trade Center (WTC) towers on the 11th of September, 2001 released a vast amount of aerosolized dust and smoke resulting in acute and chronic exposures to community members as well as responders. The WTC Environmental Health Center (WTC EHC) is a surveillance and treatment program for a diverse population of community members, including local residents and local workers with WTC dust exposure. Many of these patients have reported persistent lower respiratory symptoms (LRS) despite treatment for presumed asthma. Our goal was to identify conditions associated with persistent uncontrolled LRS despite standard asthma management. We recruited 60 patients who were uncontrolled at enrollment and, after a three-month run-in period on high-dose inhaled corticosteroid and long acting bronchodilator, reassessed their status as Uncontrolled or Controlled based on a score from the Asthma Control Test (ACT). Despite this treatment, only 11 participants (18%) gained Controlled status as defined by the ACT. We compared conditions associated with Uncontrolled and Controlled status. Those with Uncontrolled symptoms had higher rates of upper airway symptoms. Many patients had persistent bronchial hyper-reactivity (BHR) and upper airway hyper-reactivity as measured by paradoxical vocal fold movement (PVFM). We found a significant increasing trend in the percentage of Controlled with respect to the presence of BHR and PVFM. We were unable to identify significant differences in lung function or inflammatory markers in this small group. Our findings suggest persistent upper and lower airway hyper-reactivity that may respond to standard asthma treatment, whereas others with persistent LRS necessitate additional diagnostic evaluation, including a focus on the upper airway.

Year Published 2021 (4)

Arslan AA, Zhang Y, Durmus N, et al. 2021. Breast cancer characteristics in the population of survivors participating in the World Trade Center environmental health center program 2002-2019. International journal of environmental research and public health. 18 (14):7555.

HTTPS://DOI.ORG/10.3390/IJERPH18147555

Survivors

The destruction of World Trade Center on 11 September 2001 exposed local community members to a complex mixture of known carcinogens and potentially carcinogenic substances. To date, breast cancer has not been characterized in detail in the WTC-exposed civilian populations. The cancer characteristics of breast cancer patients were derived from the newly developed Pan-Cancer Database at the WTC Environmental Health Center (WTC EHC). We used the Surveillance, Epidemiology, and End Results (SEER) Program breast cancer data as a reference source. Between May 2002 and 31 December 2019, 2840 persons were diagnosed with any type of cancer at the WTC EHC, including 601 patients with a primary breast cancer diagnosis (592 women and 9 men). There was a higher proportion of grade 3 (poorly differentiated) tumors (34%) among the WTC EHC female breast cancers compared to that of the SEER-18 data (25%). Compared to that of the SEER data, female breast cancers in the WTC EHC had a lower proportion of luminal A (88% and 65%, respectively), higher proportion of luminal B (13% and 15%, respectively), and HER-2-enriched (5.5% and 7%, respectively) subtypes. These findings suggest considerable differences in the breast cancer characteristics and distribution of breast cancer intrinsic subtypes in the WTC-exposed civilian population compared to that of the general population. This is important because of the known effect of molecular subtypes on breast cancer prognosis.

Berger KI, Wohlleber M, Goldring RM, et al. 2021. Respiratory impedance measured using impulse oscillometry in a healthy urban population. ERJ Open Research. 7 (1):00560–02020.

HTTPS://DOI.ORG/10.1183/23120541.00560-2020

This study derives normative prediction equations for respiratory impedance in a healthy asymptomatic urban population using an impulse oscillation system (IOS). In addition, this study uses body mass index (BMI) in the equations to describe the effect of obesity on respiratory impedance.Data from an urban population comprising 472 healthy asymptomatic subjects that resided or worked in lower Manhattan, New York City were retrospectively analysed. This population was the control group from a previously completed case–control study of the health effects of exposure to World Trade Center dust. Since all subjects underwent spirometry and oscillometry, these previously collected data allowed a unique opportunity to derive normative prediction equations for oscillometry in an urban, lifetime non-smoking, asymptomatic population without underlying respiratory disease.Normative prediction equations for men and women were successfully developed for a broad range of respiratory oscillometry variables with narrow confidence bands. Models that

used BMI as an independent predictor of oscillometry variables (in addition to age and height) demonstrated equivalent or better fit when compared with models that used weight. With increasing BMI, resistance and reactance increased compatible with lung and airway compression from mass loading.This study represents the largest cohort of healthy urban subjects assessed with an IOS device. Normative prediction equations were derived that should facilitate application of IOS in the clinical setting. In addition, the data suggest that modelling of lung function may be best performed using height and BMI as independent variables rather than the traditional approach of using height and weight.Prediction equations for respiratory impedance were derived in an urban cohort incorporating the effects of mass loading from obesity. Urban exposures had minimal effect on impedance allowing application of the equations to a broad range of populations.

Durmus N, Pehlivan S, Zhang Y, et al. 2021. Lung cancer characteristics in the World Trade Center environmental health center. Int J Environ Res Public Health. 18 (5)

HTTPS://DOI.ORG/10.3390/IJERPH18052689

The destruction of the World Trade Center (WTC) towers on 11 September 2001 resulted in acute and chronic dust and fume exposures to community members, including local workers and residents, with well-described aerodigestive adverse health effects. This study aimed to characterize lung cancer in the WTC Environmental Health Center (WTC EHC) focusing on gender and smoking history. WTC EHC patients undergo an initial evaluation that includes WTC exposure information, demographics, and tobacco use. Detailed cancer characteristics are recorded from pathology reports. As of 31 December 2019, 248 WTC EHC patients had a diagnosis of lung cancer. More patients with lung cancer were women (57%) compared to men (43%). Many cases (47% women, 51% men) reported acute dust cloud exposure. Thirty-seven percent of lung cancer cases with available smoking history were never-smokers (≤1 pack-years) and 42% had a ≤5 pack-year history. The median age of cancer diagnosis in never-smoking women was 61 years compared to 66 years in men. Adenocarcinoma was more common in never-smokers compared to ever-smokers (72% vs. 65%) and in women compared to men (70% vs. 65%). We provide an initial description of lung cancers in local community members with documented exposure to the WTC dust and fumes.

Shao Y, Durmus N, Zhang Y, et al. 2021. The development of a WTC Environmental Health Center pan-cancer database. Int J Environ Res Public Health. 18 (4):1646.

HTTPS://DOI.ORG/10.3390/IJERPH18041646

(1) BACKGROUND: Recent studies have reported elevated risks of multiple cancers in the World Trade Center (WTC) affected community members (also called WTC "Survivors"). The large variety of WTC-cancers created a need to develop a comprehensive cancer database. This paper describes the development of a pan-cancer database at the WTC Environmental Health Center (EHC) Data Center.

(2) METHODS: A new REDCap-based pan-cancer database was created using the pathol-

ogy reports and available biomarker data of confirmed cancer cases after review by a cancer epidemiologist, a pathologist, physicians and biostatisticians.

(3) RESULTS: The WTC EHC pan-cancer database contains cancer characteristics and emerging biomarker information for cancers of individuals enrolled in the WTC EHC and diagnosed after 11 September 2001 and up to 31 December 2019 obtained from WTC EHC clinical records, pathological reports and state cancer registries. As of 31 December 2019, the database included 3440 cancer cases with cancer characteristics and biomarker information.

(4) CONCLUSIONS: This evolving database represents an important resource for the scientific community facilitating future research about the etiology, heterogeneity, characteristics and outcomes of cancers and comorbid mental health conditions, cancer economics and gene-environment interaction in the unique population of WTC survivors.

Year Published 2022 (1)

Rosen R, Shao Y, Zhang Q, et al. 2022. Cognitive function among World Trade Center-exposed community members with mental health symptoms. International Journal of Environmental Research and Public Health. 19 (6)

HTTPS://DOI.ORG/10.3390/IJERPH19063440

The World Trade Center Environmental Health Center (WTC EHC), is a federally designated clinical center of excellence for surveillance and treatment of WTC disaster exposed community members (WTC Survivors). Cognitive impairment (CI) has been extensively described in WTC responders and a concern for progressive impairment in all WTC disaster exposed groups has been raised. Cognitive status, however, has not been systematically characterized in the WTC Survivor population. We describe cognitive status in a subgroup of the Survivor population referred for mental health evaluation (N = 480) in the WTC EHC as measured by scores on the Montreal Cognitive Assessment (MoCA) instrument, and examine their association with WTC exposures and individual-level covariates including PTSD and depression screening inventory scores. In regression analyses, probable cognitive impairment (MoCA score < 26) was found in 59% of the study subjects and was significantly associated with age, race/ethnicity, education, income, depression and PTSD scores. Being caught in the dust cloud on 11 September 2011 was significantly associated with cognitive impairment even after controlling for the above. These data suggest an association with cognitive dysfunction in WTC Survivors with exposure to the toxic dust/fumes and psychological stress from the 9/11 terrorist attack and warrant further systematic study.

Appendix 3, Section 1

WTC STAC 2012 Research Recommendations

Research Recommendations WTC Scientific/Technical Advisory Committee Draft for discussion 1/22/2012

RESPIRATORY DISEASES:

The committee recommends additional research on the effect of WTC exposures on the development of chronic respiratory diseases. Specific topics include:

Continue to do follow-up studies on all WTC-exposed groups (firefighters, rescue and recovery workers, residents, children, police and emergency service workers, etc.) for whom persistent WTC-related respiratory symptoms and effects (asthma, rhinitis, sinusitis, etc.) have been documented and/or demonstrated

Determine whether existing persistent health effects among various exposed groups follow an exposure-effect gradient (as demonstrated with firefighters)

Explore genetic, environmental and other clinical co-factors associated with improving versus worsening pulmonary function and COPD.

Investigate the best diagnostic approaches to patients with respiratory symptoms but normal pulmonary function testing; develop clinical guidelines.

Investigate the role of inflammation in the persistent drop in pulmonary function among WTC first responders, including correlate lung function changes with inflammatory biomarkers in blood, sputum, or nasal/bronchial brushes.

Is inflammation a possible mechanism only in highly exposed or is it also possible at lower exposures?

Are there potential randomized clinical trials for treatment strategies to reduce the likelihood of COPD developing?

SARCOIDOSIS:

The committee recommends additional research on sarcoidosis which seems to be in excess in all of the major post-WTC cohorts. The WTC HP should encourage the four major cohorts to conduct cooperative studies to investigate genetic, demographic, occupational and clinical risk factors for sarcoidosis associated with 9/11 exposures.

CANCER:

The committee recommends continued follow-up all WTC-exposed cohorts currently under study for cancer incidence and mortality. The committee also recommends that studies should be done to detect pre-malignant changes using biomarkers in blood or sputum as well as use of other clinically appropriate techniques to detect evidence of pre-cancerous lesions or mucosal changes. Toxicological and mechanistic research should be done to better understand potential carcinogenicity of WTC dust and components.

MEDICAL SURVEILLANCE:

Research should be conducted on optimal methods of medical surveillance and screening for WTC dust exposed. Should WTC dust exposed be screened for auto immune diseases or other diseases not yet identified as WTC-related? Should enhanced screening for lung or other cancers be considered in light of both risks and benefits associated with screening tests?

HEALTH EFFECTS AMONG CHILDREN:

The committee recommends that research on pediatric environmental health effects of 9/11, including respiratory, developmental and endocrine impacts should be an immediate priority. We know very little about the health effects of the WTC disaster on the more than 30,000 children living or attending school or daycare in the area. Given children's increased susceptibility to harm, especially in critical periods of development, it is imperative that NIOSH move quickly to support in depth studies of respiratory impacts, developmental effects and endocrine disruption for this rapidly dispersing cohort.

MENTAL HEALTH INTERVENTION STUDIES:

The committee recommends that the WTC HP should solicit proposals for mental health intervention studies. While studies show substantially increased rates of PTSD and other psychiatric diseases in WTC populations, studies to define the best treatments would be valuable; clinical trials at one or more of the centers would be a logical next step.

BIOSPECIMEN REPOSITORY:

The WTC HP should solicit proposals to develop a biospecimen repository of blood and other biological samples collected with informed consent for research from individuals seen at the WTC funded health clinics. Such samples would be an important resource for future studies to investigate associations between WTC exposures and health effects.

CROSS CUTTING ISSUES:

Are there medical conditions in WTC-exposed patients that cause, are caused by, or are otherwise related to another condition in the same patient (rather than existing simultaneously but independent in the same patient) . For example, do heart conditions (not covered) develop after treatment for a respiratory condition (covered)?

What is happening in females vs. males in the health program? Research that may be based only on male participants does not consider important sex differences in the incidence of certain diseases, response to treatment, and long-term outcomes.

Consider the applicability of participatory action approaches to the WTC HP.

Recognize that WTC research is 'disaster science.'

COMMENTS FROM INDIVIDUAL WTC STAC MEMBERS

VIRGINIA WEAVER

It was a pleasure meeting you and working with you on the STAC over the last few days. Here are my three recommendations:

Mental health interventions study - my rationale for this is that, while there are studies showing substantially increased rates of PTSD and other psychiatric diseases in WTC populations, studies to define the best treatments would be valuable to this population as well as others impacted by both man-made and natural disasters. The team at NYU seems to be thinking along these lines based on the systematic review data presented to us but a clinical trial at one or more of the centers would be the logical next step.

Research to determine the best diagnostic approach to patients with respiratory symptoms but normal pulmonary function testing. Again, some work in this regard has been done in terms of oscillometry and end expiratory CT scans and so I will defer to my pulmonary colleagues on the committee as to whether this goal has been achieved. However, my rationale is that, as with recommendation #1, the value is clear for WTC populations

but would also extend to many other patients with toxic inhalation and symptoms but normal initial testing. Once the approach is clear, guidelines issued through the American Thoracic Society would be valuable.

The last one is a no-brainer — continued funding of cancer research.

WILLIAM ROM

Research topics need to emphasize respiratory disease since that is "by far" what the respondents suffer from.

1. First, what are the biomarkers that may predict COPD especially emphysema?

2. Are lung function changes correlated with blood inflammatory markers?

3. Will asthma or airway changes e.g. Constrictive bronchiolitis predict emphysema?

4. What are the characteristics of small airway disease in WTC dust-exposed? Can sputum or airway/nasal brushes predict asthma or airway diseases?

5. Are there any proteomic or genomic or metabolomic predictors of COPD in WTC dust-exposed?

6. Longitudinal studies would be much more helpful than cross-sectional since there are large cohorts already in screening and treatment clinics.

7. Are there potential randomized clinical trials for treatment strategies to reduce the likelihood of COPD developing?

8. Are there blood banks and gene repositories that can be used currently and going forward that can predict COPD/emphysema?

9. How often and how should WTC dust-exposed be screened?

10. Can inflammatory markers in blood, sputum, nasal/bronchial brushes be used to correlate with COPD/emphysema?

11. Do WTC dust exposed or those with PTSD have increased sleep apnea? Does sleep apnea correlate with small airway disease markers?

12. Do WTC dust exposed have increased cancer biomarkers in blood (proteomics, genomics) or sputum, and should they be undergoing CT screening for lung cancer?

13. What cell line systems or transgenic mice can be used to model WTC dust exposure?

JOHN DEMENT

Thanks for the reminder. The following are my three research recommendation: Further research in the role of inflammation in the persistent drop in pulmonary function among WTC first responders . This cohort is unique with regard to exposure characteristics and offers the opportunity to investigate the natural history of many respiratory diseases, including COPD and RADS. Some consideration should be given to developing a serum bank for WTC responders to be used for future studies. Combined analyses of sarcoidosis cases, pooling cases from the various WTC cohorts. This could be a descriptive study, perhaps followed by a case-control analysis if the number of cases is sufficient.

Expanded study of respiratory effects among WTC exposed children. Several schools were in the dust path and further follow-up of those exposed is needed. For these analyses, an appropriate control population is needed.

THOMAS ALDRICH, MD

Attached are three proposed research priorities for the WTC HP, one fairly well-developed and the other two just outlines.

I'm a little concerned about COI, and each proposal is followed by a brief note about COI.

1. GENETIC, DEMOGRAPHIC, OCCUPATIONAL, AND CLINICAL CHARACTERISTICS OF PATIENTS WITH WTC ASSOCIATED SARCOIDOSIS.

Sarcoidosis probably represents a genetically-primed excessive and abnormal immune response to any of a number of antigens. The frequent involvement of lung, skin and eyes has suggested an airborne route of antigen exposure. In addition to the well-known association of beryllium exposure to the development of a granulomatous disorder indistinguishable from sarcoidosis, environmental factors such as wood smoke, tree (especially pine) pollen, insecticides, mold, flight deck work on aircraft carriers, metalworking, construction work, and firefighting have been associated with increased risk of sarcoidosis.

Unusually high annual incidence and point prevalence of sarcoidosis has been demonstrated in all of the major post-WTC cohorts, with 26 new cases found in FDNY (Izbicki Chest 2007), 38 at Mt Sinai (Crowley AJInd-Med 2011), 23 at NYU (Parsia AJRCCM abstract 2010), and 43 in the registry (Jordan JOEM 2011). (At least some of the registry cases overlap with those reported in other cohorts, but it is clear that there are at least 100 new post-WTC cases). Each of the cohorts may have identified additional cases since their publications. Stored blood is available for at least the FDNY patients, and fresh blood samples can be obtained from most patients. In addition, FDNY has reported 25 firefighting-associated sarcoidosis case pre-9/11 (Prezant Chest 1999). These >100 cases represent a unique cohort of sarcoidosis cases, the majority of whom had defined temporal onset and a relatively well-es-

tablished environmental trigger. The WTC Health Program should require the four major cohorts to conduct a cooperative study of genetic and clinical characteristics of the identified post-9/11 sarcoidosis cases. The study should include at the least two controls groups: non-WTC-associated sarcoidosis cases matched for gender, age, race/ethnicity, occupation, and smoking history; and non-sarcoidosis WTC-exposed persons, similarly matched. The PI could be from any of the cohorts, but a representative of each should be included and should guarantee access to records and patients.

NOTE REGARDING COI: I was one of several authors (not first, second, or senior author) of the FDNY sarcoidosis paper in 2007. If I were not a member of the WTC Health Program STAC, I might well propose a study of this sort in any future RFP from the WTC Health Program, but, as a member of the STAC, I will undertake not to do so and not to accept any salary or other support from any contract or grant from the WTC HP on this topic.

1. **EARLY DETECTION OF LUNG (AND PERHAPS HEAD & NECK, ESOPHAGEAL, GASTRIC, COLONIC) CANCER AND BIOMARKERS FOR PRE-CANCEROUS LESIONS.**

The WTC terrorist attack led to exposure of large numbers of persons to multiple potential carcinogens. Because of the largely inhalational route of exposure, lung cancers (and also perhaps head and neck, esophageal, gastric and colon cancers) might be expected to be the most likely cancers to emerge at higher-than expected rates in the future. It is still too early to expect sufficient clinical manifestation of· any WTC-associated solid tumors to be reliably detected. However, it may be possible to demonstrate evidence of pre-cancerous lesions or mucosa changes in exposed persons.

The WTC HP should solicit proposals to evaluate the presence of known biomarkers for existing cancers or "precancerous" conditions in persons with high and low exposure to WTC and in matched, non-WTC controls. Studies could be of blood biomarkers, exhaled air or BAL DNA adducts or other biomarkers.

Bronchoscopic photodynamic evaluation could also be considered to be responsive to this priority.

Perhaps there are Head and neck, esophageal, gastric, colon, or other types of photodynamic evaluations that also could be considered.

I have no COI related to this proposal.

3. **[Third proposal redacted for potential COI]**

GUILLE MEJIA

I strongly recommend research that focuses on:

1. **Co-morbidity: We need a close look at medical condition(s) in a patient that causes, is caused by, or is otherwise related to another condition in the same patient rather than looking at a medical condition existing simultaneously**

but independent in the same patient. For example developing a heart condition (not covered) after treatment from a covered condition (respiratory).

2. **The health status of female WTC HP participants. What is happening and what is being seen in females vs. males in the health program? Relying on results of research that may be based only on male participants does not take into consideration important differences between men and women (and minorities) related to the incidence of certain diseases, how they respond to treatment, and the long term outcomes.**

Findings from these types of studies may (or may not) identify other conditions for coverage, have implications for treatment, diagnostic testing and medications, or raise more questions, etc.

SUSAN SIDEL

Attached is a short memo with my research choices.

Can we leverage top talent in specialties outside the WTC Health Program?

After reviewing the 2011 Research Grants, it occurred to me that we have a self-perpetuating system: Staffed only with specialties appropriate to diagnose and treat The List; we don't have specialists with interest and expertise in researching conditions other than those they were initially hired to treat.

Maybe that's part of the disconnect, why The List and available research does not reflect what is actually happening to people.

1. **Review the Methods & Protocols used to Collect & Collate Disease Data of Responders & Survivors in the WTC Health Program's. Implement Elements of Participatory Action Research (PAR) in this Study.**

- Past and present research and data methods do not provide a comprehensive overview of diseases caused by WTC toxins. Necessity mandates continual focus on renewing and re validating illnesses previously negotiated for monitoring and treatment.

- This is why we do not have accurate cancer numbers; the data was not collected or collected but not collated.

- The List contains health effects treatable within the purview of the medical specialties of WTC[HP] staff or specialists easily accessible at a Center of Excellence (Occupational Medicine, Pulmonologists, Psychiatrists, Gastroenterologists). Other likely WTC disease consequences requiring different specialists for diagnosis and treatment are not included.

- It is unclear if Monitoring and Treatment patients diagnosed elsewhere with a WTC-related condition, not on The List, has that diagnosis reflected in any WTC Health Program data.

- Responders complain that symptoms and ailments, "likely" WTC related conditions were/are ignored by WTC Health Program doctors, as they are not on The List. Their medical records reflect only List ailments and symptoms ignoring all other

possible WTC related health issues particularly if undiagnosed. Impoverished by ill health, specialized diagnosis is difficult for many Responders and Survivors to access. Many specialists in NYC do not accept any health insurance, let alone NYS Workers Compensation, GHI, and Blue Cross (held by many city employees) or Medicare/ Medicaid.

- It becomes circular: There is a lack of diagnosis and therefore data; downplaying the need to expand The list particularly as non-List WTC conditions must be diagnosed outside the WTC Health Program.

- "Essentially Participatory Action Research (PAR) is research which involves all relevant parties in actively examining together current action (which they experience as problematic) in order to change and improve it. They do this by critically reflecting on the historical, political, cultural, economic, geographic and other context which make sense of it .... it aims to be active co research, by and for those to be helped. Nor can it be used by one group of people to get another group of people to do what is thought best for them - whether that is to implement a central policy or an organizational or service change. Instead it tries to be a genuinely democratic or non-coercive process whereby those to be helped, determine the purposes and outcomes of their own inquiry." -Wadsworth, Y. (1998)

2. **Study Autoimmune Disease(s) as a Consequence of Exposure to Toxins Present at the WTC.**

- The WTC Health Program have been quite insular. This would be a terrific opportunity to expand our pool of specialists and leverage the expertise of top medical centers in NYC.

- Hospital for Special Surgery (HSS) of NYC, is the #2 Rheumatology Center, nationally, and a teaching hospital for Cornell Medical School.

3. **Effect of WTC Toxins on Women's Health Issues.**

STAC 2012

JULIA QUINT

1. **Effect of WTC exposures on the development of chronic respiratory disease (COPD, sarcoidosis, lung cancer, etc.)**

- Conduct research and continue to do follow-up studies on all WTC-exposed groups (firefighters, rescue and recovery workers, residents, children, police and emergency service workers, etc.) for whom persistent WTC-related respiratory symptoms and effects (asthma, rhinitis, sinusitis, etc.) have been documented and/ or demonstrated.

Examples of questions/issues that could be addressed in the research/follow-up studies:

- Whether existing persistent health effects among various exposed groups follow an exposure-effect gradient (as demonstrated with firefighters)

- Whether there are differences or similarities in the persistent health effects of the various WTC-exposed groups that may predict a risk of chronic respiratory disease

- Whether inflammation is the mech-

anism by which the adverse respiratory health effects were induced in the various exposed groups. Is inflammation a possible mechanism only in· highly exposed as indicated by the in vivo toxicological study by Gavett et al. and the in vitro study by Payne et al., or is also possible at lower exposures as indicated by the in vitro study by Wang et al.?

- Are there biomarkers (effects or exposures) that would help to predict the risk of developing chronic respiratory disease?

2. Effect of WTC exposures on the risk of developing cancer: Conduct toxicological and epidemiological research and continue to follow up all WTC-exposed groups currently under study to identify excess cancers.

Examples of questions/issues that could be addressed in the research/follow-up studies:

- Did WTC exposure increase the presence of PAH- or benzo(a)pyrene -DNA adducts in non smokers in the various exposed groups? If so, do the concentrations of PAH-DNA adducts correlate with level or time of WTC exposure?

- Did WTC exposure increase the risk or reduce the latency of testicular cancer, prostate cancer, and Non-Hodgkin lymphoma among firefighters who are already at risk for these cancers based on their occupation? IARC classifies firefighting as an occupation as 28, Possibly Carcinogenic in Humans. A meta-analysis by the IARC Working Group found that these cancers were statistically significantly increased among firefighters.

- Possibility of short, high exposures to WTC dust inducing cancer via an inflammation mechanism

- What is the theoretical lifetime cancer risk (using the default assumption that the risks are additive) associated with exposure to the 72 carcinogens (most of which are genotoxic and 15 of which are human carcinogens) identified in the WTC dust?

- Would WTC dust be carcinogenic if it were tested in an NTP animal bioassay?

3. Will WTC exposures have long-term effects on the health of children?

Continue to conduct follow-up studies of exposed children and children born to exposed women and men to determine if they develop long-term health effects.

Examples of questions/issues that could be addressed in the research/follow-up studies:

- Are the children of pregnant women who were exposed to high levels of PAHs at increased risk for developing cancer because of in-utero exposure (indicated in the studies by Perera et al.)?

- Are children with persistent symptoms at increased risk of chronic respiratory disease compared to adults with similar symptoms and levels/types of exposures?

- Whether stress-induced low birth weight caused adverse effects on the academic achievement of children born of WTC-exposed pregnant women

- Long-term effects on the academic achievement of children enrolled in schools in areas directly affected by the WTC disaster

- Are children at increased to develop cancer compared to similarly WTC-exposed adults?

KIMBERLY FLYNN

As a STAC member, I appreciate the opportunity to provide input on the important question of WTC research priorities.

First, I wish to raise a number of ideas that should inform NIOSH's approach to research solicitation, review and funding, then I list three research priorities: Approach to WTC Research:

NIOSH should solicit a diversity of proposals at different levels of funding, including pilot studies, clinical trials, mechanistic studies, epidemiologic studies and basic science research. Especially important would be work that creates resources that can be used by multiple investigators.

NIOSH should solicit proposals that address health effects to populations throughout the geographic zones of impact defined by the Zadroga Act.

NIOSH should recognize that WTC research is 'disaster science.' The understanding that 9/11-related health impacts were the result of a disaster, with all the complexity and uncertainty disaster ushers in, should inform RFPs and the proposal review process. Post-9/11, researchers and doctors affiliated with the clinical centers and data centers have worked to address the challenges of a context that differs in key ways from standard scientific research. Especially with respect to the survivor populations, reviewers must take into account that a standardized body of pre-existing medical data for study subject does not exist. In addition, the absence of reliable and comprehensive environmental measurements makes quantifying exposures impossible. It is critical that these and other limitation in available data deriving from the unique nature of the WTC disaster or the negligence of the Environmental Protection Agency not become an insurmountable barrier to conducting the research required to meet the 9/11- related health needs of survivors.

4. Research on pediatric environmental health effects of 9/11, including respiratory, developmental and endocrine impacts, should be an immediate priority. We know very little about the physical health effects of the WTC disaster on the more than 30,000 children living or attending school or daycare in the area. The only data that currently exist are WTC Health Registry surveys completed by parents of some 3000 children, and a handful of molecular epidemiology studies correlating various developmental and mutagenic effects with the presence of pollutants in cord blood - the so-called WTC pregnancy studies.

The WTC Health Registry's initial questionnaire survey found that two to three years after 9/11, parents of children who were less than 5 years old on 9/11 and enrolled in the health registry reported twice as much newly diagnosed asthma than average levels for the northeastern United States for that age group.

Nonetheless, there have been no lung function studies following up on what appears to be a widespread respiratory impact. In addition, there have been no studies of

non-respiratory health impacts, except for a handful of studies by Dr. Frederica Perrera's team at the Mailman School of Public Health, some of which show neurodevelopmental and mutagenic effects of in-utero exposures to WTC-derived PAHs.

Given children's increased susceptibility to harm, especially in critical periods of development, it is imperative that NIOSH move quickly to support in depth studies of respiratory impacts, developmental effects and endocrine disruption for this rapidly dispersing cohort.

> *5.* **The President's Cancer Panel has called the capacity to collect and preserve biologic samples essential. Blood banking from which DNA, RNA and proteins can be recovered should be done for both survivors and responders, and should include freezing live cells. This would be especially important for the pediatric population, which should be followed longitudinally. In the past decade, researchers have detected DNA adducts in the cord blood of WTC-exposed pregnant women, as well as PBDE concentrations that were found to be correlated with neurodevelopmental impairment revealed when their children were given standardized tests during the first six years of life.**

Individual toxins such as PBDE should be assayed in blood samples. In addition, more powerful techniques are available for assessing genetic damage and disruption of cell physiology, such as genomic DNA sequencing and expression profiling. As technology evolves, along with an understanding of the interplay of genetic variance interacting with external environmental factors, especially environmentally induced epigenetic changes, the blood bank would prove to be an invaluable resource for numerous researchers. Failing to blood bank now for the WTC pediatric population means foreclosing a key opportunity to investigate the biological basis of disorders caused by exposure to WTC toxins during intense phases of growth.

Finally, understanding the biological effects of complex mixtures can open the way to more accurate assessment of the WTC-exposed. In addition, this would expand a knowledge base for future disasters and as such, would be an enduring benefit that can still be draw from what was otherwise an unmitigated tragedy.

Since the underlying disease process of WTC illnesses is poorly understood, mechanistic studies of WTC-related asthma, sarcoidosis, interstitial lung disease, as well as thyroid cancer should be initiated now. Such studies will address 'diagnostic uncertainty' and 'treatment uncertainty,' in the language of the Zadroga Act. The translational benefits of these studies may be substantial, as they may provide insights into more effective intervention. Such studies may also contribute to an understanding of the carcinogenic potential of WTC exposures. Recommendations WTC Scientific/Technical Advisory Committee Draft for discussion 1/22/2012

RESPIRATORY DISEASES:

The committee recommends additional research on the effect of WTC exposures on the development of chronic respiratory diseases. Specific topics include:

- Continue to do follow-up studies on all WTC-exposed groups (firefighters, rescue and recovery workers, residents, children, police and emergency service workers, etc.) for whom persistent WTC-related respiratory symptoms and effects (asthma, rhinitis, sinusitis, etc.) have been documented and/or demonstrated
- Determine whether existing persistent health effects among various exposed groups follow an exposure-effect gradient (as demonstrated with firefighters)
- Explore genetic, environmental and other clinical co-factors associated with improving versus worsening pulmonary function and COPD.
- Investigate the best diagnostic approaches to patients with respiratory symptoms but normal pulmonary function testing; develop clinical guidelines.
- Investigate the role of inflammation in the persistent drop in pulmonary function among WTC first responders, including correlate lung function changes with inflammatory biomarkers in blood, sputum, or nasal/bronchial brushes.
- Is inflammation a possible mechanism only in highly exposed or is it also possible at lower exposures?

Are there potential randomized clinical trials for treatment strategies to reduce the likelihood of COPD developing?

SARCOIDOSIS:

The committee recommends additional research on sarcoidosis which seems to be in excess in all of the major post-WTC cohorts. The WTC HP should encourage the four major cohorts to conduct cooperative studies to investigate genetic, demographic, occupational and clinical risk factors for sarcoidosis associated with 9/11 exposures.

CANCER:

The committee recommends continued follow-up all WTC-exposed cohorts currently under study for cancer incidence and mortality. The committee also recommends that studies should be done to detect pre-malignant changes using biomarkers in blood or sputum as well as use of other clinically appropriate techniques to detect evidence of pre-cancerous lesions or mucosal changes. Toxicological and mechanistic research should be done to better understand potential carcinogenicity of WTC dust and components.

MEDICAL SURVEILLANCE:

Research should be conducted on optimal methods of medical surveillance and screening for WTC dust exposed. Should WTC dust exposed be screened for auto immune diseases or other diseases not yet identified as WTC-related? Should enhanced screening for lung or other cancers be considered in light of both risks and benefits associated with screening tests?

HEALTH EFFECTS AMONG CHILDREN:

The committee recommends that research on pediatric environmental health effects of 9/11, including respiratory, developmental and endocrine impacts should be an immediate priority. We know very little about the health effects of the WTC disaster on the more than 30,000 children living or attending school or daycare in the area. Given children's increased susceptibility to harm, especially in critical periods of development, it is imperative that NIOSH move quickly to support in depth studies of respiratory impacts, developmental effects and endocrine disruption for this rapidly dispersing cohort.

MENTAL HEALTH INTERVENTION STUDIES:

The committee recommends that the WTC HP should solicit proposals for mental health intervention studies. While studies show substantially increased rates of PTSD and other psychiatric diseases in WTC populations, studies to define the best treatments would be valuable; clinical trials at one or more of the centers would be a logical next step.

BIOSPECIMEN REPOSITORY:

The WTC HP should solicit proposals to develop a biospecimen repository of blood and other biological samples collected with informed consent for research from individuals seen at the WTC funded health clinics. Such samples would be an important resource for future studies to investigate associations between WTC exposures and health effects.

CROSS CUTTING ISSUES:

Are there medical conditions in WTC-exposed patients that cause, are caused by, or are otherwise related to another condition in the same patient (rather than existing simultaneously but independent in the same patient) . For example, do heart conditions (not covered) develop after treatment for a

respiratory condition (covered)? What is happening in females vs. males in the health program? Research that may be based only on male participants does not consider important sex differences in the incidence of certain diseases, response to treatment, and long-term outcomes.

Consider the applicability of participatory action approaches to the WTC HP.

Recognize that WTC research is 'disaster science.'

Comments from individual WTC STAC Members

VIRGINIA WEAVER

It was a pleasure meeting you and working with you on the STAC over the last few days. Here are my three recommendations:

Mental health interventions study - my rationale for this is that, while there are studies showing substantially increased rates of PTSD and other psychiatric diseases in WTC populations, studies to define the best treatments would be valuable to this population as well as others impacted by both man-made and natural disasters. The team at NYU seems to be thinking along these lines based on the systematic review data presented to us but a clinical trial at one or more of the centers would be the logical next step.

Research to determine the best diagnostic approach to patients with respiratory symptoms but normal pulmonary function testing. Again, some work in this regard has been done in terms of oscillometry and end expiratory CT scans and so I will defer to my pulmonary colleagues on the committee as to whether this goal has been achieved. However, my rationale is that, as with recommendation #1, the value is clear for WTC populations but would also extend to many other patients with toxic inhalation and symptoms but normal initial testing. Once the approach is clear, guidelines issued through the American Thoracic Society would be valuable.

The last one is a no-brainer — continued funding of cancer research.

WILLIAM ROM

Research topics need to emphasize respiratory disease since that is "by far" what the respondents suffer from.

6. First, what are the biomarkers that may predict COPD especially emphysema?

7. Are lung function changes correlated with blood inflammatory markers?

8. Will asthma or airway changes e.g. Constrictive bronchiolitis predict emphysema?

9. What are the characteristics of small airway disease in WTC dust-exposed? Can sputum or airway/nasal brushes predict asthma or airway diseases?

10. Are there any proteomic or genomic or metabolomic predictors of COPD in WTC

dust-exposed?

11. Longitudinal studies would be much more helpful than cross-sectional since there are large cohorts already in screening and treatment clinics.

12. Are there potential randomized clinical trials for treatment strategies to reduce the likelihood of COPD developing?

13. Are there blood banks and gene repositories that can be used currently and going forward that can predict COPD/emphysema?

14. How often and how should WTC dust-exposed be screened?

15. Can inflammatory markers in blood, sputum, nasal/bronchial brushes be used to correlate with COPD/emphysema?

16. Do WTC dust exposed or those with PTSD have increased sleep apnea? Does sleep apnea correlate with small airway disease markers?

17. Do WTC dust exposed have increased cancer biomarkers in blood (proteomics, genomics) or sputum, and should they be undergoing CT screening for lung cancer?

18. What cell line systems or transgenic mice can be used to model WTC dust exposure?

JOHN DEMENT

Thanks for the reminder. The following are my three research recommendation: Further research in the role of inflammation in the persistent drop in pulmonary function among WTC first responders . This cohort is unique with regard to exposure characteristics and offers the opportunity to investigate the natural history of many respiratory diseases, including COPD and RADS. Some consideration should be given to developing a serum bank for WTC responders to be used for future studies. Combined analyses of sarcoidosis cases, pooling cases from the various WTC cohorts. This could be a descriptive study, perhaps followed by a case-control analysis if the number of cases is sufficient. Expanded study of respiratory effects among WTC exposed children. Several schools were in the dust path and further follow-up of those exposed is needed. For these analyses, an appropriate control population is needed.

THOMAS ALDRICH, MD

Attached are three proposed research priorities for the WTC HP, one fairly well-developed and the other two just outlines.

I'm a little concerned about COI, and each proposal is followed by a brief note about COI.

1. **GENETIC, DEMOGRAPHIC, OCCUPATIONAL, AND CLINICAL CHARACTERISTICS OF PATIENTS WITH WTC ASSOCIATED SARCOIDOSIS.**

Sarcoidosis probably represents a genetically-primed excessive and abnormal immune response to any of a number of antigens. The frequent involvement of lung, skin and eyes has suggested an airborne route of antigen exposure. In addition to the well-known association of beryllium exposure to the development of a granulomatous disorder indistinguishable from sarcoidosis, environmental factors such as wood smoke, tree (especially pine) pollen, insecticides, mold, flight deck work on aircraft carriers, metal-working, construction work, and firefighting have been associated with increased risk of sarcoidosis. Unusually high annual incidence and point prevalence of sarcoidosis has been demonstrated in all of the major post-WTC cohorts, with 26 new cases found in FDNY (Izbicki Chest 2007), 38 at Mt Sinai (Crowley AJIndMed 2011), 23 at NYU (Parsia AJRCCM abstract 2010), and 43 in the registry (Jordan JOEM 2011). (At least some of the registry cases overlap with those reported in other cohorts, but it is clear that there are at least 100 new post-WTC cases). Each of the cohorts may have identified additional cases since their publications. Stored blood is available for at least the FDNY patients, and fresh blood samples can be obtained from most patients. In addition, FDNY has reported 25 firefighting-associated sarcoidosis case pre-9/11 (Prezant Chest 1999). These >100 cases represent a unique cohort of sarcoidosis cases, the majority of whom had defined temporal onset and a relatively well-established environmental trigger. The WTC Health Program should require the four major cohorts to conduct a cooperative study of genetic and clinical characteristics of the identified post-9/11 sarcoidosis cases. The study should include at the least two controls groups: non-WTC-associated sarcoidosis cases matched for gender, age, race/ethnicity, occupation, and smoking history; and non-sarcoidosis WTC-exposed persons, similarly matched. The PI could be from any of the cohorts, but a representative of each should be included and should guarantee access to records and patients.

NOTE REGARDING COI: I was one of several authors (not first, second, or senior author) of the FDNY sarcoidosis paper in 2007. If I were not a member of the WTC Health Program STAC, I might well propose a study of this sort in any future RFP from the WTC Health Program, but, as a member of the STAC, I will undertake not to do so and not to accept any salary or other support from any contract or grant from the WTC HP on this topic.

2. EARLY DETECTION OF LUNG (AND PERHAPS HEAD & NECK, ESOPHAGEAL, GASTRIC, COLONIC) CANCER AND BIOMARKERS FOR PRECANCEROUS LESIONS.

The WTC terrorist attack led to exposure of large numbers of persons to multiple potential carcinogens. Because of the largely inhalational route of exposure, lung cancers (and also perhaps head and neck, esophageal, gastric and colon cancers) might be expected to be the most likely cancers to emerge at higher-than expected rates in the future. It is still too early to expect sufficient clinical manifestation of· any WTC-associated solid tumors to be reliably detected. However, it may be possible to demonstrate evidence of pre-cancerous lesions or mucosa changes in exposed persons.

The WTC HP should solicit proposals to evaluate the presence of known biomarkers for

existing cancers or "precancerous" conditions in persons with high and low exposure to WTC and in matched, non-WTC controls. Studies could be of blood biomarkers, exhaled air or BAL DNA adducts or other biomarkers.

Bronchoscopic photodynamic evaluation could also be considered to be responsive to this priority.

Perhaps there are Head and neck, esophageal, gastric, colon, or other types of photodynamic evaluations that also could be considered.

I have no COI related to this proposal.

3. **[Third proposal redacted for potential COI]**

GUILLE MEJIA

I strongly recommend research that focuses on:

1. **Co-morbidity: We need a close look at medical condition(s) in a patient that causes, is caused by, or is otherwise related to another condition in the same patient rather than looking at a medical condition existing simultaneously but independent in the same patient. For example developing a heart condition (not covered) after treatment from a covered condition (respiratory).**

2. **The health status of female WTC HP participants. What is happening and what is being seen in females vs. males in the health program? Relying on results of research that may be based only on male participants does not take into consideration important differences between men and women (and minorities) related to the incidence of certain diseases, how they respond to treatment, and the long term outcomes.**

Findings from these types of studies may (or may not) identify other conditions for coverage, have implications for treatment, diagnostic testing and medications, or raise more questions, etc.

SUSAN SIDEL

Attached is a short memo with my research choices.Can we leverage top talent in specialties outside the WTC Health Program? bAfter reviewing the 2011 Research Grants, it occurred to me that we have a self-perpetuating system: Staffed only with specialties appropriate to diagnose and treat The List; we don't have specialists with interest and expertise in researching conditions other than those they were initially hired to treat. Maybe that's part of the disconnect, why The List and available research does not reflect what is actually happening to people.

1. **Review the Methods & Protocols used to Collect & Collate Disease Data of Responders & Survivors in the WTC Health Program's. Implement Elements of Participatory Action Research (PAR)**

in this Study.

- Past and present research and data methods do not provide a comprehensive overview of diseases caused by WTC toxins. Necessity mandates continual focus on renewing and re validating illnesses previously negotiated for monitoring and treatment.

- This is why we do not have accurate cancer numbers; the data was not collected or collected but not collated.

- The List contains health effects treatable within the purview of the medical specialties of WTC[HP] staff or specialists easily accessible at a Center of Excellence (Occupational Medicine, Pulmonologists, Psychiatrists, Gastroenterologists). Other likely WTC disease consequences requiring different specialists for diagnosis and treatment are not included.

- It is unclear if Monitoring and Treatment patients diagnosed elsewhere with a WTC-related condition, not on The List, has that diagnosis reflected in any WTC Health Program data.

- Responders complain that symptoms and ailments, "likely" WTC related conditions were/are ignored by WTC Health Program doctors, as they are not on The List. Their medical records reflect only List ailments and symptoms ignoring all other possible WTC related health issues particularly if undiagnosed. Impoverished by ill health, specialized diagnosis is difficult for many Responders and Survivors to access. Many specialists in NYC do not accept any health insurance, let alone NYS Workers Compensation, GHI, and Blue Cross (held by many city employees) or Medicare/ Medicaid.

- It becomes circular: There is a lack of diagnosis and therefore data; downplaying the need to expand The list particularly as non-List WTC conditions must be diagnosed outside the WTC Health Program.

- "Essentially Participatory Action Research (PAR) is research which involves all relevant parties in actively examining together current action (which they experience as problematic) in order to change and improve it. They do this by critically reflecting on the historical, political, cultural, economic, geographic and other context which make sense of it .... it aims to be active co research, by and for those to be helped. Nor can it be used by one group of people to get another group of people to do what is thought best for them - whether that is to implement a central policy or an organizational or service change. Instead it tries to be a genuinely democratic or non-coercive process whereby those to be helped, determine the purposes and outcomes of their own inquiry." -Wadsworth, Y. (1998)

2. **Study Autoimmune Disease(s) as a Consequence of Exposure to Toxins Present at the WTC.**

- The WTC Health Program have been quite insular. This would be a terrific opportunity to expand our pool of specialists and leverage the expertise of top medical centers in NYC.

- Hospital for Special Surgery (HSS) of NYC, is the #2 Rheumatology Center, nationally, and a teaching hospital for Cornell Medical School.

3. **Effect of WTC Toxins on Women's Health Issues.**

JULIA QUINT

1. **Effect of WTC exposures on the development of chronic respiratory disease (COPD, sarcoidosis, lung cancer, etc.)**

■ Conduct research and continue to do follow-up studies on all WTC-exposed groups (firefighters, rescue and recovery workers, residents, children, police and emergency service workers, etc.) for whom persistent WTC-related respiratory symptoms and effects (asthma, rhinitis, sinusitis, etc.) have been documented and/or demonstrated.

Examples of questions/issues that could be addressed in the research/follow-up studies:

■ Whether existing persistent health effects among various exposed groups follow an exposure-effect gradient (as demonstrated with firefighters)

■ Whether there are differences or similarities in the persistent health effects of the various WTC-exposed groups that may predict a risk of chronic respiratory disease

■ Whether inflammation is the mechanism by which the adverse respiratory health effects were induced in the various exposed groups. Is inflammation a possible mechanism only in· highly exposed as indicated by the in vivo toxicological study by Gavett et al. and the in vitro study by Payne et al., or is also possible at lower exposures as indicated by the in vitro study by Wang et al.?

■ Are there biomarkers (effects or exposures) that would help to predict the risk of developing chronic respiratory disease?

2. **Effect of WTC exposures on the risk of developing cancer: Conduct toxicological and epidemiological research and continue to follow up all WTC-exposed groups currently under study to identify excess cancers.**

■ Examples of questions/issues that could be addressed in the research/follow-up studies:

■ Did WTC exposure increase the presence of PAH- or benzo(a)pyrene -DNA adducts in non smokers in the various exposed groups? If so, do the concentrations of PAH-DNA adducts correlate with level or time of WTC exposure?

■ Did WTC exposure increase the risk or reduce the latency of testicular cancer, prostate cancer, and Non-Hodgkin lymphoma among firefighters who are already at risk for these cancers based on their occupation? IARC classifies firefighting as an occupation as 28, Possibly Carcinogenic in Humans. A meta-analysis by the IARC Working Group found that these cancers were statistically significantly increased among firefighters.

■ Possibility of short, high exposures to WTC dust inducing cancer via an inflammation mechanism

■ What is the theoretical lifetime cancer risk (using the default assumption that the risks are additive) associated with exposure to the 72 carcinogens (most of which are genotoxic and 15 of which are human carcinogens) identified in the WTC dust?

■ Would WTC dust be carcinogenic if it were tested in an NTP animal bioassay?

3. Will WTC exposures have long-term effects on the health of children?

Continue to conduct follow-up studies of exposed children and children born to exposed women and men to determine if they develop long-term health effects.

Examples of questions/issues that could be addressed in the research/follow-up studies:

- Are the children of pregnant women who were exposed to high levels of PAHs at increased risk for developing cancer because of in-utero exposure (indicated in the studies by Perera et al.)?
- Are children with persistent symptoms at increased risk of chronic respiratory disease compared to adults with similar symptoms and levels/types of exposures?
- Whether stress-induced low birth weight caused adverse effects on the academic achievement of children born of WTC-exposed pregnant women
- Long-term effects on the academic achievement of children enrolled in schools in areas directly affected by the WTC disaster
- Are children at increased to develop cancer compared to similarly WTC-exposed adults?

KIMBERLY FLYNN

As a STAC member, I appreciate the opportunity to provide input on the important question of WTC research priorities.

First, I wish to raise a number of ideas that should inform NIOSH's approach to research solicitation, review and funding, then I list three research priorities: Approach to WTC Research:

NIOSH should solicit a diversity of proposals at different levels of funding, including pilot studies, clinical trials, mechanistic studies, epidemiologic studies and basic science research. Especially important would be work that creates resources that can be used by multiple investigators.

NIOSH should solicit proposals that address health effects to populations throughout the geographic zones of impact defined by the Zadroga Act.

NIOSH should recognize that WTC research is 'disaster science.' The understanding that 9/11-related health impacts were the result of a disaster, with all the complexity and uncertainty disaster ushers in, should inform RFPs and the proposal review process. Post-9/11, researchers and doctors affiliated with the clinical centers and data centers have worked to address the challenges of a context that differs in key ways from standard scientific research. Especially with respect to the survivor populations, reviewers must take into account that a standardized body of pre-existing medical data for study subject does not exist. In addition, the absence of reliable and comprehensive environmental measurements makes quantifying exposures impossible. It is critical that these and other limitation in available data deriving from the unique nature of the WTC disaster

or the negligence of the Environmental Protection Agency not become an insurmountable barrier to conducting the research required to meet the 9/11- related health needs of survivors.

> ***1.*** **Research on pediatric environmental health effects of 9/11, including respiratory, developmental and endocrine impacts, should be an immediate priority. We know very little about the physical health effects of the WTC disaster on the more than 30,000 children living or attending school or daycare in the area. The only data that currently exist are WTC Health Registry surveys completed by parents of some 3000 children, and a handful of molecular epidemiology studies correlating various developmental and mutagenic effects with the presence of pollutants in cord blood - the so-called WTC pregnancy studies.**

The WTC Health Registry's initial questionnaire survey found that two to three years after 9/11, parents of children who were less than 5 years old on 9/11 and enrolled in the health registry reported twice as much newly diagnosed asthma than average levels for the northeastern United States for that age group.

Nonetheless, there have been no lung function studies following up on what appears to be a widespread respiratory impact. In addition, there have been no studies of non-respiratory health impacts, except for a handful of studies by Dr. Frederica Perrera's team at the Mailman School of Public Health, some of which show neurodevelopmental and mutagenic effects of in-utero exposures to WTC-derived PAHs.

Given children's increased susceptibility to harm, especially in critical periods of development, it is imperative that NIOSH move quickly to support in depth studies of respiratory impacts, developmental effects and endocrine disruption for this rapidly dispersing cohort.

> ***2.*** **The President's Cancer Panel has called the capacity to collect and preserve biologic samples essential. Blood banking from which DNA, RNA and proteins can be recovered should be done for both survivors and responders, and should include freezing live cells. This would be especially important for the pediatric population, which should be followed longitudinally. In the past decade, researchers have detected DNA adducts in the cord blood of WTC-exposed pregnant women, as well as PBDE concentrations that were found to be correlated with neurodevelopmental impairment revealed when their children were given standardized tests during the first six years of life.**

Individual toxins such as PBDE should be assayed in blood samples. In addition, more powerful techniques are available for assessing genetic damage and disruption of cell physiology, such as genomic DNA sequencing and expression profiling. As technology evolves, along with an understanding of the interplay of genetic variance interacting with external environmental factors, especially environmentally induced epigenetic changes, the blood bank would prove to be an invaluable resource for numerous researchers. Failing to blood bank now for the WTC pediatric population means foreclosing a key opportunity to investigate the biological basis of disorders caused by exposure to WTC toxins during intense phases of growth. Fi-

nally, understanding the biological effects of complex mixtures can open the way to more accurate assessment of the WTC-exposed. In addition, this would expand a knowledge base for future disasters and as such, would be an enduring benefit that can still be draw from what was otherwise an unmitigated tragedy. Since the underlying disease process of WTC illnesses is poorly understood, mechanistic studies of WTC-related asthma, sarcoidosis, interstitial lung disease, as well as thyroid cancer should be initiated now. Such studies will address 'diagnostic uncertainty' and 'treatment uncertainty,' in the language of the Zadroga Act. The translational benefits of these studies may be substantial, as they may provide insights into more effective intervention. Such studies may also contribute to an understanding of the carcinogenic potential of WTC exposures.

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Appendix 3, Section 2

WTC STAC 2014 Recommendations

Scientific / Technical Advisory Recommendations to the WTC Health Program Research

NUMBER	RECOMMENDATIONS FOR RESEARCH	IS THE RECOMMENDATION A HIGH PRIORITY?
1	"Investigate whether there are newly emerging health conditions or previously unrecognized health conditions not covered by the WTCHP among WTC populations."	*Yes*
2	"Characterize the disaster-related exposures that are associated with the development of specific psychiatric disorders."	*No*
3	"Determine the value of biomarkers for early detection of pre-cancerous conditions, early cancers, or other WTC-associated diseases."	*Yes*
4	"Assess health effects of WTC exposure on gestation and early life (childhood and adolescence)."	*Yes*
5	"Improved assessment of WTC exposure: inhaled, topical, ingested, or other."	*Tied*
6	"Evaluate and improve the utility and use of WTCHP data and activities for the purpose of active surveillance of health conditions in WTC-exposed populations and/or develop improved surveillance methods."	*Yes*
7	"Differentiate psychiatric disorders from symptoms and distress in relation to disaster exposure, and develop efficient and effective methods for diagnosis of disaster-related psychopathology in populations and individuals."	*Yes*
8	"Examine patterns of health care utilization and delivery in the WTCHP and the value and efficacy of the medical monitoring activities of the WTCHP."	*Yes*
9	"Study the side-effects of drugs administered for treatment of WTC-related diseases."	*No*
10	"Investigate the effectiveness and utility of specific PTSD treatments in WTC-affected groups or individuals"	*Tied*

Appendix 3, Section 3

WTC STAC 2019 Recommendations

Recommendations from the 2019 WTC Scientific and Technical Advisory Committee with

DR. HOWARD'S REPLY

October 28, 2019

JOHN HOWARD, *MD ADMINISTRATOR, WORLD TRADE CENTER HEALTH PROGRAM CENTERS FOR DISEASE CONTROL AND PREVENTION (CDC) NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH (NIOSH)*

395 E St, S.W. Suite 9200, Patriots Plaza, Washington, D.C. 20201

Dear Dr. Howard:

The World Trade Center Scientific and Technical Advisory Committee urges you to encourage the Registry to move with deliberate speed to assemble the 9/11 Millennial Study cohort. Furthermore, everything needed should be done to protect the 9/11 Millennial Study and ensure it moving forward.

Sincerely,

Elizabeth Ward, PhD

Chair, World Trade Center Scientific and Technical Advisory Committee

November 5, 2019

Elizabeth Ward, PhD Chair, World Trade Center Health Program Scientific/Technical Advisory Committee

Dear Dr. Ward:

Thank you for your letter of October 28, 2019 conveying the views of the World Trade Center (WTC) Health Program Scientific/Technical Advisory Committee arising from their last meeting in New York City on September 18, 2019.

Currently, the WTC Health Program Associate Administrator, RADM Dori Reissman, M.D., and her staff are working with the New York City Department of Health and Mental Hygiene to evaluate the feasibility of assembling the 9/11 Children's Study cohort. This effort involves the use of historical New York City Department of Education school register records to professionally trace the students and their parents/guardians in order to obtain contact information of students exposed to 9/11, and a demographically similar comparison group of "unexposed" students, for potential participation in the cohort. A report on the feasibility is expected by early Spring 2020. After receiving the report, I will evaluate how best to conduct research on the health and educational impacts of the WTC disaster in children.

I appreciate your leadership of the WTC Health Program Scientific/Technical Advisory Committee and the commitment of the Committee members.

Sincerely,

John Howard

Director, National Institute for Occupational Safety and Health, and Administrator, World Trade Center Health Program

Appendix 3, Section 4

The World Trade Center Medical Working Group of New York City 2011 Annual Report on 9/11 Health

The World Trade Center Medical Working Group of New York City 2011 Annual Report on 9/11 Health Scientific and Technical Advisory Committee

Letter to Mayor Bloomberg

2011 Annual Report on 9/11 Health November 2011

Dear Mayor Bloomberg:

Since the publication of our 2010 annual report, New York City achieved one of its major policy goals at the federal level: passage of the James Zadroga 9/11 Health and Compensation Act, which President Obama signed into law in January. We take pride in the fact that our ongoing review of the World Trade Center (WTC)-related literature documenting adverse health effects in WTC responders and survivors, and our assessment of the healthcare services needed to address these issues, as summarized in our annual reports and distributed to all members of Congress for the past two years, supported your vigorous advocacy of this legislation.

In addition to ensuring that health monitoring and treatment will continue uninterrupted for anyone who has become ill after their exposure to the WTC collapse, we are pleased that the Zadroga Act also affirms the need for continuing and expanding WTC-related research by the WTC Centers of Excellence, the WTC Health Registry and other entities. Our previous reports have identified some important opportunities for WTC-related research, particularly in the area of treatment efficacy. We are hopeful that this information will be of use to the National Institute for Occupational Safety and Health (NIOSH), which is responsible for administering the WTC Health Program, as well as to independent researchers.

The Zadroga Act also establishes a Scientific/Technical Advisory Committee for the WTC Health Program, appointed in September 2011, which will review the scientific literature for the federal government as we have done for New York City over the past four years. The Committee will be assuming an even more critical role as it issues recommendations, also based on scientific evidence, to the Program Administrator about adding WTC-related health conditions that can be treated by the WTC Health Program. In this report, we update you on the progress we have seen regarding the implementation of our recommendations since 2007, when we began reviewing the WTC literature and assessing the adequacy of services, and we summarize a decade's worth of research findings. The timeline of

9/11 health milestones that introduces this report shows how the City's ad hoc partnership with the federal government has built a solid scientific foundation for the expansion of 9/11 health services over the past decade. We are confident that even more can be accomplished in the years to come under the Zadroga Act.

Linda Gibbs, *Co-Chair*
New York City Deputy Mayor for Health and Human Services
Thomas Farley, MD, MPH, *Co-Chair*
New York City Health Commissioner

World Trade Center Medical Working Group Membership

Mayor Bloomberg appointed the World Trade Center (WTC) Medical Working Group in June 2007. Members meet regularly to review clinical and research findings on the health effects of WTC exposure. In addition to publishing an annual report, they also review the adequacy of physical and mental health services available to WTC-exposed persons, and they advise city government on approaches to communicating health risk information related to WTC exposure.

Membership

***LINDA GIBBS, CO-CHAIR** New York City Deputy Mayor for Health and Human Services*

THOMAS FARLEY, MD, MPH, Co-Chair New York City Health Commissioner

THOMAS K. ALDRICH, MD Professor of Medicine, Pulmonary Division, Montefiore Medical Center and Albert Einstein College of Medicine Chair, New York State September 11th Worker Protection Task Force

MITCHELL COHEN, PHD Associate Professor, Department of Environmental Medicine, NYU School of Medicine

JOANN DIFEDE, PhD Director, Program for Anxiety and Traumatic Stress Studies Associate Professor of Psychology in Psychiatry, Weill Cornell Medical College

KITTY H. GELBERG, PhD, MPH Chief, Epidemiology and Surveillance Section, Bureau of Occupational Health, New York State Department of Health Carolyn Greene, MD Deputy Commissioner, Division of Epidemiology, New York City Department of Health and Mental Hygiene

ELI J. KLEINMAN, MD, MPH Assistant Professor of Medicine and Hematology, Albert Einstein College of Medicine, Supervising Chief Surgeon, New York City Police Department

PHILIP J. LANDRIGAN, MD, MSc, DIH Dean for Global Health Professor and Chairman, Department of Preventive Medicine Professor of Pediatrics, Director, Center for Children's Health and the Environment, Mount Sinai School of Medicine

R. RICHARD LEINHARDT, MD, FACS Chief Surgeon, New York City Department of Correction

Clinical Associate Professor Emeritus of Otorhinolaryngology, New York Medical College

DAVID PREZANT, MD Chief Medical Officer, Special Advisor to the Fire Commissioner for Healthy Policy, Co-Director, WTC Medical Monitoring & Treatment Programs, New York City Fire Department Professor of Medicine, Albert Einstein College of Medicine

RAMANATHAN RAJU, MD Chief Executive Officer, Cook County Health and Hospital System*
**Dr. Raju left the NYC HH in September 2011*

JOAN REIBMAN, MD Medical Director, WTC Environmental Health Center, New York City Health & Hospitals Corporation Associate Professor, Medicine and Environmental Medicine, NYU Medical Center Bellevue Hospital Center

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9/11 HEALTH SERVICES & RESEARCH: A DECADE OF MILESTONES

A decade of milestones in health services and research related to the September 2001 terrorist attacks on America illustrate a steady progression of private and public commitment to assist the 410,000 individuals1 estimated to have been exposed to the collapse of the World Trade Center.

2001

► The federal government funds health screening and mental health treatment for Fire Department of New York (FDNY) members.

2002

► The federal government funds screening for non-FDNY rescue, recovery and clean-up workers at the Mount Sinai School of Medicine.

► 9/11 Mental Health and Substance Abuse Program, an insurance-like benefit, is launched with private funding to increase access to treatment for anyone in the nation directly affected by the September 2001 terrorist attacks.

► The New England Journal of Medicine publishes FDNY research defining World Trade Center (WTC) cough and noting other respiratory symptoms in firefighters.

2003

► Mount Sinai begins treating rescue, recovery and clean-up workers for WTC health problems with private funding.

► The New York City (NYC) Department of Health and Mental Hygiene (DOHMH) and the federal government establish the volunteer WTCHR to monitor the health of people directly exposed to the WTC disaster.

► The New York Academy of Medicine publishes research about the mental health of NYC residents during the first six months after the attacks.

2004

► The federal government establishes the WTC Medical Monitoring Program to screen and monitor rescue, recovery and clean-up workers at FDNY, Mount Sinai and several other institutions.

2005

► Researchers from Bellevue Hospital and the New York State Department of Health publish studies reporting an increase in new, post-9/11 respiratory symptoms in Lower Manhattan residents.

► Private philanthropy funds treatment for rescue and recovery workers in the NYC area and elsewhere in the US, and for Lower Manhattan residents, area workers and students at a Bellevue Hospital asthma clinic.

► Columbia University researchers publish a study on WTC mental health impacts among NYC schoolchildren.

2006

► Mount Sinai and other members of the WTC Medical Monitoring Program publish research showing that more than 50% of rescue, recovery and clean-up workers being monitored continued to have respiratory symptoms up to 2.5 years after 9/11.

► The federal government provides funding to treat rescue, recovery and clean-up workers for the first time and establishes the WTC Medical Monitoring and Treatment Program.

► The NYC Department of Health and Mental Hygiene publishes and distributes Clinical Guidelines for Adults Exposed to the WTC Disaster.

► Legislation is introduced in Congress to provide long-term physical and mental health care for WTC survivors and responders regardless of their ability to pay.

2007

► As private funding for WTC services is exhausted, NYC Mayor Bloomberg accepts all 15 recommendations in "Addressing the Health Impacts of 9/11," a special report he commissioned to ensure that everyone with WTC-related health problems gets the care they need.

► NYC establishes the WTC Environmental Health Center at Bellevue Hospital Center, Gouverneur Health Care Services, and Elmhurst Hospital Center to treat Lower Manhattan residents, area workers and students.

► Mayor Bloomberg appoints the WTC Medical Working Group to review clinical and research findings on 9/11 health effects.

2008

► The WTCHR publishes a study examining physical health among WTC-exposed children.

► The insurance-like benefit program begun with private funding is extended as the NYC 9/11 Benefit Program for Mental Health and Substance Use Services for local residents.

► The WTC Medical Working Group publishes its first annual report on 9/11 health that summarizes findings from more than 100 studies published since 2001.

► The federal government establishes the WTC Responder Health Program to monitor and treat rescue and recovery workers who live outside the New York City area.

► The federal government provides funding for the first time to treat Lower Manhattan residents, area workers and students at the WTC Environmental Health Center.

2009

► The Journal of the American Medical Association publishes WTCHR research estimating that as many as 88,600 adults have had symptoms of post-traumatic stress disorder and as many as 40,000 adults have developed new asthma as a result of their WTC exposure.

► The Health Department publishes Clinical Guidelines for Children and Adolescents Exposed to the WTC Disaster.

2010

► The New England Journal of Medicine publishes FDNY research showing that decreases in pulmonary function in firefighters and EMS workers have persisted for seven years, even among non-smokers.

► Congress passes the James Zadroga 9/11 Health & Compensation Act which provides federal funding for 9/11-related health monitoring, treatment and research through 2015.

► 53,485 responders and 5,130 survivors have enrolled in federally funded health monitoring and treatment services as of December 31.[2]

2011

► In compliance with the Zadroga Act, the National Institute for Occupational Safety and Health issues the First Periodic Review of Scientific and Medical Evidence Related to Cancer for the World Trade Center Health Program. It summarizes current scientific and medical findings in the peer-reviewed literature about exposures resulting from the WTC attack and cancer studies, and determines that it cannot currently propose a rule to add cancer to the list of WTC-related health conditions.

► 9/11 anniversary-themed scientific publications highlight current findings. The Lancet addresses the comorbidity of mental and physical health conditions and includes early reports on cancer and mortality.

► The federal government appoints the WTC Scientific/Technical Advisory Committee to review scientific and medical evidence and make recommendations to the WTC Health Program administrator about changing eligibility criteria and covering additional health conditions.

► WTC responders and survivors throughout the United States have access to federally funded treatment for both physical and mental health conditions for the first time through the federal WTC Health Program.

► Progress on WTC Medical Working Group Recommendations (2008–2011)

The World Trade Center (WTC) Medical Working Group has made a series of recommendations about 9/11 health treatment and services since its formation in 2007. These recommendations fall into three broad categories: funding; research and evaluation; and education. The WTC Medical Working Group remains committed to seeing these recommendations implemented in their entirety. The progress made up to the tenth anniversary of the September 2001 terrorist attacks is summarized below.

FUNDING RECOMMENDATIONS

Advocate for long-term federal funding so that the following critical activities can continue:

- Treatment of WTC-exposed populations including rescue, recovery and clean-up workers, Lower Manhattan residents, area workers (including commuters living outside of New York City), and students for illnesses related to WTC exposure at the Centers of Excellence
- Regular monitoring of firefighters, police, correction, sanitation and other rescue, recovery, and clean-up workers for WTC-related mental and physical health conditions
- Tracking the health of 71,000 people enrolled in the WTCHR, who now reside in all 50 states
- Advocate for federal funding to increase scientific knowledge about WTC-related health impacts including:
- Research at the WTC Centers of Excellence, including the development of population-specific mental health screening tools
- Investigations to identify how environmental conditions such as the WTC collapse can cause illness, specifically through laboratory experiments using stored or

generated environmental dust samples

- Research to identify biologic indicators of specific 9/11 exposures
- Other research as needed to identify people at higher risk for illness due to WTC exposure

FUNDING PROGRESS

By passing the James Zadroga 9/11 Health and Compensation Act, signed into law by President Obama in January 2011, Congress implemented a 2008 recommendation of the WTC Medical Working Group: long-term federal funding for WTC-related health monitoring, treatment and research. Prior to passage of this legislation, the WTC Centers of Excellence and the WTCHR relied on an uncertain mix of private funding, annual Congressional appropriations and New York City funding to continue health programs that began soon after 9/11, and others that developed as the mid-term health impacts of the attacks became evident. Mayor Bloomberg and several members of the WTC Medical Working Group testified before Congress in support of the Zadroga Act, along with labor and community advocates who lobbied tirelessly for the bill in the nation's capital. In addition, the Congressional sponsors of the legislation distributed copies of the 2009 and 2010 annual reports of the WTC Medical Working Group to educate their colleagues in both the Senate and the House of Representatives about the growing body of scientific literature documenting the need for continued health services and national outreach. The Zadroga Act establishes the WTC Health Program and funds it through at least 2015, with New York City paying ten percent of the overall cost. Implemented by the National Institute for Occupational Safety and Health in July 2011, the WTC Health Program serves both eligible responders and survivors, no matter where they live now in the United States. Research opportunities addressing 9/11-related health issues are also expanded under the Zadroga Act. In addition to the kind of periodic, population-based health surveys that the WTCHR has conducted with federal funding among people directly exposed to the disaster, the WTC Centers of Excellence and other scientific researchers also will be able to apply for grants to conduct clinical investigations and treatment outcome evaluations. It isn't yet clear if the Zadroga Act covers research to study how specific environmental factors may have caused WTC-related illness and to identify biologic indicators specific for 9/11 exposures.

RESEARCH AND EVALUATION RECOMMENDATIONS

Expand research on the prevalence of WTC-related conditions and determine their persistence. Document WTC-related treatment needs and effectiveness by:

- ► determining the extent to which people with potential WTC-related health conditions are receiving treatment, and by identifying coverage gaps.
- ► evaluating the effectiveness of treatment among patients with WTC-related mental and physical health conditions.
- ► estimating the number of people who may seek mental and/or physical health treatment to help policy makers project future treatment costs.

Determine whether cancer, chronic illnesses and other late-emerging diseases are elevated among WTC-exposed populations

by comparing incidence and mortality rates among WTC-exposed populations to estimated background rates for New York City. Consider using the following methods when conducting cancer investigations among WTC-exposed populations:

- Compare the number of cancer diagnoses among members of WTC cohorts who were highly exposed to the WTC disaster to the number of diagnoses among less exposed members when possible. Use of internal comparisons is expected to be more meaningful scientifically than external comparisons to other groups because of the difficulty in identifying comparable, non-exposed populations.
- Develop a common WTC exposure matrix where possible, so that the degree of exposure within and across cohorts can be categorized more consistently when analyzing cancer and other late-emerging illnesses.
- Schedule the timing of periodic cancer analyses in advance to ensure that this choice is independent of the results. Researchers also should consider conducting formal analyses no more frequently than every five years because of the length of the induction period between environmental exposures such as the WTC disaster and the development of cancer. However, during the interim, monitoring and tracking of the data can continue so that researchers would detect and share developments of interest.
- Consider using other New York City data sets (including birth and school records) in addition to the WTCHR in order to conduct cancer analyses of sufficient statistical power among pediatric populations exposed to the WTC disaster.
- Consult with other WTC researchers on an ongoing basis about the cancer analyses within WTC cohorts and coordinate the reporting of data and/or research. This kind of collaboration can help reduce confusion among the public when the results of these analyses are published and reported by the media.

EXPAND RESEARCH ON THE IMPACT OF 9/11 ON MENTAL HEALTH AND SUBSTANCE USE BY:

- collecting additional data on the prevalence of WTC-related depression, suicide and substance use among WTC-exposed populations.
- assessing the impact of chronic WTC-related physical health conditions on long-term mental health.
- studying the impact of tobacco use on WTC-related respiratory conditions.

Increase research on mental and physical health effects on vulnerable populations who were exposed to the WTC collapse including children who went to school or who lived in the area, had first responder parents, or lost family members on 9/11.

RESEARCH AND EVALUATION PROGRESS

Members of the ***WTC Medical Working Group***—or the institutions they represent—have contributed more than 125 articles to the scientific literature. Although many of these articles were published prior to the MWG's formation in 2007, subsequent research, including articles published by such prestigious journals as the ***New England Journal of Medicine, the Journal of the American Medical Association*** and the ***Lancet***, has focused on areas specifically recommended by the ***MWG***. This includes research estimating the burden of WTC-related illness to help policymakers allocate resources rationally; research about the persistence of both mental and physical con-

ditions; research into co-occurring mental health conditions such as depression and substance use; research about the impact of tobacco use on WTC-related illness; and research about cancer and mortality risk among WTC-exposed populations. In addition, researchers not affiliated with the ***MWG*** have published studies on post-9/11 suicide rates. Only now has sufficient time elapsed since ***2001*** to begin research into the potential long-term and late-emerging health impacts associated with ***WTC*** exposure, including cancer and premature mortality. Although the long-term health impacts of this exposure may not be fully understood for decades, if ever, the MWG already has begun to lay a foundation of shared methodological approaches for cancer research. After soliciting recommendations about methodological approaches from a group of nationally recognized experts including biostatisticians, environmental health scientists and cancer epidemiologists in ***2010***, ***MWG*** members representing each of the WTC Centers of Excellence and the WTCHR formed a ***WTC Analytic Methods Workgroup*** that also includes labor and community advisers. The WTC Analytic Methods Workgroup completed an analysis of exposure variables for rescue, recovery and clean-up workers and volunteers collected by its members from responses to a variety of surveys asking for similar information in different ways, and developed an exposure matrix that identifies just three common exposure variables: dust exposure on the day of ***9/11***; work periods at the WTC site; and work activities at the WTC site. The difficulty encountered in retrospectively aligning exposure measurements across cohorts underscores the importance of establishing cross-study collaborations at the outset for future disasters. ***The WTC Analytic Methods Workgroup*** also produced common rules for classifying cancers. Abstracts describing both Workgroup efforts were presented at the June 2011 meeting of the ***Council for State and Territorial Epidemiologists*** and emphasized the importance of collaboration among institutions studying an already complex health issue. Other areas of research recommended by the ***MWG*** must be more fully addressed. These include: assessing the mental and physical health of WTC-exposed children, and the children of WTC-exposed first responders; evaluating the effectiveness of treatment for WTC-related conditions; obtaining a better understanding of co-morbid mental and physical conditions and how this co-morbidity may influence disease progression, functioning and recovery; and initiating investigations into the relationship between WTC environmental contaminants and specific physical illnesses and the establishment of biologic indicators specific for WTC exposures.

EDUCATION RECOMMENDATIONS

- Increase awareness of WTC-related symptoms and the availability of clinical resources among people who were exposed to the disaster.
- •Increase awareness of Clinical Guidelines for Adults Exposed to the WTC Disaster among health care professionals, especially in areas where large numbers of WTC-exposed individuals may reside.
- Develop and disseminate clinical guidelines for children exposed to the WTC disaster.

- Educate policy makers, the media and the public about the difficulty in establishing a direct cause-effect relationship between WTC exposure and any one individual's illness for most diseases, especially those that are relatively rare.
- Gather and publish lessons learned after 2001 terrorist attacks on the World Trade Center about preventing and treating disaster-related health conditions (see section beginning on page 11).

EDUCATION PROGRESS

Members of the MWG have made enormous progress in increasing awareness of WTC-related symptoms and the availability of clinical resources among people who were exposed to the disaster. Major accomplishments since 2007 include the following:

- New York City's 311 system offers direct transfers to the NY/NJ WTC Clinical Consortium and the WTC Environmental Health Center for people seeking WTC-related services.
- The Department of Correction established a special unit to refer current employees and retirees who participated in WTC operations to appropriate treatment, and to assist them in filing for workers' compensation and pension disability.
- FDNY published WTC Health Impacts on FDNY Rescue Workers, an illustrated, easy-to-understand report about findings from the first six years of monitoring and treatment, and will be publishing a ten-year update.
- The NY/NJ WTC Clinical Consortium conducts extensive outreach including commemoration of Responder Day in June; distributes The WTC Responder Health Watch, a quarterly newsletter for all program participants; and hosted a successful conference to explain health services under the Zadroga Act.
- NYPD created a members-only website centralizing information about all WTC-related services, including the department's own on-site health monitoring program, and established a toll-free number for additional information about the availability of services.
- The NYC Department of Health and Mental Hygiene launched a "one-stop shopping" 9/11 health website with regularly updated information about WTC-related research and services which receives an average of 4,000 visitors each month; publishes a bi-monthly 9/11 health e-newsletter with nearly 9,000 current subscribers; and distributed two brochures City-wide: "Is 9/11 Affecting Your Health?," a Health Bulletin describing WTC-related symptoms and services, and a 9/11 Resource Guide, listing dozens of organizations offering various kinds of assistance.
- The WTC Environmental Health Center awarded grants to ten community-based organizations to conduct outreach; developed "Lived There? Worked There? You Deserve Care," a subway advertising campaign and brochure; held health forums for potential adult patients and parents of exposed children and adolescents; and worked with the Department of Education to inform 15,000 Lower Manhattan parents who had children in school on 9/11 about the WTC pediatric program at Bellevue Hospital.

With input from MWG members at FDNY, the NY/NJ WTC Clinical Consortium and the WTC Environmental Health Center, as well as community and labor advisers, the NYC Department of Health and Mental Hygiene revised the Clinical Guidelines for Adults Exposed to the World Trade Center Disaster it first published in 2006, and also developed Clinical Guidelines for Children and Adolescents Exposed to the WTC Disaster in conjunction with child health experts. The Health Department distributed these guidelines to physicians and pediatricians throughout New York State. In addition, the National Institute for Occupational Safety and Health distributed the adult guidelines to all state health departments in the US. The Health Department mailed the child and adolescent guidelines to more than 200 college health clinics in the northeastern US with a cover letter encouraging physicians to consider the potential impact of WTC exposure on student health.

LESSONS LEARNED

The September 11, 2001 attack on the nation's largest city by international terrorists—only the second time such an event has occurred on US soil, and one with far more devastating consequences than the 1993 bombing of the World Trade Center—altered life for millions of Americans. Government agencies, health care providers and researchers have learned a number of lessons about the health preparedness and response to environmental disasters in urban areas. Some of these lessons, broadly categorized below, have led to greater collaboration among these entities and resulted in important policy or program changes in New York City during the last decade.

THE NEED TO PROTECT FIRST RESPONDERS BY:

- restricting disaster-site access to individuals with the proper qualifications and training, identifying these individuals and recording the times they work for health follow-up.
- providing and enforcing use of adequate personal protective equipment, including pre-disaster training in the need for, and use of such protection.
- limiting the duration of physical and mental health exposures of individuals during rescue, recovery and clean-up efforts (to the extent possible) through shift rotation.
- providing early post-traumatic stress disorder (PTSD) screening for responders with known risk factors, such as a prior history of trauma.

THE NEED TO PROTECT THE HEALTH OF ALL POPULATIONS AT RISK BY:

- promoting quality, evidence-based post-disaster services effectively.
- determining as early as possible those who were potentially exposed and registering them so that a clearly defined population risk is known and so that needs can be assessed and services provided.
- delivering exposure-appropriate physical health services for acute and chronic injuries/illnesses.
- providing counseling through rapid mobilization of

community-based mental health organizations and major medical centers

► referring anyone at higher risk for post-traumatic stress disorder and other mental health conditions for comprehensive, early psychological evaluation using standardized clinical assessment tools and providing evidence-based interventions if indicated

► offering culturally competent mental health services

► exploring how internet-based technology may help increase the capacity of evidence-based mental health providers, particularly among affected individuals who may not be comfortable seeking traditional services

► implementing education and outreach programs to reduce the stigma associated with mental health treatment

► providing appropriate social support services to facilitate physical and mental health recovery

► investing in advertising and outreach, both community-based and personalized, to reach exposed individuals with unmet healthcare needs when disaster-specific services are available at no cost

► translating and providing culturally appropriate outreach materials for affected communities

THE NEED TO COLLECT HIGH QUALITY DATA BY:

► maintaining a roster of the names, addresses, affiliations and duration of work of all responders from the very beginning of the response effort to establish a baseline for future follow-up and research

OVERVIEW OF 9/11 HEALTH FINDINGS: 2001–2011

The World Trade Center (WTC) Medical Working Group has reviewed more than 300 studies published from 2001-2011 (as of September 30, 2011) that are relevant to its mission. In general, the health findings summarized below are remarkably consistent across WTC studies.

PHYSICAL HEALTH

Dozens of studies indicated that respiratory symptoms, sinus problems, asthma, and loss of lung function were diagnosed in or reported by many who were exposed to WTC dust, including nearly 60,000 rescue and recovery workers, residents and office workers who have enrolled in 9/11 health programs. For many, these conditions have persisted for nearly a decade.

► Epidemiologic studies indicate that diagnoses of new asthma among exposed groups peaked during the first 16 months after 9/11.

► Clinical studies demonstrate that the steep declines in pulmonary function first detected among firefighters and EMS workers within a year of 9/11 have largely persisted even among those who never smoked; compared to pre-9/11 data, four times as many firefighters and twice as many EMS workers had below-normal lung function for their ages six to seven years after 9/11.

► Recent studies also have identified persistent abnormal pulmonary function in other WTC rescue and recovery workers, including police, and in Lower Manhattan resi-

dents and area workers.

► Both epidemiologic and clinical studies have identified substantial co-occurrence, or comorbidity, of mental health conditions with respiratory illness.

Intense dust cloud exposure on the morning of 9/11 increased the risk for developing respiratory problems across all WTC-exposed groups. Other risk factors among specific WTC-exposed groups included:

► Rescue, recovery and cleanup workers: arriving early or working for long periods of time at the WTC site. In addition, lung function declines were slightly greater among the relatively few firefighters and EMS workers who were active cigarette smokers before and after 9/11 than for nonsmokers

► Residents: not evacuating their homes or experiencing a heavy layer of dust in their homes

► Office workers: experiencing a heavy layer of dust in their offices.

► Both residents and office workers: living and working in Lower Manhattan.

► Several studies have shown that WTC exposure is associated with sarcoidosis (an inflammation that can affect any organ, but typically affects the lungs) among rescue, recovery and clean-up workers, especially those who worked on the debris pile.

Many WTC-exposed adults were also diagnosed with or reported having heartburn, acid reflux or other gastroesophageal reflux symptoms, often but not always in conjunction with other respiratory or mental health symptoms. Researchers have identified early arrival at the WTC and intense exposure to the dust cloud as risk factors. Acid reflux, however, is common among the general population; further research is needed to understand the relationship between reflux symptoms, WTC exposure and other WTC-related health conditions. Findings have been inconsistent regarding the impact of WTC exposure on birth outcomes. Some studies suggest that reduced fetal growth found in some women who were pregnant on 9/11 may be related to the stress caused by the attacks. Other studies, however, found no impact of WTC exposure on birth outcomes. Few studies have addressed the impact of WTC exposure on child/adolescent health, especially physical health. Research about cancer and mortality in WTC-exposed populations is in its initial stages because it takes a longer time for these potential health consequences to become evident. Additional studies are needed to determine if early results are replicated, if they are replicated in different populations with different exposure levels, and if they change over time.

► The first WTC cancer risk study to be published found that firefighters with WTC exposure may be at greater risk for cancer than firefighters who weren't exposed.

The first mortality study to be published showed that persons in the WTCHR were less likely to die in the eight years of follow-up than in the general New York City population. The study, however, also showed that among Lower Manhattan residents, area workers and passersby in the Registry, those with higher levels of WTC exposure may be at greater risk for all-cause mortality and cardiac-related mortality in particular compared to those with intermediate or lower levels of WTC exposure. WTC-related illness, especially respiratory illness, has resulted in considerable disability and increased pension costs for New York City.

MENTAL HEALTH

Results from large epidemiologic studies have consistently shown that probable post-traumatic stress disorder (PTSD), identified by a positive screening using a standardized psychological assessment tool, is the most common WTC-related health effect among exposed adults, and that it often co-occurs with respiratory illness. Severity of symptoms may vary over time, however, and a face-to-face interview is required to make an individual diagnosis.

Screening positive for PTSD was more likely among those who were:

- caught in the dust cloud released by the buildings as they collapsed.
- injured as a result of the attacks.
- directly exposed to the events of 9/11, including proximity to the WTC site, witnessing horrific events, or knowing someone who was killed or injured in the attacks.

OTHER PTSD RISK FACTORS INCLUDE:

- Among rescue and recovery workers, early arrival at the WTC site, working there for a long time, or doing tasks outside of their trained area of expertise.
- Among WTC evacuees, being on a high floor in the towers, initiating evacuation late, or working for an employer that sustained fatalities.

Trauma before or after 9/11 unrelated to the terrorist attacks, such as urban or domestic violence, was also associated with PTSD or with greater symptom severity. Lack of adequate social support was associated with reduced recovery from PTSD. Firefighters with probable PTSD (see definition on previous page) were significantly more likely than those without PTSD to report difficulty functioning at work or at home up to four years after 9/11. Police officers, firefighters and emergency medical technicians generally had lower rates of PTSD than untrained volunteers because of prior training and experience with emergency response. Despite widespread evidence of PTSD among exposed groups, suicide rates at the population level in New York City did not increase in the first four years after 9/11. Depression, anxiety and substance use disorders have not been as well studied as PTSD among WTC-exposed people. The studies to date, however, suggest that the prevalence of these conditions increased shortly after 9/11 and there is significant co-morbidity with PTSD in WTC-exposed populations. The PTSD impact of 9/11 on the US population who experienced it indirectly through media coverage may have been briefer and far smaller than studies conducted in the immediate aftermath of the attacks suggested.

SOURCES: 2008, 2009, 2010, 2011 WTC Medical Working Group annual reports, which can be accessed on line at *WWW.NYC.GOV/9-11HEALTHINFO*.

(AUGUST 2010–SEPTEMBER 2011) DETAILED SUMMARY OF MOST RECENT WTC-RELATED RESEARCH

The World Trade Center (WTC) Medical Working Group identified 90 published papers related to health among the WTC-exposed in the scientific literature since its 2010 annual report, including numerous studies that were published in conjunction with the commemoration of the 10th anniversary of the September 2001 terrorist attacks. Thirty-five looked at mental health, including six child studies; 17 looked at physical health; nine looked at both mental and physical health; four reported on environmental exposures and 23 examined other issues, such as the locations, tasks and experiences of responders, a sociopolitical analysis of WTC health issues from a community perspective and the emotional content of text messages on 9/11. Just two studies evaluated treatment efficacy, which the MWG previously identified as a major gap in the literature. New research with the greatest relevance to the work of the MWG is summarized below. Research published by institutions represented on the MWG is noted in boldface type throughout the research summaries.

PHYSICAL HEALTH MID-TERM IMPACTS (5-9 YEARS AFTER 9/11):

A longitudinal study of more than 27,000 rescue and recovery workers who sought treatment at the New York/New Jersey WTC Clinical Consortium (based at the Mount Sinai School of Medicine) conducted detailed physical examinations on each worker and also assessed workers' self-reports of physician diagnoses from 2002 to 2010. Nine years after the terrorist attacks, among those still in treatment, 18.1% (1,893) still had active asthma; 20% (2,042) had sinusitis, and 32.6% (3,195) had gastroesophagael reflux disorder (GERD). All three conditions were associated with higher levels of WTC exposure among workers.3 FDNY researchers demonstrated that eight years after 9/11, the prevalence of several physician-diagnosed respiratory conditions among 10,999 WTC exposed male firefighters remained high in comparison to men in the general population. Firefighters 44 or younger were much more likely to report sinusitis/rhinitis (17.2% vs. 8.4%); bronchitis (13.2% vs. 3.3 %) and COPD/ emphysema (1.5% vs. 0.3%). Firefighters ages 45-65 were much more likely to report sinusitis/rhinitis (19.5% vs. 12.2%); current asthma (14.5% vs. 4.9%); bronchitis (13.2% vs. 3.2%); and COPD/emphysema (7.6% vs. 3.2%).4 Spirometry, an objective test to measure how well the lungs' large airways are functioning, validated subjective respiratory symptoms in a group of nearly 19,000 rescue and recovery workers being monitored at the NY/NJ WTC Clinical Consortium. Workers reporting persistent cough, wheezing, or difficulty breathing upon exertion were more likely than workers without symptoms to have lower lung function and a higher rate of bronchodilator responsiveness during their first clinical visits between 2002 and 2008.5 The nine-year cumulative incidence for spi-

rometric abnormalities among 5,769 responders at risk in the NY/NJ WTC Clinical Consortium was 41.8%; three-quarters of these abnormalities were low forced vital capacity, a measurement taken when the responders were asked to exhale all the air in their lungs as forcefully as possible.6 In a longitudinal study of 139 NYPD emergency service workers who responded to the WTC disaster, NYPD researchers found evidence of mild declines in lung function six years later, in comparison to pre-9/11 baseline data. Abnormal spirometry, seen in 5.3% of the cohort, was associated with earlier arrival and longer duration at the WTC site. The greatest declines were seen in smokers and workers without respiratory protection.7 The WTCHR, in collaboration with the WTC Environmental Health Center, also found abnormal lung function in Lower Manhattan residents and area workers who reported persistent respiratory symptoms seven to eight years after exposure to the WTC disaster. In a case control study using spirometry and oscillometry, a test to measure how well the lungs' small airways are working, researchers found that 180 enrollees with persistent respiratory symptoms (cases) were more likely to have abnormal lung function than nearly 500 enrollees (controls) who had not reported any new respiratory symptoms since 9/11. Oscillometric abnormalities were found even among cases with normal spirometry.8 Twelve patients with suspected interstitial lung disease or abnormal lung function underwent lung biopsies four to seven years after 9/11 at the WTC Environmental Health Center, which treats symptomatic Lower Manhattan area workers and residents. Pathologic findings included various degrees of interstitial lung disease, small airways disease and emphysema even though only four of the patients had a history of smoking. Researchers also noted the presence of particulate matter in lung tissue with a composition similar to that found in analyses of dust collected from the WTC site after the collapse of the buildings.9 Researchers at the NY/NJ WTC Clinical Consortium found an increased incidence of sarcoidosis among nearly 20,000 rescue and recovery workers who sought care for 9/11-related health problems in comparison with other published background rates, although no association was found with date of arrival at the WTC site, or exposure to the dust cloud released by the collapse of the buildings. Thirty eight new cases were verified from 2002 to 2007, with the highest incidence occurring two and three years after 9/11.10 Using biopsy results, WTCHR researchers confirmed 43 cases of sarcoidosis among adults in its cohort of rescue and recovery workers, Lower Manhattan residents, area workers and passersby. A nested case control study found that working on the WTC debris pile significantly increased the sarcoidosis risk for rescue and recovery workers; no risk factors were identified for other groups.11Researchers investigating obstructive sleep apnea (OSA) at the NY/NJ WTC Clinical Consortium compared a group of 50 rescue and recovery workers with aerodigestive symptoms who reported habitual snoring six to seven years after 9/11 to a similar group of men without WTC exposure who also snored habitually. OSA was associated with body mass index (BMI) and weight in the group without WTC exposure but not in the WTC workers, suggesting that factors other than obesity

may contribute to OSA among WTC responders with aerodigestive disorders.12 In a study of more than 37,000 adults enrolled in the WTCHR who reported no pre-9/11 gastroesophageal reflux symptoms (GERS), 13% reported that new GERS had persisted up to six years after 9/11. GERS were positively associated with higher levels of WTC exposure, asthma and PTSD but occurred even among enrollees who didn't report asthma or PTSD, suggesting for the first time an independent association with WTC exposure.13

SHORT-TERM IMPACTS (1-4 YEARS AFTER 9/11):

Two literature reviews focusing on birth outcomes among WTC-exposed pregnant women suggest that environmental exposure or attack-related stress reduced fetal growth in some women, a finding similar to that in studies of birth outcomes after other terrorist attacks, environmental/chemical disasters and natural disasters. Disaster literature not specific to 9/11 indicates that child development may be more influenced by maternal mental health than by direct effects of disaster-related pre-natal stress.14,15 A newer study not included in these reviews compared two groups of women who were pregnant between September 11 and December 1, 2001: 500 women who were enrolled in the WTCHR, and 50,000 women who lived at least five miles from the WTC site. Though researchers found similar birth weight and gestational age at delivery in the groups, Registry enrollees with probable PTSD were more likely than women without PTSD to deliver premature or underweight babies.16

MENTAL HEALTH

Mid-Term Impacts (4-9 years after 9/11):Rates of chronic post-traumatic stress disorder (PTSD) among WTC responders vary significantly by worker category nine years after 9/11: The prevalence of probable PTSD among more than 11,000 firefighters in the FDNY WTC Medical Monitoring and Treatment Program was four times higher than in the general population, 7.4% compared to 1.8%. Early arrival at the WTC site, exercising less and drinking more alcohol were associated with the persistence or onset of PTSD symptoms, as were co-occurring respiratory or gastroesophageal reflux symptoms.17 Researchers at the NY/NJ WTC Clinical Consortium report that workers, excluding police responders, continued to screen positive at high rates for PTSD (19.2%), depression (17.9%) and panic disorder (12.3%). Police responders had much lower rates of these conditions: PTSD (5%), depression (4.5%) and panic disorder (4.8%).18 The FDNY WTC Medical Monitoring and Treatment Program screened nearly 2,000 retired firefighters, the majority of whom were disabled, for depression, PTSD, and alcohol problems four to six years after 9/11. Among those at elevated risk for depression (23%) or PTSD (22%), 70% were at elevated risk for both conditions. Problem alcohol use and early arrival at the WTC site were identified as unique risk factors for depression and PTSD, respectively.19

SHORT-TERM IMPACTS (1-4 YEARS AFTER 9/11):

A longitudinal study suggests that modest increases in drinking and the use of psychotropic medication were associated with PTSD onset in New York City up to two years after the attacks on the World Trade Center. Among a representative sample of nearly 1,700 adults in New York City who were interviewed in late 2002 and again a year later, those with PTSD consumed one more drink per month and took psychotropic medication 20 more days per year.20 Researchers at the WTCHR estimate that 15% of 3,271 civilians who evacuated either of the WTC towers on 9/11 had PTSD two to three years later. Being on a high floor in the towers, initiating evacuation late and working for an employer that sustained fatalities were among the exposures that increased their risk for PTSD.21 A longitudinal study of more than 5,600 firefighters at the FDNY WTC Medical Monitoring and Treatment Program that began six months after 9/11 found that those with PTSD up to four years after 9/11 were nearly 20 times more likely than those without PTSD to report substantial difficulty functioning at home or work. Among the 15.5% firefighters with PTSD, nearly half developed it after the first six months.22 Two studies conducted by Weil-Cornell Medical College researchers based on more than 3,000 mostly male utility workers who were screened for mental health conditions at their place of employment offer new insights about traumatic stress among WTC recovery workers: Ten to 22 months after 9/11, eight percent of 2,960 workers had symptoms consistent with full PTSD, 6% with depression, 3.5% with anxiety and 2.5% with panic disorder. Believing that their life had been in danger was the best predictor of PTSD among these workers.23 216 workers with trauma symptoms who didn't meet the criteria for full PTSD within the first two years of 9/11 were screened again one and two years later. 29% met the criteria for sub-threshold or full PTSD at Time 2 and 24.5% met these criteria at Time 3. In addition, workers with sub-threshold PTSD reported levels of impairment roughly four times greater than workers with no PTSD symptoms.24 Among a sample of 455, mostly female patients who were screened for mental health conditions when they sought primary care at a general medicine clinic in New York City, the PTSD rate decreased significantly from 9.6% one year after 9/11 to 4.1% three years later. Patients who reported pre-9/11 depression, the only significant predictor of PTSD trajectory, were 10 times more likely to have PTSD four years after the WTC attacks than those who didn't. 25 Research published soon after 9/11 reported elevated rates of PTSD among the US population ranging from 4.3% to 17%. However, data from a national epidemiologic survey conducted from 2004 to 2005 and including nearly 35,000 people suggests that indirect experience of 9/11, such as witnessing the attack on television, had the lowest risk of PTSD, 1.3%, of 32 traumatic events listed. Other events included sexual assault as an adult or child (PTSD risk 40.2%), being stalked (PTSD risk 19.5%) and experiencing a natural disaster (PTSD risk 5.1%).26 Substantial co-morbidity across physical and mental health conditions exists among firefighters. In a study of nearly 11,000 firefighters seven to nine years after 9/11, FDNY researchers found that 41.8% of those reporting symptoms of probable PTSD also self-reported a physician diagnosis of obstructive airways disease (OAD),

which includes asthma, bronchitis or COPD/emphysema; 33.3% with probable PTSD or depression also self-reported a physician diagnosis of OAD. Among those with depression alone, 28.5% self-reported OAD. The researchers found similar results when they used medical records instead of self-reports for the analysis.27 Rescue and recovery workers who sought treatment at the NY/NJ WTC Clinical Consortium from 2002 –2010 also reported substantial co-morbidity: in a clinical population of more than 27,000 workers, nearly half with asthma (1,459 workers) also reported at least one mental health condition, as did more than a third of workers with either sinusitis (2,006 workers) or gastroesophageal reflux disease (2,348 workers). Similarly, around 70% of workers who reported PTSD (2,806 workers), depression (2,153 workers), or panic disorder (1,129 workers) also reported a physician diagnosis of at least one physical disorder.28

CANCER AND MORTALITY

FDNY researchers confirmed 263 new cases of cancer from September 11, 2001 through 2008 among 8,927 male firefighters who responded to the WTC disaster, 25 more than would have been expected among men of similar age, race and ethnicity in the general population according to the National Cancer Institute Surveillance Epidemiology and End Results (SEER) reference population. When researchers compared the WTC-exposed firefighters to unexposed firefighters they found a 19% increase in cancer overall, after making an effort to correct for both potential surveillance bias (due to changes in medical screening tests given after 9/11) and lead time bias (it is unlikely that any WTC-related cancer would develop within two years of 9/11). Lack of statistical power prevented the researchers from drawing any conclusions about specific types of cancer.29 WTCHR researchers identified 790 deaths from 2003 through 2009 among 41,930 adults who resided in New York City at the time of their enrollment in the Registry. The all-cause death rate among Registry enrollees was 43% lower than among NYC residents as a whole. Researchers detected exposure-related differences in mortality rates among those in the Registry: lower Manhattan residents, area workers and passersby with intermediate or high levels of exposure, including those with two or more injuries on 9/11, had elevated all-cause and heart disease mortality risks in comparison to those with intermediate or lower levels of exposure. The study did not detect exposure-related mortality differences among rescue and recovery workers even when internal comparisons were conducted.30

CHILDREN

A survey of more than 8,200 New York City schoolchildren in grades 4 to12 conducted six months after 9/11 indicates that 40% of their families experienced at least one of five disruptions: family relocation, job loss, restricted travel, school closure and school relocation. After adjusting for sociodemographic characteristics, WTC exposure and prior trauma, youth reporting that their parents allowed them to travel less freely

around the city after 9/11 were three times as likely to have PTSD as youth whose parents allowed them to travel without restrictions. Youth reporting family job loss were twice as likely to have PTSD as those who didn't.31

VOLUNTEERS

A longitudinal study of 4,974 adult volunteers enrolled in the WTCHR draws distinctions between affiliated volunteers and lay volunteers. Compared to affiliated volunteers, lay volunteers were:

- more likely to have been present in lower Manhattan, experienced the dust cloud, witnessed horrific events, had an injury on 9/11 and reported unmet health care needs.
- nearly twice as likely to have reported an early post-9/11 mental health diagnosis or a diagnosis of asthma or reactive airways dysfunction syndrome.
- more than twice as likely to have had chronic PTSD, late-onset PTSD, or new or worsening lower respiratory symptoms.32

RESPIRATORY PROTECTION

A longitudinal study of 9,296 rescue and recovery workers enrolled in the WTCHR who worked at least one shift on the WTC debris pile offers new insights into the use of respiratory protective equipment (RPE):

- Fewer than 20% of workers reported use of standard respirator models on 9/11 and half of the workers wore no facial covering of any kind on that date.
- The strongest predictors of using adequate RPE were affiliation with construction, utilities or environmental remediation organizations, and prior training in the use of RPE.
- Workers who reported no respiratory protection were more likely to report recurrent respiratory symptoms and some respiratory disease compared to those who used respirators.[33]

TREATMENT

Prior research has established the effectiveness of prolonged exposure therapy, a form of cognitive behavioral therapy, in treating PTSD.34 Researchers at the New York State Psychiatric Institute/Columbia University recruited 37 WTC-exposed patients for a randomized clinical trial comparing prolonged exposure therapy plus paroxetine, a selective serotonin reuptake inhibitor, to prolonged exposure therapy plus placebo. Although the study was small, it suggests that patients treated with therapy and paroxetine showed greater improvement in PTSD symptoms and remission status in ten weeks than the patients treated with therapy alone during this period.35 A study of 300 young people ages five to 21 drawn from a larger group of youth who had been exposed to the WTC disaster and referred to mental health services suggests that matching treatment intensity to need is effective. Researchers compared outcomes for youth with more trauma symptoms who received trauma-specific cognitive behavioral ther-

apy (CBT) to youth with milder symptoms who received a brief CBT skills intervention over an 18-month period following the attacks. Trauma symptoms decreased in both groups six months after they began treatment; rates of improvement were similar even though the severity of need differed.36

DISABILITY

The FDNY WTC Medical Monitoring and Treatment Program assessed quality of life among a group of 275 disabled firefighters who retired because of lung problems and compared the results to active firefighters and retired firefighters without disability pensions, all of whom were exposed to the WTC collapse, six to eight years after 9/11. Among the three groups, disabled retirees were more likely to score lower on both physical and mental health quality of life measures, but the difference between the disabled firefighters and the other two groups was less pronounced for mental health.37 An analysis of retirement pensions awarded by FDNY found that in the seven years prior to 9/11, 48% of these pensions were for accidental disability. In the seven years after 9/11, accidental disability pensions comprised 66% of the total, with 47% (1,402 pensions) related to the WTC attacks and mostly due to respiratory illness. The FDNY study also estimated that WTC-related FDNY pensions added $826 million in increased costs to the system.38

ENVIRONMENTAL EXPOSURES

Toxicological studies conducted at New York University using dust samples gathered from the WTC site within 48 hours of the buildings' collapse clearly show that particles of a size likely to have been inhaled had an adverse effect on human cell function that may have contributed to chronic lung disease, either by themselves or in combination with 10% cigarette smoke extract.39 Federal researchers investigating chemical contamination of the Hudson-Raritan Estuary (HRE) before and after 9/11 found that measurements of eleven trace elements, including arsenic, copper, lead and zinc, in blue mussels were significantly higher in the HRE than elsewhere in the nation, but post-WTC attack measurements were not significantly higher than pre-attack measurements. However, high ambient levels of trace elements in the HRE may have the made the impact of the WTC collapse less discernible.40

STRENGTHS AND LIMITATIONS OF PUBLISHED WTC-RELATED RESEARCH

Much of the data presented in this report were gathered and analyzed by scientists and clinicians associated with a select number of institutions that recognized the need to monitor the health of individuals affected by the World Trade Center (WTC) collapse early after the disaster. Particular strengths of this body of research include the fact that

many different studies have found similar physical and mental health effects across exposed groups, and that research findings are gleaned from several large longitudinal cohorts, in addition to numerous one-time surveys. Weaknesses stem predominantly from the absence of pre-existing data in most populations and the lack of initial funding for studies.

SOME OF THE LARGEST WTC STUDY GROUPS INCLUDE:

- Nearly all FDNY responders who responded to the disaster. All have pre- and post-9/11 medical records, and the population is restricted to FDNY rescue workers, thus minimizing recruitment bias. The group receives ongoing clinical monitoring with strong participation, even among retirees, indicating limited bias from longitudinal dropout.

- A large cohort of responders enrolled in the New York/New Jersey WTC Clinical Consortium at the Mount Sinai School of Medicine, the State University of New York at Stony Brook, New York University/ Bellevue Hospital, Queens College and the University of Medicine and Dentistry of New Jersey for clinical screening, monitoring and treatment. This Consortium collects similar data to FDNY to facilitate comparisons across worker groups.

- A high percentage of NYPD members were exposed to the disaster at various locations. The NYPD Medical Division, like FDNY, has pre- and post-9/11 medical records for these individuals. The pre-9/11 exposure of this cohort is similar to that of New York City residents which makes study findings relevant to the larger population.

- A growing cohort of symptomatic patients who include residents, area workers and clean-up workers at the WTC Environmental Health Center at Bellevue Hospital Center, Gouverneur Health Care Services and Elmhurst Hospital Center.

- The WTCHR, the largest post-disaster exposure registry in US history, enrolling more than 71,000 exposed individuals to be tracked for an expected period of 20 years. The diverse cohort includes rescue, recovery and clean-up workers; residents; office workers; students; and passers-by.

Several significant challenges also affect the ability to conduct accurate research on 9/11 health effects. It is important to highlight these limitations as they characterize many but not all of the published studies described in this report, and to review these limitations when planning data collection efforts after future disasters:

- With the exception of the FDNY cohort, the exact size and composition of the population affected by the disaster remains unknown, although estimates have been developed and published. This, along with selective participation in cohorts, can affect calculation of incidence rates and comparison of these rates across groups.

- It is difficult to measure how much and what type of exposure different people had to traumatic or environmental impacts of 9/11. All exposure measurements remain imprecise.

- Many studies are conducted on volunteer or clinic-based samples, which may not be representative of the true population of exposed people. Depending on the enrollment criteria of specific studies,

they may suffer from recruitment bias with over-representation of those who are ill.

- People with post-traumatic stress disorder (PTSD) may be under-represented in studies because avoidance of anything that reminds them of 9/11 can be symptomatic of the condition.
- It is difficult to determine the incidence and prevalence rates for many potentially WTC- related conditions, including persistent cough, dyspnea, sinusitis, gastrointestinal symptoms, PTSD and depression because confirmatory laboratory or diagnostic testing is either not available or because an acknowledged "gold standard" does not exist for diagnosing a condition.
- Many studies rely on self-reports of a range of non-specific symptoms and conditions to measure the burden of these conditions in exposed populations without verification of diagnoses.
- The high frequency of certain conditions in the general population, especially acid reflux, as well as the absence of background incidence or pre-9/11 data in most WTC-exposed populations, make it difficult to draw firm conclusions about whether or not post-9/11 diagnoses can be attributed definitively to WTC exposure at a clinical level.
- Increased monitoring and diagnostic testing of WTC-exposed populations in comparison to the general public may result in a detection bias for some conditions, such as sarcoidosis and cancer.
- Few studies have examined the physical effects of WTC exposure on children and adolescents.

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