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FAST TRACK ARTICLE

Health Effects and Occupational Exposures Among Office Workers Near the World Trade Center Disaster Site

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The extent of health effects and exposure to environmental contaminants among workers and residents indirectly affected by the September 11, 2001, attack on the World Trade Center (WTC) is unknown. The objective of this study was to evaluate concerns related to health effects and occupational exposures three months after the WTC disaster among a population of employees working in a building close to the disaster site. A cross-sectional questionnaire survey was performed of Federal employees working near the WTC site in New York City (NYC) and a comparison group of Federal employees in Dallas, Texas. An industrial hygiene evaluation of the NYC workplace was conducted. Constitutional and mental health symptoms were reported more frequently among workers in NYC compared to those in Dallas; level of social support was inversely related to prevalence of mental health symptoms. Post-September 11th counseling services were utilized to a greater degree among workers in NYC, while utilization of other types of medical services did not differ significantly between the groups. No occupational exposures to substances at concentrations that would explain the reported constitutional symptoms were found; however, we were unable to assess potential occupational exposures in the time immediately after the WTC disaster. There is no evidence of ongoing hazardous exposure to airborne contaminants among the workers surveyed. Specific causes of reported constitutional health symptoms have not been determined. Health care providers and management and employee groups should be aware of the need to address mental health issues as well as constitutional symptoms among the large number of workers in the NYC area who have been indirectly affected by the WTC disaster. (J Occup Environ Med. *2002;44:601–605*)

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The collapse of the World Trade Center (WTC) after the attack on September 11, 2001, has affected a large number of people in the New York City (NYC) area, likely including all of the approximately 500,000 workers in southern Manhattan. A survey of Manhattan residents approximately two months after the WTC disaster found that 10% reported symptoms consistent with current depression and 8% reported symptoms consistent with posttraumatic stress disorder (PTSD) (among respondents who lived near the WTC the prevalence of PTSD symptoms was 20%).[1] A national survey several days after the WTC disaster found that 44% of adults reported symptoms of stress, and that stress reactions varied according to many variables (including region of the country the persons were from).[2] Despite these recent studies, there remains limited available information concerning health issues among persons indirectly affected by large-scale disasters.[3,4]

Responding to a request from the US Department of Health and Human Services (DHHS) in November 2001, the Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health (NIOSH), evaluated concerns related to post-September 11th occupational exposures and health effects among DHHS workers at the Federal Office Building (Federal Building), 26 Federal Plaza, NYC.[5] Here we summarize reported symptoms and occupational exposures among this group

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of office workers who were indirectly affected by the WTC disaster.

Methods

Medical Evaluation

This study was performed as part of the NIOSH Health Hazard Evaluation Program; worker participation was by informed consent. The evaluation primarily concerned DHHS employees in the NYC Federal Building, which is approximately 5 blocks northeast of the WTC site. Employees from the DHHS Regional Office in Dallas, Texas, served as a comparison group and were administered a similar questionnaire. A comparison group was included in this survey because building occupants, in general, are known to experience a variety of symptoms sometimes attributed to their work environment. The group of employees from the Dallas Regional Office was chosen as the comparison group because it was felt by DHHS administrators in Washington, D.C. to be similar in many respects to the group of DHHS employees in the NYC Federal Building in terms of number of employees, type of work, and work location (several hundred employees performing primarily office/administrative work in a large building in an urban setting).

After information concerning the NIOSH evaluation was distributed to all DHHS employees at each location, all DHHS employees at each location were invited to participate in the survey. The surveys were performed on December 4 to 5, 2001 (NYC), and on December 12, 2001 (Dallas). The questionnaire was self-administered and included questions about work duties and location, current symptoms, selected information on past medical history, and questions related to activities directly or indirectly related to the WTC attack. Along with questions concerning constitutional symptoms (such as headache, eye, nose, and throat irritation, and respiratory symptoms) occurring in the four months before the survey, the questionnaire included two series of questions assessing symptoms of depression and PTSD occurring in the month before the survey. Eleven questions pertaining to depression were adapted from the 20-question Center for Epidemiologic Studies Depression Scale (CES-D).[6] Possible responses ranged from (0) 'rarely' to (3) 'always' in a 4-point scale. Persons were defined as exhibiting 'depressive symptoms' if the sum of their responses exceeded 12.[7] The questions related to PTSD included 17 questions derived from diagnostic criteria for PTSD found in the Diagnostic and Statistical Manual of Mental Disorders, 4th Edition (DSM-IV).[8,9] Persons who provided an affirmative response to these questions according to the diagnostic criteria were defined as exhibiting 'PTSD symptoms.' The prevalence of symptoms was compared between workers in NYC and those in Dallas using the prevalence ratio (PR) and 95% confidence intervals (95% CI). A 95% CI that excluded one, or a significance level of $P \leq 0.05$, was considered to indicate a statistically significant finding.

Industrial Hygiene Evaluation

An industrial hygiene assessment was conducted that included area air sampling in representative areas of the Federal Building for asbestos, 28 different elements, volatile organic compounds, total dust, fine particles, polynuclear aromatic hydrocarbons, polychlorinated biphenyls, and carbon monoxide. Bulk samples of settled material were collected at an air intake and analyzed for elements and asbestos.[5] One of the primary goals of the industrial hygiene evaluation was to assess whether compounds present at Ground Zero of the WTC site after September 12, 2001,[10] had migrated into the Federal Building.

Results

Medical Evaluation

One hundred ninety-one (68% of the 279 available) workers in NYC and 155 (47% of the 328 available) workers in Dallas completed the questionnaire. Selected characteristics of the two groups of participants are presented in Table 1. Of note, the groups were similar in terms of age, gender, race, current cigarette use, and history of respiratory conditions. The group of NYC employees had a lower percentage of employees with at least some college education. Dallas employees were more likely to report conditions consistent with atopy (allergies, hayfever, skin allergies, eczema). To evaluate the potential role of residential exposure to contaminants from the WTC site, the survey included a question concerning zip code of residence since the WTC disaster. Among the workers in NYC, four persons (2% of the 191) reported living in lower Manhattan (defined by a northern boundary of zip codes 10013 and 10002—approximately corresponding to Charlton St. and Broome St.); further analysis of the data based on location of residence was not performed.

Table 2 presents a summary of symptoms reported occurring in the four months before the survey. Table 3 summarizes information concerning reported use of counseling and medical services, and Table 4 presents the number and percentage of participants from NYC and Dallas meeting our definitions of depressive or PTSD symptoms. Selected characteristics of workers in NYC are summarized in Table 5 regarding the presence of these symptoms; of note, persons with two or less confidants* were more likely to report both depressive and PTSD symptoms than those with three or more. There were no significant differences in the reporting of depressive or PTSD symptoms among workers with college education or more compared to those with a high school education or less.

The prevalence of symptoms varied by agency (examples of DHHS agencies at each of these sites are the Centers for Medicare/Medicaid Services and the Administration for Children and Families) within

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TABLE 1
Description of Survey Participants

	Participants in NYC N = 191	Participants in Dallas N = 155	*P* Value
Age - mean (yr)	46	48	0.35
Female - no. (%)*	126 (66)	90 (59)	0.15
Race - Nonwhite - no. (%)	73 (41)	54 (35)	0.23
Education - Some college or more - no. (%)	153 (84)	143 (93)	<0.01
History of allergy, hayfever, eczema - no. (%)	86 (46)	93 (60)	<0.01
History of respiratory conditions† - no. (%)			
Asthma	18 (9)	12 (8)	0.57
Bronchitis	8 (4)	4 (3)	0.39
Current cigarette smoking - no. (%)	14 (7)	18 (12)	0.17
Social support‡ - no. (%)			0.79
2 or less	50 (26)	39 (25)	
>2	139 (74)	116 (75)	
Personally witnessing some part of the WTC disaster	131 (69)	—	—

* Data presented as number and percentage of respondents.
† Affirmative responses to questions concerning the presence of these conditions prior to September 11, 2001.
‡ Response to "How many people do you feel at ease with and can talk to about what is on your mind."

TABLE 2
Reported Constitutional Symptoms

Symptom*	No. (%) of Workers in NYC Reporting Symptom	No. (%) Workers in Dallas Reporting Symptom	Prevalence Ratio [95% CI]	No. (%) of Workers in NYC Currently with Symptom†	No. (%) Workers in NYC With Worsening at Worksite‡
Bad taste in mouth	59 (32)	4 (3)	12.3 [4.6–33.2]§	18 (31)	41 (69)
Shortness of breath	51 (28)	7 (5)	6.1 [2.9–13.1]§	25 (49)	34 (67)
Chest tightness	51 (27)	7 (5)	6.0 [2.8–12.9]§	19 (37)	35 (69)
Nausea/vomiting	37 (20)	6 (4)	5.2 [2.2–11.9]‖	13 (35)	25 (68)
Eye irritation	117 (62)	19 (12)	5.0 [3.2–7.7]§	40 (34)	95 (81)
Wheezing	38 (21)	9 (6)	3.5 [1.8–7.1]§	19 (50)	25 (66)
Nose/throat irritation	125 (66)	33 (21)	3.1 [2.3–4.3]§	52 (42)	92 (74)
Severe headache	70 (38)	21 (14)	2.8 [1.8–4.3]§	31 (44)	46 (66)
Rash or skin irritation	27 (14)	9 (6)	2.4 [1.2–5.0]‖	10 (37)	10 (37)
Diarrhea	19 (10)	7 (5)	2.2 [1.0–5.1]‖	9 (47)	5 (26)
Cough	104 (56)	41 (27)	2.1 [1.6–2.8]§	43 (41)	68 (65)
Head or sinus congestion	95 (52)	65 (42)	1.2 [1.0–1.6]§	53 (56)	62 (65)
Indigestion	20 (11)	17 (11)	1.0 [0.5–1.8]‖	9 (45)	8 (40)

* Questions concerning symptoms referred to symptoms experienced in the 4 months prior to the survey.
† Number (%) of workers in NYC reporting symptom in the 4 months prior to the survey that reported having symptom at time of NIOSH survey.
‡ Number (%) of workers in NYC reporting symptom in the 4 months prior to the survey that reported symptom was made worse with exposure to worksite after September 11, 2001.
§ Unadjusted data presented - prevalence ratio and confidence intervals were similar after adjusting for gender, race, education, age, and current cigarette smoking.
‖ Unadjusted data presented - prevalence ratio and confidence intervals were similar after adjusting for gender, race, education, and age.

DHHS at both sites. For example, among agencies with eight or more participants, the prevalence of eye irritation ranged from 27 to 81% in NYC and 0 to 21% in Dallas, and the prevalence of depressive symptoms ranged from 0 to 45% in NYC and 0 to 29% in Dallas.

Industrial Hygiene

One of two samples of settled dust (obtained at a ventilation outdoor air intake) indicated the presence of chrysotile asbestos (in the range of 1% to <3%). None of the 13 air samples for fibers revealed asbestos. The 12 area air samples collected inside the building indicated that concentrations of many of the potential contaminants were below the limit of detection for the method used; there was no indication of an occupational exposure hazard to these various compounds.[5]

Comment

Our survey indicates that workers in NYC were more likely than those in Dallas to report a wide variety of constitutional symptoms, and many were still symptomatic at the time of the NIOSH survey. We found that the NYC and Dallas groups were similar in terms of most demographic characteristics that we surveyed. We did find that the Dallas

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TABLE 3
Use of Medical and Counseling Services

	Workers in NYC N = 191 No. (%)*	Workers in Dallas N = 155 No. (%)	*P* Value
Visiting physician for constitutional symptoms†	63 (33)	39 (25)	0.11
Having physician-prescribed medication‡	33 (72)	24 (86)	0.17
Taking time off work due to constitutional symptoms	70 (37)	36 (23)	<0.01
Emergency room visit since September 11, 2001	10 (5)	9 (6)	0.83
Used counseling services§	85 (45)	3 (2)	<0.01
Think would benefit from more counseling	53 (31)	9 (6)	<0.01

* Data presented as number and percentage of respondents.
† Affirmative response to question asking whether participant has seen a doctor because of the symptoms reported in Table 2.
‡ Among those reporting seeing a physician, affirmative response to question about prescribed medication for the symptoms.
§ Response to a question concerning use of formal (such as EAP counselor or group or private therapist) supportive counseling of any type.

TABLE 4
Prevalence of Mental Health Symptoms by City

Symptom	Workers in NYC No. (%)*	Workers in Dallas No. (%)	PR (95% CI)†
Depressive symptoms‡	60 (32)	14 (10)	3.2 (1.9–5.5)
PTSD symptoms§	47 (25)	6 (4)	5.7 (2.5–13.1)

* Data presented as number and percentage of respondents.
† Unadjusted data presented - prevalence ratio and confidence intervals were similar after adjusting for gender, race, education, and age.
‡ 'Depressive symptoms' were defined as a score of more than 12 (out of a total possible score of 33) for the 11 questions in the questionnaire taken from the modified CES-D scale.
§ 'PTSD symptoms' were defined by affirmative responses (answers of 'moderately,' 'quite a bit,' or 'extremely') to those questions defining PTSD according to DSM-IV criteria.

workers reported a higher background prevalence of conditions consistent with atopy. If this characteristic had an effect on the reported symptoms, it would likely lead to greater symptom reporting among the Dallas workers and therefore, to an underestimate of the difference in symptom prevalence between NYC and Dallas workers. Utilization of medical services for reported constitutional symptoms did not differ significantly between workers at the two sites. No occupational exposures to substances at concentrations that would explain the reported constitutional symptoms were found; however, we were unable to assess potential exposures of these workers in the time immediately after the WTC disaster. We observed an elevated prevalence of symptoms of depression and PTSD among workers in

TABLE 5
Prevalence of Mental Health Symptoms Among Workers in NYC by Selected Characteristics

	# (%) With Depressive Symptoms*	PR (95% CI)	# (%) With PTSD Symptoms†	PR (95% CI)
Gender				
Female	45 (37)	1.7 (1.0–2.9)	36 (29)	1.7 (0.9–3.0)
Male	14 (22)		11 (17)	
Race				
Nonwhite	26 (38)	1.4 (0.9–2.2)	14 (19)	0.8 (0.5–1.5)
White	27 (26)		24 (23)	
Education				
High school or less	9 (31)	1.0 (0.5–1.7)	9 (30)	1.3 (0.7–2.4)
College	48 (32)		35 (23)	
Know victim‡				
Yes	28 (37)	1.3 (0.9–2.0)	24 (32)	1.5 (0.9–2.5)
No	31 (29)		23 (21)	
Social support§ (No. confidants)				
2 or less	27 (56)	2.5 (1.7–3.7)	21 (42)	2.3 (1.4–3.8)
3 or more	31 (23)		25 (18)	

* 'Depressive symptoms' were defined as a score of more than 12 (out of a total possible score of 33) for the 11 questions in the questionnaire taken from the modified CES-D scale.
† 'PTSD symptoms' were defined by affirmative responses (answers of 'moderately,' 'quite a bit,' or 'extremely') to those questions defining PTSD according to DSM-IV criteria.
‡ Response to the question "Did you know anyone who was seriously injured or killed during the attack."
§ Response to the question "How many people (friends or relatives) do you feel at ease with and can talk to about what is on your mind."

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NYC compared to those in Dallas, and despite the fact that counseling services were utilized to a greater extent among workers in NYC, approximately 1/3 of those surveyed in NYC felt they would benefit from additional counseling.

The variability of reported symptoms by agency, along with the fact that we have no reason to believe potential exposures to environmental contaminants immediately after the WTC disaster varied by agency for these workers, suggests that factors not fully assessed in our evaluation may be important in understanding the reported symptoms. Among these other factors, the nature of organizational social support in response to the disaster, as well as more general work organization factors, may be important.[11] Regarding the former, our data suggest that improving social support within an organization may be beneficial with regards to minimizing depressive and PTSD symptoms in a postdisaster situation.

Our evaluation has several limitations. First, participants in our survey from both NYC and Dallas may not be representative of the entire workforces at those locations because participation was incomplete. Second, our questionnaire asked participants to report symptoms which are nonspecific and could potentially be affected by many factors we did not assess (including various types of both work-related and nonwork-related factors), but which may possibly have differed between the two work locations. Regarding such potential work-related factors, we are limited in our ability to assess whether work-related symptoms reported among workers in NYC may be related to factors directly related to the WTC attack or some other preexisting problems in the building. And third, our environmental survey in NYC was conducted more than two months after the WTC attack; it is possible that changing outdoor environmental conditions (such as changes in the wind and changes in the type or quantity of contaminants being produced at the WTC site) would alter the type and concentration of contaminants present in the Federal Building.

Clinicians and public health professionals must be aware that constitutional and mental health symptoms must both be addressed among persons in the NYC area indirectly involved with the WTC disaster. Further clinical follow-up and surveillance activities will be needed to help improve our understanding of currently reported symptoms and the potential for long-term health effects related to the WTC disaster.

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