Alcohol and Drug-Related Mortality Among Enrollees in the World Trade Center Health Registry (WTCHR), 2004 to 2012

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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.

Keywords: alcohol, disaster, drugs, mortality, World Trade Center

Alcohol and drug poisonings are a major public health concern in the United States (US). From 2006 to 2010, excessive alcohol use accounted for an average of one in ten deaths among adults (aged 20 to 64 years).[1] In 2014, a total of 47,005 US deaths were unintentional drug poisonings (overdose); more than half (61%) of these deaths were related to opioids.[2] In fact, overdose death rates have been on the rise, with a 2.2-fold increase in the total number of deaths from 2002 to 2015.[3] There was a 2.8-fold increase in the number of deaths involving opioid drugs between 2002 and 2015. In New York City (NYC) in 2016, there were 1374 drug overdose deaths, a 46% increase from the previous year, in part due to increased numbers of fentanyl-associated deaths.[4] The current analysis, however, only includes data through 2012, thus pre-dating the recent outbreak of fentanyl-associated deaths. This paper addresses whether alcohol and drug overdose deaths are increased in the population exposed to the 9/11 World Trade Center (WTC) disaster.

The September 11th (9/11) attacks in NYC resulted in numerous psychological and physical hazards leading to both short and long-term mental health problems, including posttraumatic stress disorder (PTSD), depression, and excessive alcohol and other drug use[5–10] A 2011 study of mortality among WTC Health Registry (Registry) enrollees found lower than expected rates of all-cause mortality; however, the standardized mortality ratio (SMR) for ''other mental disorders,'' which includes deaths related to the use of opioids, cocaine, and other psychoactive substances, was elevated among rescue/recovery workers [SMR 2.18, 95% confidence interval (95% CI) 0.94 to 4.29].[11] Given the increasing numbers of deaths due to excessive alcohol and drug use nationally, and the suggestive findings in the Registry's initial mortality analysis, it is important to examine substance-abuse related deaths in more detail. The role of probable PTSD is a particular concern due to the potential for this to contribute to the severity of this problem in the WTC disaster population.

To date, no study has specifically examined alcohol and drug-related mortality among those directly impacted by the events of 9/11. To better understand the long-term effects of disaster exposure on mental health and alcohol and other drug use, this study aims to a) identify deaths attributable to alcohol or other drug use among Registry enrollees whose death occurred in NYC, and b) examine factors associated with alcohol or other drug-related deaths compared with deaths from other causes.

METHODS

The Registry, a cohort study of 71,431 individuals directly exposed to the events of 9/11 in NYC, was designed to monitor the physical and mental health effects of direct exposure to the events of 9/11 or the subsequent rescue and recovery efforts for at least 20 years. Details on Registry eligibility criteria, recruitment methods, and findings have been published elsewhere.[7,12,13] In summary, Registry enrollees are composed of rescue/recovery workers and volunteers, lower Manhattan residents and area workers, passers-by on 9/11, and school children and staff. The Registry protocol was approved by the institutional review boards of the Centers for Disease Control and Prevention (CDC) and NYC Department of Health and Mental Hygiene.

Ascertainment of Deaths Among Enrollees

NYC vital records were used as the source of mortality data because 60% of Registry enrollees resided in NYC at Wave 1. Identifying data on Registry enrollees were linked to NYC vital records mortality data from January 1, 2003, to December 31, 2012. Key identifiers from the Registry and NYC vital records were compared electronically and records that matched on parts of identifiers such as name, address, date of birth, or social security number were considered potential matches. Each potential match was reviewed by two independent reviewers. In the case of disagreement, a third reviewer determined whether the case was a match.

International Classification of Diseases codes, 10th revision (ICD-10) for underlying cause of death,[14] were obtained from NYC vital records and used to categorize deaths. Deaths with an underlying cause of death related to alcohol or other drug use, defined as a cause of death that is attributable to alcohol or drug use (CDC), were categorized as ''alcohol or drug-related deaths.'' Deaths that did not have an alcohol or drug-related underlying cause of death, but with alcohol or drug use listed as a contributing factor, were categorized as indeterminate, and the remaining deaths were categorized as ''deaths from other causes.''

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Analytic Sample

Because we used NYC Vital Records to identify deaths, we limited this analysis to Registry enrollees whose deaths occurred in NYC. We excluded enrollees who were under age 18 years at enrollment, whose enrollment survey was completed by a proxy, or whose death occurred before January 1, 2004. We also excluded enrollees with missing information on age and date of birth. We included all alcohol- or drug-related deaths and all deaths from other causes in the analysis, and excluded deaths of indeterminate cause (deaths where alcohol/drug use was a contributing cause, not the underlying cause, $n = 5$).

WTC Exposures

We examined the following WTC exposures: being in the North or South WTC towers or another collapsed building at the time of the attack; witnessing at least three events (seeing planes hit the buildings, buildings collapsing, people falling or jumping from buildings, people injured, or people running); having been present in the dust cloud on 9/11; sustaining an injury other than eye irritation/injury (laceration, strain, sprain, burn, fracture, dislocation, or concussion); and having participated in rescue, recovery, or clean-up work. Rescue/recovery work was performed by both traditional (eg, police officers, firefighters) and nontraditional (eg, construction and utility workers, volunteers) responders.

Covariates

Sociodemographic variables associated with excess alcohol and drug use in previous studies (gender, age, race/ethnicity, household income (for 2002), education, marital status, employment status, and smoking status) were included as covariates.[15,16] Information on these variables was collected at enrollment in the Registry.

Probable 9/11-related PTSD in the last 30 days was assessed at Wave 1 using the PTSD Checklist-Stressor Specific Version (PCL-17), in which questions in the re-experiencing and avoidance/numbing domains were queried specific to 9/11. The PCL-17 is a self-reported, 17-item scale corresponding to the DSM-IV criteria and is commonly used in epidemiologic research. Cases of probable 9/11-related PTSD were defined using a score of at least 44 on the PCL-17, which is recommended for use among civilians (sensitivity ranging from 0.94 to 0.97, specificity from 0.86 to 0.99, diagnostic efficiency from 0.83 to 0.96), hereafter referred to as PTSD.[17,18] As in a previous Registry study,[19] enrollees with missing PCL-17 items and a score from the remaining items that could only be compatible with a total score of 43 or less or at least 44 were categorized accordingly; otherwise PTSD was considered missing.

Statistical Analysis

We compared alcohol and drug-related deaths to deaths from other causes using Chi-square tests to test for significant bivariate associations. Multivariable logistic regression was used to assess for significant associations between alcohol and drug-related deaths, 9/11-related PTSD and each of the WTC exposures that was significant at the bivariate level ($P < 0.05$), adjusting for gender, age, and smoking status. Data analyses were conducted using SAS Version 9.4 (SAS Institute, Cary, NC).

Human Subjects

Informed consent approval was obtained through the NYC Department of Health and Mental Hygiene Institutional Review Board.

RESULTS

We identified 66 alcohol or drug-related deaths and 1131 deaths from other causes (Table 1) occurring between January 1, 2004, and December 31, 2012, among Registry enrollees whose death occurred in NYC. Males accounted for 81.8% of alcohol or drug-related deaths and 53.2% of deaths from other causes. Enrollees aged from 18 to 44 years comprised 42.4% of alcohol or drug-related deaths but accounted for 10.1% of deaths from other causes. The largest proportion of alcohol or drug-related deaths was among enrollees who had never been married (41.3%), while the largest proportion of deaths from other causes occurred among those who were married or living with a partner (46.0%). More than half of alcohol or drug-related deaths occurred among smokers (51.6%), while smokers comprised 20.5% of deaths from other causes. There were no significant differences between alcohol or drug-related deaths and deaths from other causes by race, income, education, or employment status.

Nearly one-fourth (24.5%; Table 1) of all decedents had 9/11-related PTSD at Wave 1; PTSD prevalence was significantly higher among persons who died due to alcohol or drug-related causes (46.9%) than persons who died of other causes (23.2%). The proportion of enrollees with WTC exposures, including witnessing horror, being in the dust cloud, sustaining an injury, and participating in rescue/recovery work, was significantly higher among enrollees whose deaths were attributable to alcohol or drug use.

Among alcohol or drug-related deaths, the largest category of decedents had alcohol/drug abuse as the underlying cause of death (40.9%, $n = 27$; Table 2). Drug/alcohol poisonings of accidental, intentional, or undetermined intent accounted for one-third of alcohol or drug-related deaths (33.3%, $n = 22$) and the remaining alcohol or drug-related deaths (25.7%, $n = 17$) were a result of the physical effects of chronic alcohol abuse. The majority of deaths from other causes were attributed to malignant neoplasms/cancers (40.3%) and diseases of the circulatory system (31.6%) (Table 3).

The odds of dying from an alcohol or drug-related cause were greater among enrollees who were male [adjusted odds ratio (AOR): 2.61; 95% CI: 1.28 to 5.34)], aged 18 to 44 years (AOR: 4.40; 95% CI: 2.43 to 7.97), or smoking at enrollment (AOR: 3.53; 95% CI: 2.02 to 6.18) (Table 4). The odds of dying from an alcohol or drug-related cause were two times greater (AOR: 2.09; 95% CI: 1.16 to 3.79) among enrollees with 9/11-related PTSD compared with those without. With respect to specific exposures, the odds of alcohol or drug-related deaths were significantly elevated among rescue/recovery workers (AOR: 2.83; 95% CI: 1.53 to 5.22) and those who had sustained an injury on 9/11 (AOR: 2.12; 95% CI: 1.08 to 4.16).

DISCUSSION

In this study of 1193 persons directly exposed to the WTC terror attacks whose death occurred between 2004 and 2012 in NYC, deaths related to alcohol and drug use were significantly associated with 9/11-related PTSD, performing rescue/recovery work, and sustaining an injury on 9/11.

WTC exposure, specifically rescue/recovery work and sustaining and injury on 9/11, was associated with significantly elevated odds of alcohol or drug-related mortality. These findings are consistent with previous post-disaster studies, which have reported elevated levels of alcohol use and high-intensity binge drinking among rescue/recovery workers.[6,20–22] Rescue/recovery workers in our cohort likely experienced WTC exposures that were of greater intensity and duration than nonrescue/recovery workers, which may explain part of the greater odds of alcohol or drug-related mortality observed in this group. Studies of firefighters in the U.S. have demonstrated that binge drinking is substantially higher among firefighters than the general population.[23,24] In addition, The National Survey on Drug Use and Health gathers information about substance use and dependence or abuse by occupation and industry. This survey found that construction

TABLE 1. Alcohol or Drug-Related Deaths Versus Deaths From Other Causes In New York City, Among Registry Enrollees, 2004–2012

	Total	Alcohol or Drug Related	Other Causes	
	N (%)	*N* (%)	*N* (%)	*P*
	1,193 (100.0)	66 (5.5)	1,127 (94.4)	
Manner of death				
Natural	1,093 (91.6)	34 (51.5)	1,059 (94.0)	<0.0001
Accident	56 (4.7)	27 (40.9)	29 (2.6)	
Suicide	18 (1.5)	4 (6.1)	14 (1.2)	
Homicide	7 (0.6)	0 (0.0)	7 (0.6)	
Undetermined	19 (1.6)	1 (1.5)	18 (1.6)	
Gender				
Male	654 (54.8)	54 (81.8)	600 (53.2)	<0.0001
Female	539 (45.2)	12 (18.2)	527 (46.8)	
Age at Wave 1, years				
18–29	17 (1.4)	6 (9.1)	11 (0.9)	<0.0001
30–44	126 (10.6)	22 (33.3)	104 (9.2)	
45–64	582 (48.8)	36 (54.6)	546 (48.5)	
65 and older	468 (39.2)	2 (3.0)	466 (41.4)	
Race/Ethnicity				
Non-Hispanic White	610 (51.1)	39 (59.1)	571 (50.7)	0.2583
Non-Hispanic Black	214 (17.9)	9 (13.6)	205 (18.2)	
Hispanic	141 (11.8)	10 (15.2)	131 (11.6)	
Asian/ Multiracial/Other	228 (19.1)	8 (12.1)	220 (19.5)	
Household income at Wave 1				
100,000 +	120 (12.0)	9 (16.4)	111 (11.7)	0.4959
75,000–99,999	104 (10.4)	8 (14.5)	96 (10.1)	
50,000–74,999	155 (15.5)	10 (18.2)	145 (15.3)	
25,000–49,999	273 (27.2)	12 (21.8)	261 (27.6)	
24,999 or less	350 (35.0)	16 (29.1)	334 (35.3)	
Education level at Wave 1				
College/Post-college degree	375 (32.2)	20 (31.3)	355 (32.3)	0.1517
Some college	252 (21.7)	20 (31.3)	232 (21.1)	
HS graduate/GED	313 (26.9)	17 (26.5)	296 (26.9)	
Less than high school	223 (19.2)	7 (10.9)	216 (19.7)	
Marital status at Wave 1				
Married/Living with partner	524 (45.3)	20 (31.7)	504 (46.0)	<0.0001
Divorced/Separated	244 (21.1)	8 (12.7)	236 (21.6)	
Widowed	166 (14.3)	9 (14.3)	157 (14.3)	
Never married	224 (19.3)	26 (41.3)	198 (18.1)	
Employed at Wave 1				
Yes	609 (52.1)	40 (62.5)	569 (51.5)	0.0866
No	560 (47.9)	24 (37.5)	536 (48.5)	
Smoker at Wave 1				
Yes	259 (22.2)	33 (51.6)	226 (20.5)	<0.0001
No	910 (77.8)	31 (48.4)	879 (79.5)	
Present in tower*				
Yes	49 (4.1)	3 (4.5)	46 (4.1)	0.7491*
No	1,144 (95.9)	63 (95.5)	1,081 (95.9)	
Witnessed ≥3 events†				
Yes	448 (37.6)	34 (51.5)	414 (36.7)	0.0160
No	745 (62.4)	32 (48.5)	713 (63.3)	
Dust cloud				
Yes	626 (52.5)	43 (65.2)	583 (51.7)	0.0338
No	567 (47.5)	23 (34.8)	537 (47.7)	
Sustained an injury				
Yes	144 (12.1)	19 (28.8)	125 (11.1)	<0.0001
No	1,049 (87.9)	47 (71.2)	1,002 (88.9)	
Rescue/Recovery worker				
Yes	279 (23.4)	39 (59.1)	240 (21.3)	<0.0001
No	914 (76.6)	27 (40.9)	887 (78.7)	
PTSD at Wave 1				
Yes	284 (24.5)	30 (46.9)	254 (23.2)	<0.0001
No	876 (75.5)	34 (53.1)	842 (76.8)	

PTSD, posttraumatic stress disorder.

*Tower = World Trade Center Tower I or II.

†Witnessed three or more of the following events: seeing planes hit the buildings, buildings collapsing, people falling or jumping from buildings, people injured, or people running.

TABLE 2. Underlying Causes of Death for Alcohol and Other Drug-Related Deaths 2004–2012 ($n = 66$)

	Number of Deaths	% of Alcohol and Other Drug-Related Deaths
Alcoholic cirrhosis of the liver	13	20
Accidental poisoning due to other drugs	11	17
Alcoholism/alcohol dependence	8	12
Psychoactive substance dependence	6	9
Cocaine dependence	4	6
Opioid dependence	4	6
Accidental poisoning due to alcohol	3	5
Accidental poisoning due to narcotics and psychodysleptics	3	5
Harmful/abuse of alcohol – nondependent	3	5
Alcoholic hepatitis	2	3
Harmful/abuse of psychoactive substances: nondependent	2	3
Intentional self-poisoning due to other drugs	2	3
Alcoholic cardiomyopathy	1	2
Alcoholic liver disease - unspecified	1	2
Intentional self-poisoning due to non-opioid analgesics	1	2
Intentional self-poisoning due to sedatives and psychotropics	1	2
Poisoning of undetermined extent	1	2

and utility workers were among the occupations most likely to report heavy alcohol use (16.5% and 10.3%, respectively) and illicit drug use (11.6% and 6.1%, respectively) in the last 30 days, as well as a substance use disorder in the past year (14.3% and 11.5%, respectively).[25]

TABLE 3. Underlying Causes of Death for Deaths From All Other Causes ($n = 1{,}127$), 2004–2012

Cause of Death	Number of Deaths	% of Other Deaths
Malignant neoplasms/cancers	454	40.3
Diseases of the circulatory system	356	31.6
Diseases of the respiratory system	86	7.6
External causes	53	4.7
Endocrine, nutritional, and metabolic diseases	44	3.9
Infectious and parasitic diseases	41	3.6
Diseases of the digestive system	21	1.9
Diseases of the nervous system	17	1.5
In-situ neoplasms and diseases of blood	13	1.2
Mental and behavioral disorders	13	1.2
Diseases of genitourinary system	10	0.9
Diseases of musculoskeletal system and connective tissue	8	0.7
Symptoms, signs, and abnormal clinical findings not otherwise classified	6	0.5
Congenital malformations, deformations, and chromosomal abnormalities	3	0.3
Pregnancy, childbirth, and puerperium	1	0.1
Diseases of the skin and subcutaneous tissue	1	0.1

TABLE 4. Unadjusted and Adjusted Odds Ratios and 95% Confidence Intervals (CIs) for Death Due to Alcohol and Other Drugs Compared With Death Due to Other Causes, 2004–2012

	Unadjusted Odds Ratio (95% CI)	Adjusted OR (95% CI)*
Gender		
Male	3.95 (2.09–7.47)	2.61 (1.28–5.34)
Female		REF
Age at Wave 1, years		
18–44	6.48 (3.85–10.96)	4.40 (2.43–7.97)
45 and older		REF
Smoker at Wave 1		
Yes	4.14 (2.48–6.91)	3.53 (2.02–6.18)
No		REF
9/11-related PTSD at Wave 1		
Yes	2.93 (1.76–4.88)	2.09 (1.16–3.79)
No		REF
WTC exposures		
Rescue/Recovery worker		
Yes	5.34 (3.20–8.90)	2.83 (1.53–5.22)
No		REF
Sustained an injury		
Yes	3.21 (1.84–5.70)	2.12 (1.08–4.16)
No		REF
Witnessed ≥3 events		
Yes	1.83 (1.11–3.01)	1.61 (0.85–3.04)
No		REF
Caught in the dust cloud		
Yes	1.72 (1.02–2.90)	1.29 (0.68–2.45)
No		REF

OR, odds ratio; PTSD, posttraumatic stress disorder; WTC, World Trade Center.
*Model adjusted for gender, smoking, PTSD, injury, rescue/recovery worker, witnessed ≥3 events, caught in dust cloud.

As sustaining an injury on 9/11 was associated with alcohol or drug-related mortality and many injuries may have been treated with prescription opioid analgesics, it is important to note that more than half of alcohol or drug-related deaths in our study were unintentional poisonings ($n = 35$), of which 40% included either an opioid ($n = 13$) or benzodiazepine ($n = 1$). Prescription opioids are often used to treat moderate-to-severe pain and are frequently prescribed following injury. In recent years, there has been a dramatic increase in the acceptance and use of prescription opioids for the treatment of chronic, noncancer pain, which is strongly associated with increasing opioid-related morbidity and mortality.[26] Moreover, nonmedical use of prescription opioids, defined as using medications that were not prescribed or in larger doses than prescribed, is a strong risk factor for overdose and heroin use.[27] It is therefore important to provide disaster and trauma-exposed persons with educational materials and counseling on the risk of excessive alcohol use and drug use as well as safe use of analgesic medications.

In our study, PTSD was a strong risk factor for alcohol or drug-related mortality. Previous Registry studies have observed a strong association between PTSD and excessive alcohol use.[6,22] In a nationally representative sample of adults in the United States, 21.4% of adults with PTSD used alcohol, drugs, or both to relieve symptoms of PTSD.[28] It is possible that the use of alcohol or drugs to self-medicate PTSD symptoms leads to excessive and/or chronic alcohol or drug use, resulting in increased substance use-related morbidity and mortality. Postdisaster health assessments should include screening for both current substance use disorders and at-risk alcohol and drug use behaviors.

STRENGTHS AND LIMITATIONS

This study has several limitations, including reliance on self-reported data. We did not collect information on use of alcohol or prescription and/or illicit drugs on or before 9/11, and the data only includes death through 2012 and therefore do not reflect the currently increasing number of deaths due to fentanyl. The assessment of PTSD was based on a self-administered questionnaire rather than clinical interview; however, the PCL-17 is widely used in epidemiologic studies and considered to have good diagnostic efficiency. Data on 9/11 exposures were collected 2 to 3 years post-9/11 and might have been subject to recall bias. The most prevalent specific cause of substance-related death in this sample was liver cirrhosis, which typically requires decades of very heavy drinking to lead to death. This is an indicator that this particular substance use problem may well have pre-existed the 9/11 attacks.

Among the strengths of this analysis are the size of the overall cohort from which deaths were selected, detailed WTC exposure information, and the diverse population represented by Registry enrollees, including persons with varied, direct WTC exposures, and both rescue/recovery workers and community members.

CONCLUSION

These findings highlight the importance of providing disaster and trauma exposed persons with educational materials and counseling on alcohol and other substance use as well as safe medication usage. Substance abuse is a covered 9/11-related condition in the WTC Health Program.[29] Screening for both current substance use disorders and at-risk alcohol and drug use behaviors should be included as part of postdisaster mental health assessments. Moreover, it is imperative that substance use be addressed concomitantly with the treatment of comorbid mental health conditions such as PTSD and depression.

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