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Relationship between Persistent posttraumatic Stress Disorder and Human Remains Exposure for Staten Island Barge and Landfill Recovery and Clean-up Workers After 9/11

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WHAT IS KNOWN

- Clean-up and recovery workers at the Staten Island landfill and on barges after the attacks on 9/11were exposed to hazardous debris and human remains
- Adverse mental health consequences have been associated with exposure to human remains during war time, and following natural disasters- and plane crashes

WHAT THIS PAPER ADDS

- A 9/11 occupational exposure index that examines the unique cumulative effects of Staten Island landfill and barge- specific work exposures
- Dose-response relationship between human remains exposure and PTSD
- Sanitation workers were at higher risk of PTSD when exposed to human remains compared to firefighters and police

ABSTRACT: *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 during 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.*

Keywords: *World Trade Center, post-traumatic stress disorder (PTSD), 9/11, human remains*

Abbreviations: *World Trade Center (WTC)*, *New York City Police Department (NYPD)*, *Fire Department of New York City (FDNY)*, *Department of Sanitation of New York City (DSNY), Post-traumatic stress disorder (PTSD)*, *Staten Island (SI)*

INTRODUCTION

The World Trade Center (WTC) attack on September 11, 2001 (9/11) resulted in the deaths of nearly 3,000 individuals (Vlahov et al., 2002). The 16 acres of land on which the WTC Twin Towers stood became a crime scene for the investigation of one of the largest acts of terrorism in the United States (Mackinnon & Mundorff, 2007). An estimated 91,000 WTC rescue/recovery workers were exposed to dust and debris from the collapsed buildings (Murphy et al., 2007) and possibly human remains, particularly during the removal and sifting of thousands of tons of debris for recovery of human remains and personal effects (Ekenga et al., 2011; Farfel et al., 2008; Murphy, 2006; Perrin et al., 2007; Vlahov et al., 2002).

Between September 12, 2001 and July 31, 2002, over 1.8 million tons of debris from the WTC site (Ground Zero) were transported by truck to lower Manhattan piers and then loaded onto barges for transfer to the Staten Island (SI) Fresh Kills Landfill (landfill) for processing as a part of the recovery efforts and criminal investigation (Mackinnon & Mundorff, 2007). The Office of the Chief Medical Examiner for the City of New York (OCME) was tasked with sorting through an estimated 54,000 personal effects and over 20,000 human remains, resulting in the identification of 59% of the victims (Bowler et al., 2012; Goldenberg, 2015; New York State Museum, 2004; WTC Operational Statistics, 2015).

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SI workers were exposed to debris which contained not only pulverized matter from the collapse of the WTC buildings (Brackbillet al., 2006; Landrigan et al., 2004; Lioy et al., 2002) but hazardous waste, chemicals, and microorganisms already present at the landfill, a former 3,000-acre New York City (NYC) garbage disposal site that was closed prior to 9/11 (Anatomy: World Trade Center/Staten Island Landfill Recovery Operation, 2004; Dawsey, 2013; Gelberg, 1997; Suflita et al., 1992). While work at the landfill was performed by personnel of the NYC Police Department (NYPD), NYC Fire Department (FDNY), the Federal Bureau of Investigation (FBI), and OCME, most of whom likely had prior training or experience in human remains recovery work, large numbers of workers not likely to have had this type of training or experience also participated in this painstaking work, including NYC Department of Sanitation (DSNY) personnel, construction workers, and volunteers affiliated with organizations (e.g., Red Cross) (Debchoudhury et al., 2011; Ekenga et al., 2011).

Previous research has shown that adverse mental health consequences, particularly posttraumatic stress disorder (PTSD), have been associated with exposure to human remains during war time, and following natural disasters, plane crashes and other events (Andersen, Christensen, & Petersen, 1991; Bartone, Ursano, Wright, & Ingraham, 1989; McCarroll et al., 1995; Miles, Demi, & Mostyn-Aker, 1984; Steinglass & Gerrity, 1990; Ursano, Fullerton, Kao, & Bhartiya, 1995). PTSD has been found to be elevated in 9/11 rescue, recovery and clean-up workers (North et al., 2002; Perrin et al., 2007). This increase may be due to the nature of work performed during or after a disaster. In a study of over 8,000 WTC police responders, Pietrzak et al., found that exposure to human remains was associated with an increased likelihood of PTSD (Pietrzak et al., 2012). There is limited research regarding the extent to which encountering human remains after the WTC disaster may have resulted in lasting psychological effects.

There is a particular gap in the literature regarding the effects of human remains exposure on SI landfill and barge workers who were engaged in intensive debris handling and sorting activities after 9/11. This study examined the self-reported exposure to human remains among those who worked at the SI landfill and barges in order to assess subsequent PTSD among these workers more than 10 years after 9/11.

METHODS

The methods used to collect World Trade Center Health Registry (WTCHR or Registry) data have been previously published (Brackbill et al., 2009; Farfel et al., 2008; Murphy, 2006; Perrin et al., 2007). Briefly, the 71,431 individuals enrolled in the Registry comprise several eligibility groups: Rescue, recovery and clean-up workers and volunteers; lower Manhattan workers and passersby on 9/11; lower Manhattan residents; and school children and school staff. Enrollees were recruited from lists that were provided by employers or governmental agencies (30%) and through public outreach (70%) (Farfel, DiGrande, & Brackbill, 2008). Three waves of surveys were distributed to participants; Wave 1 (W1) (2003-04); Wave 2 (W2) (2006-07) and Wave 3 (W3) (2011-12). Data were collected via paper, computer assisted telephone interviews (CATI), in-person interviews, or web-based surveys. The Registry protocol and subsequent sub-studies were approved by the Institutional Review Boards of the Centers for Disease Control and Prevention and the NYC Department of Health and Mental Hygiene.

The initial lack of data on the health effects of working on the landfill and barges led to a two-phase investigation focusing on the unique experiences and exposures of SI landfill and barge workers enrolled in the Registry. Phase I was a qualitative study conducted in 2009 which was designed to investigate the 9/11-related experiences and exposures of SI workers (Ekenga et al., 2011). Findings from Phase I were used by the investigators to develop Phase II, an in-depth sub-group survey in the context of the ongoing Registry prospective cohort study. The Phase II survey assessed prior disaster experience or training, tasks performed at landfill or barge sites, use of protective equipment, site-specific experiences, and current employment status for all enrollees who reported having worked on the SI landfill or barges. The survey was distributed via mail from June 2010 to November 2011 to 4,147 SI workers, with a response rate of 55% (n = 2,287).

Study Variables

Primary Outcomes

Persistent posttraumatic stress disorder (PTSD)

PTSD was measured at all three waves using a 9/11-specific PTSD Checklist (PCL), a validated tool which measures self-reported symptoms of PTSD in the past 30 days. The PCL is a tool that is widely used to assess self-reported data regarding PTSD symptomology. Symptoms are event-specific as related to 9/11 and have been previously used in Registry studies of PTSD (Perrin et al., 2007). The PCL includes 17-items scored on a scale of 1 (not at all) to 5 (extremely), with summed scores ranging from 17 to 85 (Blanchard, Jones-Alexander, Buckley, & Forneris, 1996; Weathers et al., 1993). Probable PTSD was defined as meeting a cutoff score of 44 on the PCL, as well as meeting the following criteria from the Diagnostic and Statistical Manual of Mental Disorders Fourth Edition (DSM-IV): at least one re-experiencing symptom (DSM-IV criterion B), three avoidance symptoms (DSM-IV criterion C), and two hyperarousal symptoms (DSM-IV criterion D) (Smith et al., 1999). The PCL has relatively high levels of sensitivity (94%-97%) and specificity (86%-99%) as well as positive predictive value of 70%-97% (Blanchard, Jones-Alexander, Buckley, & Forneris, 1996; Ruggiero, Ben, Scotti, & Rabalais, 2003; Ventureyra et al., 2001; Weathers, et al., 1993). Blanchard has reported that the PCL $\geq$ 44 cutoff provides the highest level of diagnostic efficiency at 0.94 (Blanchard, Jones-Alexander, Buckley, & Forneris, 1996). Persistent PTSD was defined as having met the PTSD criteria detailed above at either W1 or W2 and at W3.

Additional Study Variables

Staten Island exposure scale and other work-related variables

In order to measure the cumulative effects of SI-specific working conditions and exposures after 9/11, we created a SI exposure scale consisting of seven questions grouped into three categories 1) visual (seeing dust in the air and impaired visibility), 2) respiratory (breathing in dust from the debris piles, construction activities, sorting activities, or unpaved roads, breathing in diesel or gasoline fumes, and breathing in garbage odors), and 3) protective measures (wearing a Tyvek suit, Nomex suit, or any other disposable protective suit, and use of shower facilities) that were analyzed in the aggregate. This scale was based on the findings from the Phase I survey and our analysis found the scale to have good reliability (Cronbach's α = 0.84). The possible responses for all questions were: every day, almost every day, some days, almost never, and never. These responses were scored from 4 (every day) to 0 (never) except those regarding wearing a disposable suit or using a shower facilities at the worksite which, due to their protective nature, were given the reverse score of 0 (every day) to 4 (never). The aggregated scores ranged from 0-28. We classified the workers' scores into low (0-19), and high (20-28) exposures based on the median score. Additional work-related characteristics were: having worked on the pile at Ground Zero; which was reported at W1; and having prior disaster training or experience.

Exposure to human remains

The frequency of an enrollee's exposure to human remains was

asked in a separate question: 'How often did you encounter human remains at your worksite?' The responses to this question ranged from never to every day.

Social support

An abbreviated version of the Medical Outcomes Study Social Support Survey (Ritvo et al., 1997; Sherbourne & Stewart, 1991), asked at W3, was used to assess the impact of social support on persistent PTSD. The social support scale measured the frequency of how often an enrollee has someone available to take them to the doctor, have a good time with them, hug them, prepare meals for them, and understand their problems. This scale has been used in previous Registry studies, and has been shown to be a predictor of unmet mental health care needs among WTCHR enrollees with PTSD or depression (Brackbill, et al., 2009; Brackbill et al., 2013; Ghuman et al., 2014). Each of the five social support questions' responses was scored from 0 (none of the time) to 4 (all of the time). The five individual scores were summed and categorized as: very high social support (16 to 20); high social support (12 to 15); medium social support (7 to 11); and low or no social support (0 to 6).

Study Population

On the Registry's W1 survey, a total of 4,490 workers reported that they worked at the SI landfill or barges, which had to include at least one shift between September 12, 2001 to July, 26, 2002 on a pier in lower Manhattan or on Staten Island, at the World Trade Center Recovery Operation on Staten Island located at the Fresh Kills Landfill, Staten Island, NY, or on at least one of the NYC Department of Sanitation barges or trucks used to transport debris between the WTC site and the WTC Recovery Operation on Staten Island. In our analysis, we excluded workers who were less than 18 years of age at October 20, 2010 (n = 7), non-English speakers (n = 36), and those who did not consent to future studies (n = 300), which left 4,147 enrollees who were eligible for Phase II

A total of 2,287 out of 4,147 (55%) eligible enrollees completed the Phase II SI survey. Compared to survey non-participants, participants who completed the survey were more likely to be: older; non-Hispanic; married and have a higher income and level of education. Of these, 2,021 (88%) verified that they had worked at either the landfill or on the piers or barges. Only participants who completed both the Waves 2 and 3 follow-up surveys were included (n = 1,592) in order to assess the persistence of the outcome of interest. We excluded those who screened positive for PTSD for the first time at W3 (n = 66) in order to rule out new-onset, rather than persistent, PTSD, those missing information on PTSD at Wave 3 (n = 69), and those with incomplete information on PTSD at prior waves (n = 6). The final analytic sample consisted of 1,451 enrollees (Figure 1).

Statistical Analyses

All analyses were conducted using SAS 9.2 (Cary, N.C.). We conducted bivariate analyses, using chi-square tests of independence, to examine the characteristics of our study population, comparing those with persistent PTSD to those without. A logistic regression model, adjusted for age, sex, Hispanic ethnicity, education, occupation, having worked on the pile at Ground Zero, and social support, assessed the association between human remains exposure and other SI work exposures and persistent PTSD in order to examine the cumulative effects of adverse physical exposures at the worksite along with the increased frequency of exposure to human remains.

RESULTS

Characteristics of Study Population

Staten Island survey participants were primarily male (85.3%), age 45 years and older at the time of the W3 survey (82.0%) and had more than a high school education at W1 (69.0%). Almost half (47.8%) of participants reported also working on the pile at Ground Zero. The largest proportion of respondents worked for NYPD (29.5%), followed by DSNY with 16.3%, and FDNY with 11.9%. Overall, 108 workers (7.4%) met the case definition for persistent PTSD (Table 1). FDNY, DSNY and NYPD workers were almost exclusively male (100%, 99%, and 89%, respectively) (Data not shown).

Factors Associated with Persistent PTSD among S.I. Workers

Encountering human remains was significantly associated with persistent PTSD; 13.3% of those who encountered human remains every day had persistent PTSD compared to 2.4% of those who reported never encountering human remains. Factors significantly associated with persistent PTSD in bivariate analyses included male gender, having a high school or lower educational level, working on the pile at Ground Zero, a high score on the Staten Island Exposure Scale, and low social support. Having prior disaster training or experience was not associated with persistent PTSD in bivariate analysis. Prevalence of persistent PTSD was highest in sanitation workers (11.5%), and lowest in police (5.7%) (Table 1).

DSNY and FDNY workers had higher odds of persistent PTSD than those affiliated with the NYPD, even after controlling for exposure and disaster training. Lower social support was associated with higher odds of persistent PTSD (Table 2). Hispanic ethnicity and having a high school or lower educational level were also strong predictors of persistent PTSD. Age and sex were not associated with persistent PTSD in the adjusted model (data not shown).

A dose-response relationship was found between frequency of human remains exposure and persistent PTSD (adjusted odds ratio (AOR): every day = 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 compared to workers with the lower SI exposure scores, those with highest exposure had more than three times the odds of having persistent PTSD (AOR: 3.38; 95% CI: 1.93-5.90) (Table 2).

DISCUSSION

Staten Island landfill and barge debris removal work terminated on July 26, 2002, yet exposure to human remains and other SI landfill and barge-specific exposures from this work were found to be strong predictors of PTSD 10-11 years later. Similar to other studies of 9/11-affected populations, Hispanic ethnicity and having a high school or lower educational level were also found to be strong predictors of persistent PTSD (Bowler et al., 2012; DiGrande et al., 2008; Galea et al., 2002). Adverse mental health consequences, particularly PTSD, have been associated with exposure to human remains during wartime, peacekeeping missions, disasters, and other events that have resulted in casualties (Andersen, Christensen, & Petersen, 1991; Bartone, Ursano, Wright, & Ingraham, 1989; Green,

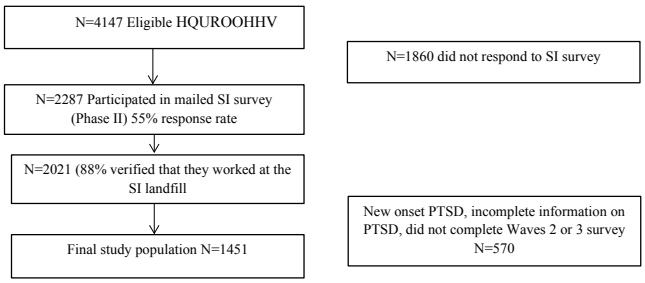

Figure 1.
Staten Island Landfill and Barge Worker Study Population Flow Chart

Table 1.
Characteristics of Staten Island Barge and Landfill Recovery and Clean-up workers and Persistent PTSD

	Total	Persistent PTSD at W3*	
	N = 1592 n (%)	Yes n (%)	P-Value
Total	1592 (100)	108 (7.4)	
Gender			
Male	1358 (85.3)	100 (8.1)	0.02
Female	234 (14.7)	8 (3.7)	
Age at Wave 3 years			
25-44	287 (18.0)	15 (5.7)	0.23
45+	1305 (82.0)	93 (7.8)	
Hispanic Ethnicity			
Yes	135 (8.5)	14 (11.6)	0.07
No	1455 (91.4)	93 (7.0)	
Education at Wave 1			
High School or less	490 (30.8)	45 (10.2)	0.01
More than High School	1098 (69.0)	63 (6.3)	
Encountered Human Remains			
Every day	161 (10.1)	19 (13.3)	<.0001
Almost Every day	130 (8.2)	14 (11.7)	
Some days	545 (34.2)	46 (9.5)	
Almost Never	231 (14.5)	16 (7.3)	
Never	492 (30.9)	11 (2.4)	
Disaster training and or experience			
Yes	753 (47.3)	46 (6.5)	0.21
No	812 (51.0)	59 (8.2)	
Staten Island Exposure Scale **			
[20-28](high)	753 (47.3)	88 (12.1)	<.0001
[0-19](low)	820 (51.5)	19 (2.7)	
Social Support at Wave 3			
[0-6] least	111 (7.0)	19 (19.6)	<.0001
[7-11]	192 (12.1)	23 (13.9)	
[12-15]	358 (22.5)	37 (11.6)	
[16-20] most	895 (56.2)	26 (3.1)	
Worked on the pile at Ground Zero			
Yes	761 (47.8)	72 (10.6)	<.0001
No	831 (52.2)	36 (4.7)	
Occupation***			
NYPD	469 (29.5)	25 (5.7)	0.001
FDNY	189 (11.9)	21 (12.6)	
DSNY	259 (16.3)	26 (11.5)	
Other	675 (42.4)	36 (5.8)	

* Persistent PTSD is defined as a total PCL score ≥ 44 and meeting the DSM-IV criteria at Wave 3 in addition to meeting a total PCL score ≥ 44 and DSM-IV criteria at either Wave 1 or Wave 2
** The Staten Island (SI) Exposure scale measures the cumulative effects of SI exposures for recovery and clean-up workers after 9/11. The scale's seven survey questions measured both worksite exposures and protective measures. Responses were scored from 4 to 0, with protective questions receiving a reverse score of 0-4. Each individual question score was combined into a cumulative score of low (0-19) and high (20-28) exposures.
*** FDNY: New York City Fire Department; DSNY: The City of New York Department of Sanitation; NYPD: New York City Police Department

Table 2.
Multivariable logistic regression model* of the association between encountering human remains and other landfill exposures and persistent PTSD** among Staten Island Barge and Landfill Recovery and Clean-up workers

	AOR	95% CI
Social Support at W3		
[0-6] least	7.66	3.77-15.54
[7-11]	4.13	2.19-7.79
[12-15]	4.24	2.44-7.36
[16-20] most	1.0	
Occupation***		
NYPD	1.0	
FDNY	2.46	1.20-5.04
DSNY	2.52	1.25-5.07
Other	1.61	0.89-2.92
Encountered Human Remains		
Every day	4.77	2.00-11.52
Almost every day	4.35	1.75-10.80
Some days	2.98	1.43-6.22
Almost never	2.24	0.96-5.19
Never	1.0	
Staten Island Exposure Scale⁺		
[0-19] low	3.38	1.93-5.90
[20-28] high	1.0	

* Model adjusted for sex, age group, Hispanic ethnicity, education, and working on the pile at Ground Zero social support, occupation, frequency of encountering human remains, and the Staten Island Exposure Scale.
** Persistent PTSD is defined as a total PCL score ≥ 44 and meeting the DSM-IV criteria at Wave 3 in addition to meeting a total PCL score ≥ 44 and DSM-IV criteria at either Wave 1 or Wave 2
*** FDNY: New York City Fire Department; DSNY: The City of New York Department of Sanitation; NYPD: New York City Police Department
⁺ The Staten Island (SI) Exposure scale was created in order to measure the cumulative effects of SI exposures for recovery and clean-up workers after 9/11. The scale's seven survey questions measured both worksite exposures and protective measures. Responses were scored from 4 to 0, with protective questions receiving a reverse score of 0-4. Each individual question score was combined into a cumulative score of low (0-19) and high (20-28) exposures.

Lindy, Grace, & Gleser, 1989; McCarroll, Ursano, & Fullerton, 1995; Miles, Demi, & Mostyn-Aker, 1984; Steinglass & Gerrity, 1990; Stellman et al., 2008; Sutker et al., 1994; Ursano, Fullerton, Kao, & Bhartiya, 1995). One-third of recovery personnel evaluated 20-months after a DC10 plane crash on Mount Erebus, Antarctica, resulting in 257 deaths, were found to have immediate physiological symptoms including anxiety, depression, increased tension, sleep disturbance, or intrusive memories (Taylor & Frazer, 1982). A study done on disaster assistance workers after the December 12, 1985 crash of an airliner with 248 soldiers on a peacekeeping mission found a dose-response relationship between degree of exposure to human remains and psychological distress six and twelve months post-disaster (Bartone, Ursano, Wright, & Ingraham, 1989). Workers who spent extended periods of time with families during body identification experienced negative psychological health outcomes similar to those found in our study (Bartone, Ursano, Wright, & Ingraham, 1989). Anticipated contact with human remains has also been shown to increase psychological distress (Keller & Bobo, 2002; McCarroll, Ursano, & Fullerton, 1995).

Rescue and recovery workers may be traumatized by the experience or expectation of encountering human remains following disasters, particularly if they are enlisted from ranks of workers and other volunteers who have little or no training or experience in tasks that may expose them to human remains (Ursano & McCarroll, 1990). Workers with the DSNY and FDNY were more likely to have persistent PTSD compared to NYPD workers, even after controlling for demographic variables and prior disaster training or experience. In contrast to other studies, (McCarroll, Ursano, & Fullerton, 1995; Perrin et al., 2007) we found that workers' reported prior training or disaster experience did not play a role in their risk for PTSD in the adjusted analyses. Others have reported that even well-trained professionals may experience clinically-significant symptoms after exposure to dead bodies (Ursano & Hermsen, 1996). Perrin et al. found that 9/11 responders who performed tasks atypical to their usual occupation demonstrated a greater risk for PTSD, with the strongest relationship among construction and sanitation workers (Perrin et al., 2007). Our finding may be explained in part by the fact that DSNY and FDNY workers, unlike NYPD workers, likely performed 9/11-related tasks that were atypical of their routine tasks. In particular, DSNY workers typically do not have the training or experience to deal with encountering human remains.

Our finding of a significant protective effect of social support in relation to persistent PTSD is consistent with other Registry studies

(Brackbill et al., 2009). Pietrzak's (2013) study of police responders to 9/11, and other research has shown that social support may aid in the handling of stressful events (Bassuk, 1991; Cohen & Wills, 1985; Galea et al., 2002; Pietrzak et al., 2013). Reissman and Howard noted that pre-disaster assessments of workers who may be involved in any aspect of disaster work may identify individuals who are at higher risk for mental health illness (Reissman & Howard, 2008). Over twenty years ago, McCarroll et al., recommended strategies for disaster preparedness and response that remain useful, including providing: pre-briefing and training on specific tasks; breaks; adequate time for sleep and rest; and regular time off (McCarroll, Ursano, Wright, & Fullerton, 1993). They further suggested that post-work transition periods and embedding mental health professionals to assist with the immediate needs of responders may also help. Importantly, screening responders for early identification of PTSD and referral to evidence-based treatment may help prevent long-term illness. Lastly, increasing levels of spouse and co-worker involvement and providing other sources of social support may also help reduce PTSD among responders following disasters (McCarroll, Ursano, Wright, & Fullerton, 1993).

Strengths and Limitations

Strengths of this study include its large sample size, and the ability to look at long-term health outcomes, as the cohort was followed longitudinally for over 10 years. Another strength of this quantitative study is that it was informed and guided by the results of the qualitative phase.

One limitation of this study is that it relied on self-reported exposure information collected over 8 years after the attacks, which may be subject to recall bias. The term "human remains" may be broadly interpreted, and the survey did not distinguish between human remains and personal effects of victims. Further research will be needed to investigate whether there is differential impact of encountering human remains versus personal effects. Despite these limitations, the Phase I interviews, focus groups and subsequent Phase II survey have led to better delineation and understanding of the tasks performed at SI, including prior disaster experience and training, location of work on or after 9/11, the frequency of the exposure to human remains and the aggregated responses to the SI Exposure Scale.

CONCLUSIONS

We found that Staten Island workers who were frequently exposed to human remains during clean-up work after 9/11 had an increased risk of developing persistent PTSD. Our findings highlight the ongoing need for strategies to prevent adverse mental health outcomes associated with exposure to human remains post-disaster. Potential interventions include pre-briefing and training workers to handle human remains before participating in disaster response; embedding mental health professionals to provide ongoing psychological support during such a response effort; and conducting prompt screening for PTSD and referral to evidence-based treatment after the response.

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