

The Longitudinal Course of PTSD Among Disaster Workers Deployed to the World Trade Center Following the Attacks of September 11th

Judith Cukor, Katarzyna Wyka, Brittany Mello, Megan Olden, Nimali Jayasinghe, and Jennifer Roberts
Weill Cornell Medical College

Cezar Giosan
Berkeley College

Michael Crane
Mt. Sinai School of Medicine

JoAnn Difede
Weill Cornell Medical College

This study examined the long-term mental health outcomes of 2,960 nonrescue disaster workers deployed to the World Trade Center site in New York City following the September 11, 2001 (9/11) terrorist attacks. Semistructured interviews and standardized self-report measures were used to assess the prevalence of posttraumatic stress disorder (PTSD) and other psychopathology 4 and 6 years after the attacks. Clinician-measured rates of PTSD and partial PTSD 4-years posttrauma were 8.4% and 8.9%, respectively, in a subsample of 727 individuals. Rates decreased to 5.8% and 7.7% for full and partial PTSD 6 years posttrauma. For the larger sample, self-report scores revealed probable PTSD and partial PTSD prevalence to be 4.8% and 3.6% at 4 years, and 2.4% and 1.8% at 6 years. Approximately 70% of workers never met criteria for PTSD. Although PTSD rates decreased significantly over time, many workers remained symptomatic, with others showing delayed-onset PTSD. The strongest predictors of ongoing PTSD 6 years following 9/11 were trauma history (odds ratio (OR) = 2.27, 95% confidence interval (CI) [1.06, 4.85]); the presence of major depressive disorder 1–2 years following the trauma (OR = 2.80, 95% CI [1.17, 6.71]); and extent of occupational exposure (OR = 1.31, 95% CI [1.13, 1.51]). The implications of the findings for both screening and treatment of disaster workers are discussed.

The September 11, 2001 (9/11) terrorist attacks on the World Trade Center (WTC) in New York City had a widespread impact on the psychological well-being of the public at large, especially those who worked and lived near Ground Zero. Personnel whose ordinary duties did not include search and rescue disaster relief work who were deployed to the WTC site in the days and weeks following 9/11 were exposed to distressing sights and disturbing

odors over the course of their duties; many felt in danger of injury or worse. The 10th anniversary of 9/11 affords us the opportunity to examine the long-term mental health consequences of these workers' occupational exposure as well as gain insight into the course of posttraumatic stress disorder (PTSD) and related disorders following a terrorist attack.

An extensive literature exists on the psychological consequences of disasters (Norris et al., 2002). Overall, studies have found high rates of PTSD, major depressive disorder (MDD), and substance abuse or dependence (Norris et al., 2002), with PTSD believed to be the most common mental health problem following disaster (Galea, Nandi, & Vlahov, 2005; Neria, Nandi, & Galea, 2008; Norris et al., 2002). The prevalence of PTSD after human-made or technological disasters, such as a shooting spree or industrial accident, is generally higher than after natural disasters (Norris et al., 2002). Furthermore, the extent of exposure is an important

Judith Cukor, Katarzyna Wyka, Brittany Mello, Megan Olden, Nimali Jayasinghe, Jennifer Roberts, JoAnn Difede, Department of Psychiatry, Weill Cornell Medical College; Cezar Giosan, School of Liberal Arts, Berkeley College; Michael Crane, Department of Preventive Medicine, Mt. Sinai School of Medicine.

Correspondence concerning this article should be addressed to Judith Cukor, Department of Psychiatry, Weill Cornell Medical College, 525 East 68th Street, Box 200, New York, NY 10065. E-mail: juc2010@med.cornell.edu.

© 2011 International Society for Traumatic Stress Studies. View this article online at wileyonlinelibrary.com DOI: 10.1002/jts.20672

correlate of disaster-related PTSD. A comprehensive review of human-made or technological disasters found that PTSD prevalence among those involved in rescue and recovery work ranged from 5 to 40% (Galea et al., 2005). This range was higher than the prevalence found in the general population (1–11%) and lower than the documented prevalence among direct survivors (25–75%; Galea et al., 2005).

The nature of disaster work means responders are particularly vulnerable to a variety of mental health issues, because they are repeatedly exposed to trauma as part of their work. Specifically, intensity and duration of exposure have been shown to play an important role in symptom development (Norris et al., 2002). Perceptions of safety may also play a role, since those 9/11 disaster workers who had greater exposure reported lower perceived safety, which was in turn associated with greater intrusion and hyperarousal PTSD symptoms as well as depressive symptoms (Fullerton, Ursano, Reeves, Shigemura, & Grieger, 2006). Additionally, disaster workers who perceived their lives were in danger were more likely to report PTSD symptoms (Cukor et al., 2011).

Studies investigating the mental health outcomes of disaster workers and volunteers who responded to 9/11 have found varying results (Bills et al., 2008). Perrin et al. (2007) conducted an analysis of almost 29,000 rescue and recovery workers from various professional and volunteer organizations who enrolled in the WTC Health Registry using the PTSD Checklist (PCL; Weathers, Litz, Herman, Huska, & Keane, 1993) and found an overall PTSD prevalence of 12.4% for workers 2 to 3 years after 9/11, ranging from 6.2% for police to 21.2% for volunteers unaffiliated with organizations working at the site. Construction or engineering workers, a group that includes utility workers, had a probable PTSD rate of 17.8% (Perrin et al., 2007). For all occupations except police, the probability of PTSD increased with the amount of time at Ground Zero, with a higher risk for those in occupations less prepared for disaster work or who engaged in tasks outside of their training (Perrin et al., 2007). Another study found 22% of 89 WTC disaster workers had acute stress disorder symptoms and 26% had depressive symptoms 2 weeks after the attack (Fullerton et al., 2006). Reporting on the current dataset, Cukor and colleagues (2011) found 8% of 2,960 utility workers deployed to the WTC had full PTSD, 9.3% had partial PTSD, 6% had MDD, 3.5% had generalized anxiety disorder (GAD), and 2.5% had panic disorder approximately 20 months (range = 10–34 months) following the attacks. In a survey comparing 1,131 exposed disaster workers with 224 unexposed workers approximately 2 years after 9/11, exposed workers had significantly higher prevalence rates of probable PTSD (13.5% vs. 5.7%), MDD (16.1% vs. 4.4%), panic disorder (7.2% vs. 1.5%), and alcohol use (6.8% vs. 3.9%; Gross et al., 2006). Among 3,015 Red Cross disaster workers, 10.7% utilized mental health services within the year following 9/11, and those with higher PTSD intrusion or hyperarousal symptoms were more likely to seek mental health treatment (Elhai et al., 2006). Notably, a number of the aforementioned studies reported rates of

PTSD 2 to 3 years after the trauma, an exception to the majority of research on mental health outcomes following disaster, which focuses on the immediate aftermath of the event and concludes within the first year postdisaster (Difede & Cukor, 2009; Norris et al., 2002). Nevertheless, studies of rates of PTSD beyond 3 years are scarce. Examining the course of PTSD over an extended period can provide essential information about the nature of PTSD, the optimal timing of treatment, and which treatments might work best at different time points postdisaster.

The effects of 9/11 on community samples has also been widely studied. One study found the prevalence of probable 9/11-related PTSD in Manhattan residents living south of 110th Street declined from 7.5% at 1 month, to 1.7% at 4 months, and 0.6% 6 months after 9/11 (Galea et al., 2003), but it is unknown whether new cases of PTSD emerged subsequent to the study period. Norris, Tracy, and Galea (2009) examined common PTSD trajectories over 3 years in 1,267 participants in randomly selected phone interviews of New York City metropolitan area residents following 9/11. Using four waves of assessments (6, 12, 18, and 30 months after 9/11), they found that 53.4% of New Yorkers displayed little or no symptoms (resistance), 19.4% showed a steep decline of symptoms soon after the trauma (resilience) or a gradual decline of symptoms (recovery), and 27.3% showed a low number of initial symptoms that worsened over time (delayed) or symptoms that remained high throughout (chronic). In a longitudinal cohort study of 455 predominantly Hispanic, low-income, primary care patients at a New York City hospital, 9.6% had probable PTSD approximately 1 year after 9/11, declining to 4.1% approximately five years post-9/11, using PCL-based estimates (Neria et al., 2010). Among probable PTSD cases at the 5-year assessment, however, 75% (15/20) displayed delayed-onset PTSD.

In addition to prevalence over time, psychosocial factors play an important role in predicting the onset and course of PTSD. A prospective study using a self-report measure in a community-based population sample of adults living in New York City on 9/11 assessed 1,681 participants 1 and 2 years following the WTC attacks and found about 3% had delayed-onset probable PTSD over the past year at the follow-up assessment (Adams & Boscarino, 2006). Those with delayed-onset PTSD were more likely to be Latino, to have experienced more negative life events and prior traumas, and to have a decline in self-esteem between time points (Boscarino & Adams, 2009).

Among those studies of disaster workers that include data past the 1-year mark, the findings of psychopathology are variable. A study investigating airport rescue and disaster personnel exposed to a deadly United Airlines airplane accident ($n = 207$) and a non-exposed comparison group ($n = 421$) reported significantly higher rates of PTSD (16.7% vs. 1.9%) 13 months after the crash, along with elevated rates of depression (Fullerton, Ursano, & Wang, 2004). In a study examining PTSD 27 years after an oil rig disaster, 6.1% of survivors had PTSD and were three times more

likely to have any psychiatric disorder than a nonexposed comparison group as measured on the Structured Clinical Interview (SCID) for *Diagnostic and Statistical Manual of Mental Disorders (4th ed.; DSM-IV; First, Spitzer, Williams, & Gibbon, 1997)*, suggesting that disaster exposure is an important predictor of chronic psychopathology (Boe, Holgersen, & Holen, 2011). Anxiety disorders, excluding PTSD, were more than four times more common among survivors than the comparison group.

The primary focus of this study is to examine the longitudinal course of PTSD and related disorders following the terrorist attacks of 9/11. Specifically, rates of PTSD, MDD, GAD, and panic disorder are studied over three waves of assessments with 9/11 nonrescue disaster workers spanning 2002 to 2008. Furthermore, we examined the ability of known risk factors to predict the course of longitudinal PTSD and other psychopathology.

METHOD

Subjects

This sample comprises 2,960 WTC disaster recovery utility workers who were assessed at their workplace through the Weill Cornell 9/11 Screening Program (see Cukor et al., 2011; Difede, Roberts, Jayasinghe, & Leck, 2006 for greater detail). During the course of their work assisting in clean-up and utility service restoration, these individuals were exposed to the excavation of human remains and the danger of working within and on top of unstable structures, in an environment at high risk for another attack. Workers were sent to the site by their employer based on their individual skills and abilities; they did not self-select to work at Ground Zero. The interviews were conducted at the employer's headquarters during annual fitness-for-duty evaluations required for all workers who were deployed to the WTC site. These workers were screened for psychological distress and offered free and confidential treatment as needed. The company received only overall statistics reflecting rates of psychiatric symptomatology, protecting the confidentiality of participants. The Weill Cornell Institutional Review Board approved use of this information for research purposes. Participants were assessed by psychologists at an initial evaluation that took place between July 2002 and April 2004 (T1), with 96% of interviews conducted in 2002 and 2003. Workers were then scheduled for approximately annual assessments until the end of the project in 2008.

To assess rates of PTSD and related psychopathology over time, data have been divided into two follow-up waves: 2004/2005 (T2) and 2007/2008 (T3). Eighty-nine percent of workers from the original sample were available for assessments at T2 ($n = 2,626$), with 86% ($n = 2,556$) having a clinical interview.

At T3, 67% ($n = 1,983$) of the original sample completed a self-report based assessment and 26% ($n = 770$) had clinical assessments. This lowered rate of clinical interviews resulted from a change of screening procedures that took place in 2005.

Until then, all workers were assessed using a comprehensive battery of widely used, well-validated clinical and self-report measures. Beginning in 2005, for reasons of cost-effectiveness, only those who were deemed at high risk (HR group) for PTSD and related psychopathology ($n = 1,129$) continued to be assessed by psychologists, and the remaining workers were screened using self-report measures, with in-person follow-up interviews as needed. The HR group included those with partial or full PTSD based on the Clinician Administered PTSD Scale (CAPS; Blake et al., 1990), past or current psychopathology, or who were present at the WTC during the attacks. In addition, a random sample ($n = 416$) of those not at high risk were also scheduled for clinical assessments to allow comparisons on clinician-administered measures.

The mean time from the WTC attacks at T1 was 19.2 months ($SD = 4.95$, range = 9–31), T2 was 40 months ($SD = 4.6$, range = 27–51), and T3 was 77.33 months ($SD = 5.58$, range = 63–87).

Measures

PTSD was assessed using the CAPS (Blake et al., 1990), a standardized clinical interview that assesses the frequency and intensity of each PTSD symptom over the past 30 days. Questions were asked with exposure to the WTC site as the referent. This project used the F1/I2 scoring method to diagnose PTSD, whereby having a minimum score of 1 on the frequency scale (i.e., the symptom is present to some extent) and a minimum score of 2 on the intensity scale (i.e., at least moderate intensity) qualified as a symptom toward a diagnosis of PTSD. Partial PTSD was defined as meeting criteria for Cluster B and either Cluster C or D on the PTSD measure. Interrater reliability at T1 ranged from .98 to .99 for the three-symptom cluster severity scores and total severity score.

The Posttraumatic Stress Checklist-Civilian Version (PCL-C) is a self-report measure used to assess PTSD. It contains the 17 items of the PTSD diagnostic criteria according to the *DSM-IV* (American Psychiatric Association, 1994) scored on a 5-point Likert-type scale. It has excellent psychometric properties and strong correlation with the CAPS (Mayou, Tyndel, & Bryant, 1997). Subjects were instructed to respond to the questions specifically regarding their WTC-related exposure. Though diagnosis of PTSD cannot be established using this self-report instrument, probable PTSD was determined by using a rating of *moderately* (at least 3 on the 5-point Likert scale) as qualifying as a symptom towards probable diagnosis, and counting a minimum of one positive Cluster B symptom, three positive Cluster C symptoms, and two positive Cluster D symptoms. Partial PTSD for the PCL was defined as meeting criteria for Cluster B and either Cluster C or Cluster D symptoms. Cronbach's α in the sample at T1 was .94.

Other psychopathology was assessed using the SCID modules for major depression, panic disorder, and generalized anxiety disorder. Participants were questioned about current and past symptomatology and were given a diagnosis based upon the *DSM-IV* criteria. Time constraints prevented the administration of the full

SCID, so these commonly co-occurring conditions with PTSD were chosen to be assessed. Substance use was not assessed because of the expectation that truthful reporting might be limited due to the potential consequences of substance use on work status, despite the fact that interviews were confidential (Difede, Roberts, et al., 2006). The SCID has been shown to be reliable and valid in the diagnosis of depression and anxiety (First et al., 1997).

Basic demographic information was gathered from all workers. Workers were asked whether they had received any WTC-related mental health treatment. In addition, workers completed the WTC Exposure Questionnaire, which was developed by a panel of trauma experts (Difede, Cukor, Jayasinghe, & Hoffman, 2006) to assess degree of exposure to the 9/11 attacks. Aspects of occupational exposure included duration of time at the site, and seeing human remains or witnessing people jumping from the towers. Personal exposure included presence of a loved one in the WTC vicinity, or injury or death of a family member or friend. Subjective exposure was defined as feeling that one's life was in danger. All items were scored dichotomously (1 = *endorsement*; 0 = *nonendorsement*) and a total score was calculated for occupational and personal exposure by summing all endorsed items. Prior trauma history was assessed with the Traumatic Events Interview (TEI). This clinician-administered instrument elicits information regarding several types of trauma ranging from natural disasters to childhood and adult physical and sexual abuse (Green, 1993). Trauma history was scored dichotomously (1 = *any trauma present*, 0 = *all trauma absent*).

Data Analysis

Two sets of descriptive statistics were used to describe prevalence of PTSD and related psychopathology at 2004/2005 (T2) and 2007/2008 (T3). First, the rates of presumed PTSD based on the PCL are presented for the entire sample. Then the subsample of 770 high-risk and control individuals are described separately with prevalence by CAPS scores.

Multinomial logistic regressions with odds ratios (*ORs*) were used to examine potential predictors of PTSD status based on CAPS 6 years after 9/11 (T3). Likewise, linear regression analysis was used to predict PCL severity scores at T3. Known PTSD predictors were evaluated, including trauma history, comorbid psychopathology, psychiatric history, and 9/11 events exposure. All analyses were adjusted for baseline PTSD status or severity and for missing data between T1 and T3. Lastly, WTC-treatment utilization in the sample was described using general descriptive statistics and adjusted *ORs*.

Adjustments were made in all analyses to account for variables that differentiated those who participated in follow-up assessments at T3 from those who had left the company or were otherwise unavailable. Specifically, those unavailable for assessments at T3 were older ($M = 47.62$, $SD = 9.77$ vs. $M = 41.64$, $SD = 8.88$, $t(737) = 16.00$, $p < .001$); more likely to be Caucasian (36.5%

vs. 24.9%, $\chi^2(1, N = 2,936) = 40.06$, $p < .001$); less educated (35.1% vs. 30.4% with high school diploma or less, $\chi^2(1, N = 2,725) = 6.94$, $p < .05$); and married (33.9% vs. 28.8%, $\chi^2(1, N = 2,860) = 6.21$, $p < .05$). The attrition from T1 to T3 was unrelated to either PTSD symptom severity or diagnostic status at T1 (based on CAPS or PCL).

RESULTS

PCL-Based Probable PTSD

Four years following 9/11 (T2), PCL-based estimate of probable PTSD for the full sample with complete data ($n = 2,626$) was 4.8% ($n = 125$) and 3.6% ($n = 94$) for partial PTSD, compared to 9.5% ($n = 280$) and 9.3% ($n = 278$) of the full sample ($n = 2,960$), respectively, at T1 (see Table 1). Twenty-eight individuals without probable PTSD at T1 reported symptoms consistent with PTSD at T2. Six years post-9/11 (T3), the PCL-based estimate of probable PTSD for the full sample with complete data ($n = 1,983$) was 2.4% ($n = 48$) and 1.8% ($n = 36$) for partial PTSD. Twenty individuals who did not report symptoms consistent with PTSD at baseline did so at T3.

Seventy-eight percent ($n = 1,510$) of individuals with complete PCL data at all three time points did not meet either probable partial or full PTSD criteria according to the PCL during the duration of the program, indicating that at least 51% of the original sample (1,510/2,960) was likely PTSD-free. The rate at T2 alone shows that 69.5% (2,058/2,960) were PTSD-free at T1 and T2, suggesting that the true proportion of PTSD-free participants is closer to 69.5% rather than 51%. This is reflected in the CAPS data at T1 at which point more than 80% of the full sample did not meet criteria for full or partial PTSD.

CAPS-Based PTSD for Subsample

At T2, 8.4% ($n = 61$) of the subsample ($n = 727$) met criteria for PTSD as measured by the CAPS, with an additional 8.9% ($n = 65$) reporting symptoms consistent with partial PTSD (see Table 2). At T3, CAPS-based PTSD rate for the subsample ($n = 727$) was 5.8% ($n = 42$), with the rate of partial PTSD at 7.7% ($n = 56$). Forty-five workers who were not diagnosed with PTSD at T1 reported symptoms consistent with PTSD at T2. Ninety-six percent (43/45) of delayed-onset PTSD cases at T2 were members of the designated high-risk group. There were also 18 new PTSD cases at T3. Nineteen individuals (17.6%) who had T1 PTSD diagnosis still met criteria for PTSD at T3 and 69.4% (75/108) experienced a full remission by T3.

Other Disorders

At T2, rates of other psychopathology were 3.2% ($n = 82$) for MDD, 1.8% ($n = 46$) for GAD, and 2.9% ($n = 73$) for panic

Table 1. Posttraumatic Stress Disorder Status and PCL Score at Three Points Across Time for the Sample ($N = 2,960$)

Period	Probable PTSD				Probable partial PTSD				No PTSD			
	<i>n</i>	%	<i>M</i>	<i>SD</i>	<i>n</i>	%	<i>M</i>	<i>SD</i>	<i>n</i>	%	<i>M</i>	<i>SD</i>
T1	280	9.5	51.94	9.80	278	9.3	37.45	5.93	2,402	81.1	21.89	5.45
T2	125 ^a	4.8	52.73	8.72	94 ^b	3.6	36.33	5.46	2,407 ^c	91.7	20.38	4.96
T3	48 ^d	2.4	51.85	10.48	36 ^e	1.8	36.64	5.86	1,899 ^f	95.8	19.41	4.23

Note. T1, $N = 2,960$; T2, $n = 2,626$; T3, $n = 1,983$. PTSD = posttraumatic stress disorder; PCL = Posttraumatic Stress Disorder Checklist; T1 = July 2002–April 2004; T2 = 2004/2005; T3 = 2007/2008.

^a $n = 72$ probable PTSD at T1 and T2, $n = 28$ new probable PTSD, $n = 25$ progressed from partial PTSD at T1.

^b $n = 31$ partial PTSD at T1 and T2, $n = 42$ new partial PTSD, $n = 21$ partial remission from probable PTSD at T1.

^c $n = 2,058$ no PTSD at T1 and T2, $n = 192$ remission from partial PTSD at T1, $n = 157$ remission from probable PTSD at T1.

^d $n = 17$ probable PTSD at T1, T2, and T3, $n = 20$ new probable PTSD.

^e $n = 6$ partial PTSD at T1, T2, and T3, $n = 9$ new partial PTSD.

^f $n = 1,510$ no PTSD at T1, T2, and T3.

disorder. New cases of MDD ($n = 49$), GAD ($n = 43$), and panic disorder ($n = 66$) were reported at T2 and were associated with T1 PTSD diagnosis, $OR = 4.18$, 95% CI [1.98, 8.77]; $OR = 6.41$, 95% CI [3.32, 12.35]; and $OR = 7.14$, 95% CI [4.20, 12.20], respectively, all $p < .001$. Meeting criteria for MDD at T2, but not at T1, was also associated with occupational exposure after controlling for PTSD diagnostic status at T1, $OR = 1.18$, 95% CI [1.06, 1.30], $p < .005$. New panic disorder was not associated with any exposure variables nor was new GAD.

Longitudinal Course of PTSD

Predictors of PTSD status (full PTSD diagnosis vs. partial PTSD vs. no PTSD) were determined for all individuals with complete CAPS data ($n = 727$) at the conclusion of the screening project (T3). After controlling for baseline CAPS PTSD diagnostic status and demographic variables, several variables emerged as significant predictors of T3 PTSD diagnostic status (see Table 3). Presence of major depressive disorder at T1 and greater occupational exposure differentiated individuals with full PTSD

diagnosis from those with partial PTSD, $OR = 5.87$, 95% CI [1.56, 22.17]; $OR = 1.30$, 95% CI [1.07, 1.57], respectively; and no PTSD status, $OR = 2.80$, 95% CI [1.17, 6.71]; $OR = 1.31$, 95% CI [1.13, 1.51], respectively. In addition, having a history of trauma was associated with a greater risk for partial PTSD as compared to the no PTSD group, $OR = 1.97$, 95% CI [1.08, 3.59]; and for the full PTSD as compared to the no PTSD group, $OR = 2.27$, 95% CI [1.06, 4.85]. Similarly, ordinary regression analysis implicated the same variables (i.e., MDD, occupational exposure, and trauma history) as well as T1 panic disorder as correlates of T3 PCL severity scores for the entire sample (see Table 4).

Treatment Utilization

Analysis of WTC-related treatment utilization among probable PTSD groups according to the PCL revealed that 48.7% of those with probable PTSD at T1 (116/238) reported receiving treatment between 2002 and 2008, whereas 26.4% (73/276) of those in the probable partial PTSD group and 4.7% (117/2,446) of those

Table 2. Posttraumatic Stress Disorder Diagnostic Status Based on CAPS Interview at Three Points Across Time

Period	PTSD		Partial PTSD		No PTSD	
	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%
T1	108	14.9	130	17.9	489	67.3
T2	61	8.4	65	8.9	601	82.7
T3	42	5.8	56	7.7	629	86.5
Δ T1 to T2	47	43.5	65	50.0	112	22.9
Δ T1 to T3	66	61.1	74	56.9	140	28.6

Note. Personnel with complete interview data at all points, $n = 727$. PTSD = posttraumatic stress disorder; CAPS = Clinician-Administered PTSD Scale; T1 = July 2002–April 2004; T2 = 2004/2005; T3 = 2007/2008; Δ = change from.

Table 3. Baseline Predictors of CAPS-Based PTSD Status at 6 Years

Variable	PTSD vs. No PTSD		PTSD vs. Partial PTSD		Partial PTSD vs. No PTSD	
	OR	95% CI	OR	95% CI	OR	95% CI
Trauma history	2.27*	[1.06, 4.85]	1.15	[0.46, 2.91]	1.97*	[1.08, 3.59]
MDD	2.80*	[1.17, 6.71]	5.87**	[1.56, 22.17]	0.48	[0.15, 1.49]
GAD	2.94	[0.96, 9.06]	3.40	[0.69, 13.45]	0.86	[0.24, 3.11]
Panic disorder	3.20	[0.92, 11.14]	2.50	[0.47, 13.45]	1.28	[0.32, 5.17]
Past diagnosis ^a	0.67	[0.30, 1.53]	0.77	[0.28, 2.17]	0.87	[0.43, 1.76]
Exposure						
Occupational	1.31***	[1.13, 1.51]	1.30**	[1.07, 1.57]	1.01	[0.87, 1.17]
Personal	0.82	[0.52, 1.30]	0.62	[0.36, 1.06]	1.33	[0.94, 1.88]
Subjective	1.57	[0.77, 3.19]	1.22	[0.51, 5.07]	1.29	[0.72, 2.30]

Note. $n = 673$. CAPS = Clinician-Administered PTSD Scale; PTSD = posttraumatic stress disorder; MDD = major depressive disorder; GAD = generalized anxiety disorder; OR = odds ratio; CI = confidence interval. Past psychiatric disorder includes only MDD, GAD, and panic. Multinomial logistic regression adjusted for baseline PTSD status and demographic variables.

* $p < .05$. ** $p < .01$. *** $p < .001$.

who did not meet partial or full PTSD criteria reported receiving treatment between 2002 and 2008. Among those with complete CAPS data, entering treatment was associated with higher T1 CAPS severity scores in the partial PTSD and no PTSD groups ($M = 33.60$, $SD = 9.73$ vs. $M = 28.98$, $SD = 9.49$, $p < .001$; and $M = 16.48$, $SD = 12.59$ vs. $M = 6.83$, $SD = 7.44$, $p < .001$, respectively), but not in the PTSD group ($M = 54.14$, $SD = 15.08$ vs. $M = 51.04$, $SD = 13.16$, $p = .092$). However, extent of exposure (occupational and personal) was associated with entering treatment in the PTSD group, even after adjusting for CAPS PTSD severity score, $OR = 1.12$, 95% CI [1.016, 1.234], and $OR = 1.432$, 95% CI [1.093, 1.876]. Interestingly, comorbid diagnosis of MDD, GAD, or panic disorder

were not associated with treatment utilization in either the PTSD or partial PTSD groups.

DISCUSSION

Here we present longitudinal data on the prevalence and predictors of PTSD 4 and 6 years following the 9/11 attacks in 2,960 nonrescue disaster workers originally assessed 1–2 years following the disaster, with clinician-administered interviews in a subsample of individuals. The general course of symptomatology highlighted substantial reductions in PTSD and probable PTSD prevalence between T1 and T2, and again between T2 and T3. Improvement in symptoms over time is the common course observed in

Table 4. Baseline Predictors of PTSD Symptom Score at T3

Variable	<i>B</i>	<i>SE</i>	95% CI
Trauma history	0.76*	0.31	[0.16, 1.36]
Major depressive disorder	3.44***	0.72	[2.04, 4.85]
Generalized anxiety disorder	0.13	0.80	[−1.44, 1.70]
Panic disorder	4.96***	1.02	[2.96, 6.96]
Past depressive, anxiety or panic disorder	−0.21	0.44	[−1.08, 0.65]
Exposure			
Occupational	0.35**	0.07	[0.21, 0.49]
Personal	0.08	0.20	[−0.31, 0.46]
Subjective	0.25	0.32	[−0.38, 0.87]

Note. $R^2 = .27$, $F(14, 1743) = 47.82$, $p < .001$. Dependent variable, Posttraumatic Stress Disorder Checklist, adjusted for baseline scores and demographic variables. T3 = 2007/2008; CI = confidence interval.

* $p < .05$. ** $p < .01$. *** $p = .001$.

longitudinal studies (Orcutt, Erickson, & Wolfe, 2004), and was reported in 79% of the 34 studies with longitudinal data reviewed by Norris and colleagues (2002). A notable finding, however, of this study was the striking numbers of new cases of PTSD at T2 and T3 as determined by the CAPS. Though Norris et al. notes that cases of delayed-onset PTSD are less common, reports of their occurrence exist (Koren, Arnon, & Klein, 1999; Mayou et al., 1997; Sungur & Kaya, 2001). Indeed this rate of delayed-onset PTSD is similar to those found in community samples 2–3 years following 9/11 (Adams & Boscarino, 2006; Neria et al., 2010; Norris et al., 2009), though longer-term studies in this population are rare.

Prior to T3, we identified a high-risk (HR) group who would receive the full clinician-administered assessment as a cost-effective measure to alleviate the time and expense of screening approximately 3,000 workers. This HR group included individuals with a psychiatric history, those who were present during the attacks, participants who met criteria for full or partial PTSD at T1, and those with other depressive or anxiety disorders at T1. Analyses in the subsample revealed that this HR group was at a much greater risk for the development of delayed-onset PTSD. This has important ramifications for large-scale screening programs. Though prevalence of PTSD and related psychopathology reduces over time, the presence of new-onset cases provides a compelling reason for continued screening and treatment programs. These data indicate that priority be placed on the assessment of individuals who would fall into the HR group, as they comprise a disproportionate number of those with newly emerging symptomatology. Our findings also shed light on the course of PTSD postdisaster. Analyses of the CAPS in the subsample revealed that rates of PTSD 1–2 years after the 9/11 attack decreased by more than 50% by 6 years following the trauma, and presumed rates of PTSD in the larger sample at 6 years were almost a quarter of rates 1–2 years after the trauma according to the PCL. These rates of remission attest to great resilience. However, the fact that approximately 13.5% of the subsample continued to have symptoms of partial or full PTSD 8 years after the WTC attacks calls attention to the seriousness of this disorder that affects functioning, and pervasively affects the individual's life, for this long period. Almost half of the probable full PTSD group and one-quarter of the probable partial PTSD group reported engaging in treatment between 2002 and 2008. It is unclear if treatment utilization would have been lower if the screening program had not provided psychoeducation and access to treatment services. The utility of screening programs extends to their ability to provide education about symptoms and offer treatment resources to individuals who may not seek them out on their own. Such a program targeting those who would fall into the high-risk category would capture the group with the largest risk.

For both CAPS-based diagnostic analyses, and PCL-based severity analyses, trauma history, major depression at T1, and occupational exposure all emerged as predictors of PTSD status or

symptom severity at T3. Panic disorder at T1 also emerged as a predictor in PCL analyses. These data provide further support for the roles of trauma history and exposure variables as the primary predictors of PTSD development, as well as comorbid diagnoses for increasing severity of symptoms. The fact that extent of exposure emerges as a significant predictor for the maintenance of PTSD compels us to consider how it may be manipulated to protect those exposed to trauma. Often, exposure is an immutable variable, consisting of an individual being in a certain place at a certain time when disaster strikes. In the case of disaster workers, however, who are sent to the scene in the aftermath of an incident, the extent of the exposure may be more easily regulated. Shorter shifts spread among more individuals may be essential to controlling rates of chronic PTSD. This is certainly a complicated issue, and workers' personal desires may or may not change the outcome. For example, it would be important to explore whether shorter shifts would be beneficial for both individuals untrained for disaster work who follow company orders, as well as for those disaster workers who feel strongly about staying until the job is done.

It is informative to examine the significant percentage of the sample that remained PTSD-free for all time points. Notably, these individuals worked in an environment that not only carried the echoes of recent trauma, but in a city that was poised for another attack, with the atmosphere that accompanies anticipated disaster. The high percentage of workers in this PTSD-free group serves as a reminder of the general resilience of individuals who were called upon to work at a disaster site that do not develop PTSD, and that indeed, PTSD is a disorder that occurs primarily in a subset of individuals who have psychiatric vulnerability combined with more intense exposure.

Some limitations may affect the interpretation of these results. Rates of attrition were small for T2, but larger for T3, and significantly related to race and age. This reflects the individuals for whom appointments were not scheduled, likely due to their leaving the company or their retirement, at which point they were no longer scheduled for company-based assessments. The introduction of a new, cost-effective approach propelled us to limit clinician-administered interviews at T3, which altered the data available for reporting; thus all analyses were performed on the subsample, and the conclusions drawn from PCL data are labeled probable in terms of their diagnostic ability. In addition, the role of treatment in the population is unclear, affecting our ability to form clear conclusions about the course of PTSD. Although we asked participants a yes-or-no question regarding current WTC-related treatment, we did not assess length, quality, or type of treatment. Therefore, we could not ascertain rates of PTSD in treated versus untreated groups. Longitudinal studies devoted to comparisons between treated and untreated samples would be worthy additions to our knowledge base. Finally, although we assessed trauma-specific and established predictors of PTSD, it was not feasible to include every variable, known or unknown, which might affect rates of

symptomatology, including substance use, social support, or locus of control.

CONCLUSION

These results underscore the importance of mandatory screening programs for groups exposed to high levels of trauma and disaster, as concluded by other studies of disaster workers (McFarlane, Williamson, & Barton, 2009). Individuals with a trauma history, comorbid major depression, and greater occupational exposure are at risk for chronic PTSD that was still evident 6 years after the event. Mandatory screening programs could serve to identify those at risk for chronic PTSD, and offer education and resources for treatment. The psychological benefits of decreased suffering to the individual and their families would be accompanied by economic benefits to the community in decreasing the financial impact of PTSD. Anxiety disorders have significant economic impact through decreased productivity and sickness absences, increased disability, medical treatment costs, and costs associated with comorbidity (Kessler & Greenberg, 2002). It has become accepted practice to screen for medical complications associated with certain work environments, such as respiratory diseases. The mandatory screening of PTSD remains neglected, however, perhaps due to the unnecessary stigma surrounding mental health. Evidence of long-term psychological sequelae of working at a disaster site, with its impact upon the individual and the community, should spur the correction of this imbalance.

REFERENCES

- Adams, R. E., & Boscarino, J. A. (2006). Predictors of PTSD and delayed PTSD after disaster: The impact of exposure and psychosocial resources. *Journal of Nervous and Mental Disease, 194*, 485–493. doi:10.1097/01.nmd.0000228503.95503.e9
- American Psychiatric Association. (1994). *Diagnostic and statistical manual of mental disorders* (4th ed.). Washington, DC: Author.
- Bills, C. B., Levy, N. A. S., Sharma, V., Charney, D. S., Herbert, R., Moline, J., & Katz, C. L. (2008). Mental health of workers and volunteers responding to events of 9/11: Review of the literature. *Mount Sinai Journal of Medicine, 75*, 115–127. doi:10.1002/msj.20026
- Blake, D. D., Weathers, F., Nagy, L. M., Kaloupek, D. G., Klauminzer, G., Charney, D. S., & Keane, T. M. (1990). A clinician rating scale for assessing current and lifetime PTSD: the CAPS-1. *Behavioral Therapist, 13*, 187–188.
- Boe, H. J., Holgersen, K. H., & Holen, A. (2011). Mental health outcomes and predictors of chronic disorders after the north sea oil rig disaster. *Journal of Nervous and Mental Disease, 199*, 49–54. doi:10.1097/NMD.0b013e31820446a8
- Boscarino, J. A., & Adams, R. E. (2009). PTSD onset and course following the World Trade Center disaster: Findings and implications for future research. *Social Psychiatry and Psychiatric Epidemiology, 44*, 887–898. doi:10.1007/s00127-009-0011-y
- Cukor, J., Wyka, K., Jayasinghe, N., Weathers, F., Giosan, C., Leck, P., . . . Difede, J. (2011). Prevalence and predictors of posttraumatic stress symptoms in utility workers deployed to the World Trade Center following the attacks of September 11, 2001. *Depression & Anxiety, 28*, 210–217. doi:10.1002/da.20776
- Difede, J., & Cukor, J. (2009). Evidence-based long-term treatment of mental health consequences of disasters among adults. In Y. Neria, S. Galea, & F. H. Norris (Eds.), *Mental health and disasters* (pp. 336–349). New York: Cambridge University Press.
- Difede, J., Cukor, J., Jayasinghe, N., & Hoffman, H. (2006). Developing a virtual reality treatment protocol for posttraumatic stress disorder following the World Trade Center attack. In M. J. Ray (Ed.), *Novel approaches to the diagnosis and treatment of PTSD* (pp. 219–234). Fairfax, VA: IDS Press.
- Difede, J., Roberts, J., Jayasinghe, N., & Leck, P. (2006). Evaluation and treatment of emergency services personnel following the World Trade Center attack. In Y. Neria, R. Gross, R. Marshall, & E. Susser (Eds.), *September 11, 2001: Treatment, research and public mental health in the wake of a terrorist attack* (pp. 333–354). New York, NY: Cambridge University Press.
- Elhai, J. D., Jacobs, G. A., Kashdan, T. B., DeJong, G. L., Meyer, D. L., & Frueh, B. C. (2006). Mental health service use among American Red Cross disaster workers responding to the September 11, 2001 U. S. terrorist attacks. *Psychiatry Research, 143*, 29–34. doi:10.1016/j.psychres.2005.10.004
- First, M. B., Spitzer, R. L., Williams, J. B. W., & Gibbon, M. (1997). *Structured Clinical Interview for DSM-IV SCID*. Washington, DC: American Psychiatric Association.
- Fullerton, C. S., Ursano, R. J., Reeves, J., Shigemura, J., & Grieger, T. (2006). Perceived safety in disaster workers following 9/11. *The Journal of Nervous and Mental Disease, 194*, 61–63. doi:10.1097/01.nmd.0000195307.28743.b2
- Fullerton, C. S., Ursano, R. J., & Wang, L. (2004). Acute stress disorder, posttraumatic stress disorder, and depression in disaster or rescue workers. *American Journal of Psychiatry, 161*, 1370–1376. doi:10.1176/appi.ajp.161.8.1370
- Galea, S., Nandi, A., & Vlahov, D. (2005). The epidemiology of post-traumatic stress disorder after disasters. *Epidemiologic Reviews, 27*, 78–91. doi:10.1093/epirev/mxi003
- Galea, S., Vlahov, D., Resnick, H., Ahern, J., Susser, E., Gold, J., . . . Kilpatrick, D. (2003). Trends of probable post-traumatic stress disorder in New York City after the September 11th terrorist attacks. *American Journal of Epidemiology, 158*, 514–524. doi:10.1093/aje/kwg187
- Green, B. L. (1993). Trauma History Questionnaire. In B. H. Stamm & E. M. Varra (Eds.), *Instrumentation in stress, trauma, and adaptation* (pp. 366–369). Northbrook, IL: Research and Methodology Interest Group of the International Society for Traumatic Stress Studies.
- Gross, R., Neria, Y., Tao, X. G., Massa, J., Ashwell, L., Davis, K., . . . Geyh, A. (2006). Posttraumatic stress disorder and other psychological sequelae among World Trade Center clean up and recovery workers. *Annals of the New York Academy of Sciences, 1071*, 495–499. doi:10.1196/annals.1364.051
- Kessler, R. C., & Greenberg, P. E. (2002). The economic burden of anxiety and stress disorders. In K. L. Davis, D. Charney, J. T. Coyle, & C. Nemeroff (Eds.), *Neuropsychopharmacology: The fifth generation of progress: An official publication of the American College of Neuropsychopharmacology* (pp. 981–992). Philadelphia, PA: Lippincott Williams & Wilkins.
- Koren, D., Arnon, I., & Klein, E. (1999). Acute stress response and posttraumatic stress disorder in traffic accident victims: A one-year prospective, follow-up study. *American Journal of Psychiatry, 156*, 367–373.
- Mayou, R., Tyndel, S., & Bryant, B. (1997). Long-term outcome of motor vehicle accident injury. *Psychosomatic Medicine, 59*, 578–584.
- McFarlane, A. C., Williamson, P., & Barton, C. A. (2009). The impact of traumatic stressors in civilian occupational settings. *Journal of Public Health Policy, 30*, 311–327. doi:10.1057/jphp.2009.21
- Neria, Y., Nandi, A., & Galea, S. (2008). Post-traumatic stress disorder following disasters: A systematic review. *Psychological Medicine, 38*, 467–480. doi:10.1017/S0033291707001353
- Neria, Y., Olfson, M., Gameroff, M. J., DiGrande, L., Wickramaratne, P., Gross, R., . . . Weissman, M. M. (2010). Long-term course of probable PTSD after

- the 9/11 attacks: A study in urban primary care. *Journal of Traumatic Stress*, *23*, 474–482. doi:10.1002/jts.20544
- Norris, F. H., Friedman, M. J., Watson, P. J., Byrne, C. M., Diaz, E., & Kaniasty, K. (2002). 60,000 disaster victims speak: Part I. An empirical review of the empirical literature, 1981–2001. *Psychiatry*, *65*, 207–239. doi:10.1521/psyc.65.3.207.20173
- Norris, F. H., Tracy, M., & Galea, S. (2009). Looking for resilience: Understanding the longitudinal trajectories of responses to stress. *Social Science & Medicine*, *68*, 2190–2198. doi:10.1016/j.socscimed.2009.03.043
- Orcutt, H. K., Erickson, D. J., & Wolfe, J. (2004). The course of PTSD symptoms among Gulf War veterans: A growth mixture modeling approach. *Journal of Traumatic Stress*, *17*, 195–202. doi:10.1023/B:JOTS.0000029262.42865.c2
- Perrin, M. A., DiGrande, L., Wheeler, K., Thorpe, L., Farfel, M., & Brackbill, R. (2007). Differences in PTSD prevalence and associated risk factors among World Trade Center disaster rescue and recovery workers. *American Journal of Psychiatry*, *164*, 1385–1394. doi:10.1176/appi.ajp.2007.06101645
- Sungur, M., & Kaya, B. (2001). The onset and longitudinal course of a man-made post-traumatic morbidity: Survivors of the Sivas disaster. *International Journal of Psychiatry in Clinical Practice*, *5*, 195–202. doi:10.1080/136515001317021662
- Weathers, F. W., Litz, B. T., Herman, D. S., Huska, J. A., & Keane, T. M. (1993, October). *The PTSD Checklist (PCL). Reliability, validity, and diagnostic utility*. Paper presented at the annual meeting of the International Society for Traumatic Stress Studies, San Antonio, TX.