

# Trends of Elevated PTSD Risk in Firefighters Exposed to the World Trade Center Disaster: 2001–2005

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## SYNOPSIS

**Objectives.** We identified trends in the prevalence of elevated posttraumatic stress disorder (PTSD) risk as determined by the Fire Department of the City of New York (FDNY)-modified PTSD Checklist in World Trade Center (WTC)-exposed firefighters. We also examined trends in relation to WTC exposure, social support, change in recreational activities, and functional health.

**Methods.** We analyzed 16,826 questionnaires from 10,074 firefighters in yearly intervals, from September 12, 2001, to September 11, 2005.

**Results.** The prevalence of elevated PTSD risk increased over time, from 9.8% in year 1 to 10.6% in year 4 ( $p < 0.0001$ ). Earliest arrival at the WTC site (odds ratio [OR] = 6.0; 95% confidence interval [CI] 4.4, 8.3), prolonged work at the site (OR=2.0; 95% CI 1.8, 2.3), providing supervision without previous supervisory experience (OR=4.1; 95% CI 2.8, 6.1), and retirement due to a WTC-related disability (OR=1.3; 95% CI 1.1, 1.5) were associated with ever having elevated PTSD risk. Difficulty functioning at home was strongly associated with elevated PTSD risk (ORs ranged from 17.0 [95% CI 14.5, 20.0] in year 1 to 26.7 [95% CI 20.3, 35.2] in year 3), as was difficulty functioning at work (ORs ranged from 12.1 [95% CI 10.2, 14.2] in year 1 to 23.0 [95% CI 14.6, 36.3] in year 2).

**Conclusions.** Elevated PTSD risk was associated with exposure to the WTC site as well as functional impairment, and remained largely unabated during the first four years of the study. Screening for elevated PTSD risk may be useful in identifying those who could benefit from interventions during long-term follow-up, as well as in the immediate aftermath of disasters.

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The attack on the World Trade Center (WTC) on September 11, 2001 (9/11) is considered the largest terrorist attack on U.S. soil to date. The attack killed 2,974 residents and workers in Lower Manhattan, including 343 rescue workers (341 firefighters and two paramedics) from the Fire Department of the City of New York (FDNY). The collapse of the WTC towers required substantial rescue, recovery, and cleanup efforts during the 10 months following the disaster.<sup>1-4</sup> FDNY employees were responsible for a large part of the salvage process, working at the site until its close on July 25, 2002, and were continually subjected to dangerous and chaotic working conditions, fear for personal safety, and contact with victims' body parts or personal effects.

The mental health of WTC first responders, including firefighters, police officers, and paramedics, has subsequently become of great interest. Research has shown that disasters caused by human intent, such as terrorist attacks, create more negative psychological consequences in survivors than do natural disasters.<sup>5</sup> One such negative mental health effect is the onset of posttraumatic stress disorder (PTSD), which has been documented to be one of the most prevalent and debilitating effects of terrorism-related incidents.<sup>6</sup>

PTSD is a mental health condition that may develop in people who are exposed to any kind of disturbing event, such as natural disasters and environmental destruction, violence, acts of war, and, in recent years, terrorist attacks. PTSD has been reported in populations of all ages and demographics, including U.S. war veterans,<sup>7,8</sup> war refugees and asylum seekers,<sup>9,10</sup> sexual assault survivors,<sup>11</sup> and survivors of natural and man-made disasters.<sup>12-14</sup> PTSD has been associated with poorer mental and physical health,<sup>15</sup> violent behavior,<sup>16</sup> adjustment issues,<sup>17</sup> and poor performance at work and in school.<sup>18</sup> It has also been found to dramatically alter an individual's lifestyle, causing difficulty functioning at home and at work,<sup>8,19</sup> depression and anxiety,<sup>20</sup> and changes in social and leisure habits, including reductions in physical activity.<sup>21</sup>

Conversely, factors such as coping resources and perceived social support from family and friends have been shown to be protective against PTSD onset.<sup>22,23</sup> A study of veterans of war operations in Iraq has found that unit support, personal resilience, and post-deployment social support were associated with decreased PTSD and depressive symptoms.<sup>24</sup>

The only other terrorist attack in the U.S. after which PTSD has been extensively studied is the Oklahoma City, Oklahoma, bombing in 1995, where PTSD was diagnosed in 34% of survivors and 13% of firefighters.<sup>25,26</sup> After 9/11, many studies have attempted to

estimate the prevalence of PTSD in victims and rescue workers. One study found that PTSD was reported in 37% of survivors and evacuees,<sup>27</sup> a prevalence similar to that which was found in Oklahoma City. In addition, depending on the different screening instruments and scoring thresholds used, as well as different sampling methods, PTSD was also found in 12% to 17% of firefighters in the WTC Registry (which includes FDNY and non-FDNY members),<sup>28</sup> in 12% to 13% of firefighters in the FDNY WTC Medical Monitoring and Treatment Program,<sup>29</sup> and in 11% to 20% of non-FDNY rescue and recovery workers in the Mt. Sinai Coordinated WTC Medical Monitoring and Treatment Program.<sup>30</sup> However, these studies focused on the overall prevalence of mental health outcomes, and did not examine changes in the prevalence or correlates of PTSD by year.

Individuals at high risk for PTSD should be identified so that mental health and other services can be offered as soon as possible. Changes in PTSD correlates over time have important implications in determining the type and amount of resources to be allotted to those at highest risk, both immediately after the disaster and years later. Interventions that might reduce disease burden and severity can also be tailored to address factors that may be particularly important at a specific time period or in a specific subgroup after the disaster has occurred.

This study tracked the prevalence of elevated PTSD risk in FDNY firefighters who were present during the first two weeks of the WTC attack in the first four years following the disaster. This work also examined variables associated with elevated PTSD risk in each of the four years to determine if time since the event influenced PTSD risk factors. Variables of interest were those previously shown to play a role in contributing to PTSD, such as WTC time of arrival and work-related stressors.<sup>31</sup> Other variables, including functional impairment, changes in exercise habits and alcohol use, and psychosocial support, were also included to investigate their association with elevated PTSD risk in this large group.

## METHODS

After 9/11, a formal Medical Monitoring Program (FDNY-WTC-MMP) was implemented to screen and monitor FDNY rescue workers who were exposed to the WTC disaster. These health evaluations, which are ongoing and scheduled every 12 to 18 months, include a physical examination by a physician and completion of self-administered health questionnaires. These questionnaires obtain information on exposure to the WTC site, physical health symptoms, mental

health symptoms, and other variables using touch-screen computers. Trained personnel are available to answer questions.

### Participants

As of 9/11, the FDNYWTC rescue workforce consisted of 13,441 firefighters and emergency medical services (EMS) personnel who were hired before the close of the WTC site on July 25, 2002. The following people were excluded from the current study: 2,417 EMS workers and 206 fire marshals, due to differences in job duties performed at the site; 724 firefighters who arrived at the disaster site more than 14 days after the rescue and recovery effort began, because of demographic differences between them and those who arrived sooner; and 20 female firefighters, due to small numbers. After these exclusions, the final analytic sample consisted of 10,074 male firefighters who completed 16,826 questionnaires during one or more monitoring exams in the four years studied, from September 12, 2001, to September 11, 2005. We analyzed 8,679 questionnaires in year 1; 1,161 in year 2; 2,820 in year 3; and 4,166 in year 4. No participant filled out more than one questionnaire per year. Unless otherwise noted, firefighters include chiefs, line officers (lieutenants and captains), and firefighters. Participation in the study described in this article required written consent and was approved by the Institutional Review Board at Montefiore Medical Center.

### Data sources

Demographic data, work tenure information, and the number of coworker deaths on 9/11 from the members' assigned firehouses were obtained from the FDNY employee database. All other variables were collected from participants' responses on the FDNY-WTC-MMP self-administered questionnaires. Mental health questions used to determine elevated PTSD risk were adapted from the PTSD Checklist (PCL)-Civilian Version; their use in this population has been previously described.<sup>29</sup> Briefly, in the FDNY questionnaire, questions from the PCL-Civilian Version were modified to fit the context of 9/11. For example, questions would begin, "Since the disaster, have you experienced any of the following. . . ." In addition, answers were administered in a binary (yes/no) format for simplicity and speed. Other variables of interest included psychosocial support and counseling (both professional and nonprofessional, FDNY and non-FDNY), change in alcohol use, change in exercise habits, work-related stressors, and functional health.

### Elevated PTSD risk

PTSD diagnosis can only be determined by interview with a trained clinician. Because our outcome was based on a screening tool, we refer to the outcome as "elevated PTSD risk." *Elevated risk* is a term used in previous studies to distinguish those who may be at an increased risk of developing a mental health condition (e.g., major depressive disorder or PTSD), but do not have a confirmatory diagnostic interview.<sup>32</sup> Using the information collected from the mental health section of the self-administered questionnaire described previously, we required that two different conditions be satisfied to score positive for elevated PTSD risk. The first condition was based on the Diagnostic and Statistical Manual of Mental Disorders version IV (DSM-IV-TR<sup>®</sup>) diagnostic criteria for PTSD and required respondents to have at least two affirmative responses to questions in the arousal domain, at least one affirmative response to questions in the re-experiencing domain, and at least three affirmative responses to questions in the avoidance/numbing domain.<sup>33</sup> The second condition was based on a non-weighted summation of at least nine affirmative responses out of a possible 14 questions.<sup>29</sup> In our prior work, a score  $\geq 9$  was determined to be an appropriate threshold for elevated PTSD risk. Elevated PTSD risk was assessed during each year and overall as a never/ever variable.

Two questions that dealt with functional impairment at work or at home were excluded from the scoring algorithm, as they are omitted from the PCL-Civilian Version, but were used in separate bivariate analyses.

### WTC exposure

Exposure to the WTC site was determined using the previously described FDNY-WTC-MMP Exposure Intensity Index.<sup>34</sup> This index categorized exposure to the WTC site based on arrival time. Those who first arrived during the morning of 9/11 (day 1) and were present during the tower collapses were categorized as the most severely exposed, or Arrival Group 1; those arriving during the afternoon of 9/11 were categorized as Arrival Group 2; those arriving on day 2 were categorized as Arrival Group 3; and those who arrived at any time between days 3 and 14 were categorized as Arrival Group 4. A duration variable was created by summing the number of months that an individual reported working at the site, whether or not they were on duty.

### Time periods

The data from the 16,826 questionnaires used in this study were collected from 10,074 participants described

previously and analyzed in one-year time intervals based on the date of administration. Time periods were year 1 (from September 12, 2001, to September 11, 2002), year 2 (from September 12, 2002, to September 11, 2003), year 3 (from September 12, 2003, to September 11, 2004), and year 4 (from September 12, 2004, to September 11, 2005).

### Data analysis

We analyzed potential risk factors in relation to elevated PTSD risk, as previously defined. We used simple logistic regression models with odds ratios (ORs) and 95% confidence intervals (CIs) to assess unadjusted associations between categorical variables, such as arrival group and functional impairment, and elevated PTSD risk. We used marginal logistic regression models fit with generalized estimating equations to assess differences in annual prevalence by arrival group and retirement status. Multivariable logistic regression models for each year predicting elevated PTSD risk were constructed using variables that were statistically significant in bivariate analyses or were shown to be important in other studies. Variables retained in the final models were significant at  $p < 0.05$  or were shown to impact other variables in the model. Arrival group, age on 9/11, and duration of months spent working at the WTC site were retained in all models. We used the Hosmer-Lemeshow goodness-of-fit test to check for fitness of all final models. All statistical analyses were performed using SAS® version 9.1.<sup>35</sup>

## RESULTS

The analytic sample included 10,074 male participants who completed 16,826 questionnaires between September 12, 2001, and September 11, 2005. Participants were predominantly white (93.8%), and on 9/11 had a mean age of 39.6 years (standard deviation  $\pm 7.5$ ). The number of participants in each year of the cross-sectional analyses was 8,679 in year 1; 1,161 in year 2; 2,820 in year 3; and 4,166 in year 4. Of those taking questionnaires in year 1, 934 returned for a follow-up questionnaire in year 2, 2,319 returned in year 3, and 3,498 returned in year 4. In the overall sample, 16.0% ( $n=1,607$ ) first arrived at WTC during the morning of 9/11 (Arrival Group 1), 64.5% ( $n=6,497$ ) first arrived during the afternoon of 9/11 (Arrival Group 2), 11.7% ( $n=1,181$ ) first arrived on 9/12 (Arrival Group 3), and 7.8% ( $n=789$ ) first arrived between three and 14 days after 9/11 (Arrival Group 4). The median number of months of work at the WTC site was 4.4, and 32.4% of participants worked at the site for four months or

longer. Of the 2,281 participants (22.6%) who retired by the end of the study, 1,402 (61.5%) retired with a disability, of which 58 were due to a psychological disability. Table 1 shows these and other unadjusted demographic characteristics in relation to ever having elevated PTSD risk.

### Prevalence of PTSD

In the first year after 9/11 (from September 12, 2001, to September 11, 2002), 9.8% ( $n=851/8,679$ ) of firefighters reported symptoms sufficient to meet our definition of elevated PTSD risk, reporting the threshold number of symptoms in each domain and a summary score of at least 9. Subsequently, the following percentages of firefighters met the criteria for elevated PTSD risk: 9.9%, 11.7%, and 10.6% for years 2, 3, and 4, respectively.

Elevated PTSD risk at any time during the study was associated with earlier arrival time (Arrival Group 1 vs. all others; OR=2.7; 95% CI 2.3, 3.0) (Figure 1) and with spending  $\geq 4$  months working at the WTC site (OR=2.0; 95% CI 1.8, 2.3;  $p < 0.0001$ ). Elevated PTSD risk was also associated with disability retirement at any time during the study (disability retirement vs. regular retirement or active status; OR=1.4; 95% CI 1.2, 1.6).

### Domains

In all years, symptoms in the DSM-IV-TR arousal domain remained the most common, reported by 45.9% to 53.3% of participants, depending on the follow-up year, followed by symptoms in the re-experiencing domain, reported by 32.6% to 39.3% of participants, depending on the follow-up year. Avoidance/numbing domain was the least reported symptom group, reported by only 16.8% to 20.3% of participants, depending on the follow-up year (Figure 2).

### Functional health

In year 1, 15.5% of the cohort reported having increased difficulty functioning at home, and 9.1% reported increased difficulty functioning at work. These percentages remained fairly stable over time, with difficulty functioning at home consistently more common than difficulty functioning at work: 17.2% vs. 10.4% at year 2, 15.4% vs. 9.3% at year 3, and 14.0% vs. 8.6% at year 4 ( $p < 0.0001$ , all years).

Difficulty functioning at home and separately, and difficulty functioning at work were associated with elevated PTSD risk during each time period. The same pattern also held true for each domain: arousal, re-experiencing, and avoidance/numbing (Table 2).

**Work-related stressors**

Work-related stressors were associated with ever having elevated PTSD risk. A total of 1,663 (16.5%) firefighters worked at a firehouse that experienced one or more 9/11-related deaths (range: 1–11; median = 3). For each additional death in a member's firehouse, there was a corresponding 10.0% increase in the odds

of ever having elevated PTSD risk (OR=1.1; 95% CI 1.1, 1.2).

Supervisory responsibility was found to be an important stressor. Of those reporting supervisory responsibilities during the collapse ( $n=562$ ), 80.2% were officers or line officers ( $n=101$  and  $n=350$ , respectively), and 19.8% ( $n=111$ ) were firefighters.

**Table 1. Characteristics of the firefighter population from the Fire Department of the City of New York ( $n=10,074$ ) by ever having elevated PTSD risk, 2001–2005**

Variable	Total ( $n=10,074$ )	Percent	Ever elevated PTSD risk ( $n=1,454$ )	Percent	Never elevated PTSD risk ( $n=8,620$ )	Percent	Unadjusted odds ratio	95% CI
Arrival group								
Morning of 9/11	1,607	16	430	30	1,177	14	6.04	4.38, 8.32
Afternoon of 9/11	6,497	64	869	60	5,628	65	2.55	1.87, 3.48
Day 2	1,181	12	110	8	1,071	12	1.70	1.19, 2.43
Days 3–14	789	8	45	3	744	9	Ref.	Ref.
Prolonged work at the WTC site (>4 months) <sup>a</sup>								
≥4 months	3,269	32	665	46	2,604	30	2.02	1.78, 2.29
<4 months	4,722	47	530	36	4,192	49	Ref.	Ref.
Education <sup>b</sup>								
High school	2,616	26	334	23	2,282	26	Ref.	Ref.
College	4,713	47	707	49	4,006	46	1.17	1.03, 1.34
Some college	2,030	20	291	20	1,739	20	1.11	0.94, 1.31
Post-college	328	3	63	4	265	3	1.58	1.18, 2.12
Age (in years) on 9/11								
20–29	1,021	10	139	10	882	10	Ref.	Ref.
30–39	4,335	43	664	46	3,671	43	1.15	0.94, 1.40
40–49	3,882	39	564	39	3,318	38	1.08	0.88, 1.32
50–59	799	8	83	6	716	8	0.74	0.55, 0.98
≥60	37	0	4	0	33	0	0.77	0.27, 2.20
Retirement status								
Disability	1,402	14	253	17	1,149	13	1.32	1.14, 1.54
Regular	879	9	88	6	791	9	0.67	0.53, 0.84
Active	7,793	77	1,113	77	6,680	77	Ref.	Ref.
Number of deaths in firehouse								
0	8,411	83	1,093	75	7,318	85	Ref.	Ref.
1–3	968	10	190	13	778	9	1.63	1.38, 1.94
4–6	408	4	103	7	305	4	2.26	1.79, 2.85
7–9	218	2	49	3	169	2	1.94	1.40, 2.69
10–11	69	1	19	1	50	1	2.54	1.50, 4.33
Firefighters with supervising responsibilities during the collapse								
Yes	111	1	45	3	66	1	4.14	2.82, 6.07
No	9,963	99	1,409	97	8,554	99	Ref.	Ref.
Previous disaster experience								
Yes	2,590	26	470	32	2,120	25	1.46	1.30, 1.65
No	7,484	74	984	68	6,500	75	Ref.	Ref.

<sup>a</sup>Duration information was missing on 2,083 individuals.

<sup>b</sup>Education information was missing on 387 individuals.

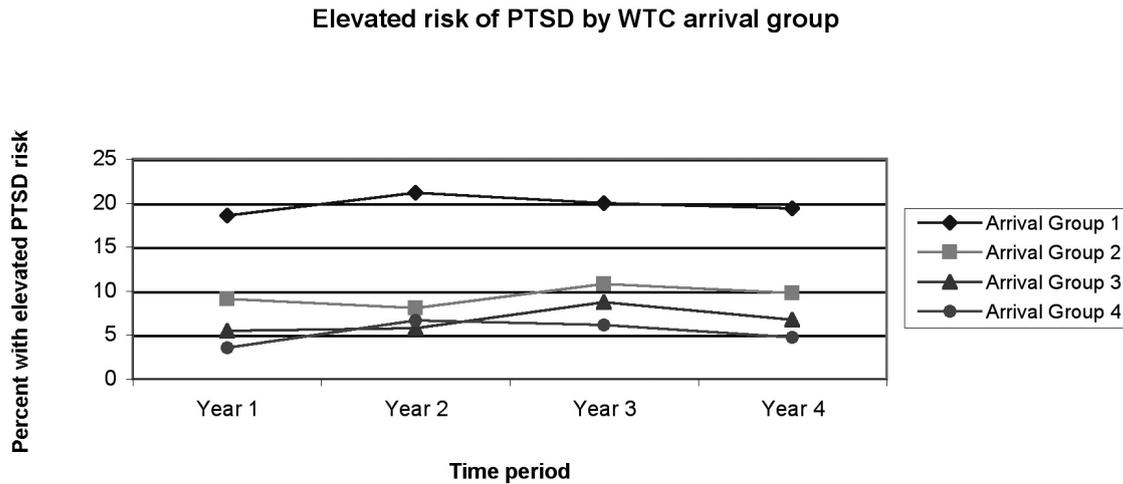
PTSD = posttraumatic stress disorder

CI = confidence interval

Ref. = referent

WTC = World Trade Center

**Figure 1. Prevalence rates of elevated PTSD risk based on time of arrival at the WTC site, by year (2001–2005) (n=10,074)<sup>a</sup>**



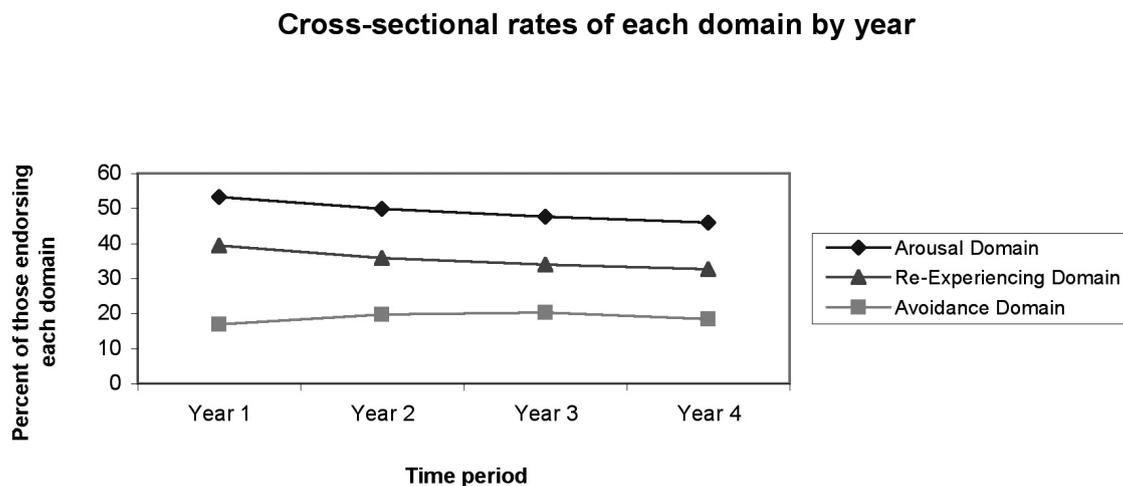
<sup>a</sup>p<0.0001 determined by a marginal logistic regression model  
 PTSD = posttraumatic stress disorder  
 WTC = World Trade Center

We found a significantly greater proportion of elevated PTSD risk in firefighters (30.0%), who normally did not have supervisory responsibilities but assumed those responsibilities during the disaster, as compared with officers (17.0%) or line officers (16.0%), who already had training and supervisory experience (OR=2.4; 95% CI 1.5, 3.7).

**Psychosocial support**

Receiving any counseling services was associated with elevated PTSD risk. In year 1, those individuals with elevated PTSD risk were four times more likely to use counseling services (OR=4.0; 95% CI 3.4, 4.6). This association remained unchanged in years 2 through 4 (data not shown). Elevated PTSD risk was also

**Figure 2. Prevalence rates of each domain of the DSM-IV-TR<sup>®</sup> diagnostic criteria for PTSD—re-experiencing, avoidance/numbing, and arousal—by year (2001–2005) (n=10,074)<sup>a</sup>**



<sup>a</sup>p<0.0001 determined by a marginal logistic regression model  
 DSM-IV-TR = Diagnostic and Statistical Manual of Mental Disorders, version IV  
 PTSD = posttraumatic stress disorder

**Table 2. Associations in 10,074 firefighters from the Fire Department of the City of New York between reporting elevated PTSD risk, reporting each PTSD domain, and reporting difficulty functioning at home and at work, by year (2001–2005)**

Variable	Year 1 Unadjusted odds ratio (95% CI) <sup>a</sup>	Year 2 Unadjusted odds ratio (95% CI) <sup>a</sup>	Year 3 Unadjusted odds ratio (95% CI) <sup>a</sup>	Year 4 Unadjusted odds ratio (95% CI) <sup>a</sup>
Difficulty functioning at home				
Elevated PTSD risk	17.0 (14.5, 20.0)	20.6 (13.1, 32.3)	26.7 (20.3, 35.2)	22.6 (17.9, 28.4)
Arousal	17.4 (13.9, 21.8)	17.7 (10.3, 30.4)	51.2 (29.8, 89.4)	33.7 (22.7, 49.8)
Re-experiencing	5.3 (4.6, 6.0)	5.8 (4.2, 8.1)	8.2 (6.5, 10.4)	6.4 (5.3, 7.8)
Avoidance/numbing	12.7 (11.1, 14.5)	12.9 (9.1, 18.3)	20.4 (15.9, 26.0)	20.3 (16.5, 25.0)
Difficulty functioning at work				
Elevated PTSD risk	12.1 (10.2, 14.2)	23.0 (14.6, 36.3)	18.4 (13.8, 24.5)	20.1 (15.7, 25.7)
Arousal	16.6 (12.3, 22.4)	13.5 (7.0, 26.1)	27.7 (15.5, 49.8)	28.3 (17.3, 46.3)
Re-experiencing	4.8 (4.0, 5.6)	6.1 (4.0, 9.3)	7.0 (5.2, 9.3)	7.2 (5.6, 9.3)
Avoidance/numbing	10.8 (9.2, 12.6)	18.8 (12.1, 29.4)	15.9 (11.8, 21.4)	19.1 (14.8, 24.7)

<sup>a</sup>Odds ratios and 95% CIs were estimated with bivariate logistic regression ( $p < 0.05$ ).

PTSD = posttraumatic stress disorder

CI = confidence interval

associated with receiving emotional support from family, friends, or coworkers (OR=1.7; 95% CI 1.4, 2.1). Emotional support was not assessed after year 1, as that question was omitted from subsequent versions of the questionnaire.

### Multivariable analyses

Similar associations with elevated PTSD risk were found in all four years, with differences mainly due to smaller participant numbers in years 2 and 3. The association between elevated PTSD risk and WTC exposure (arrival group or duration of months spent working at WTC) was significant in year 4 as well as in year 1 (Table 3).

At year 1, in addition to WTC exposure, variables associated with elevated PTSD risk included receiving counseling services (OR=2.9; 95% CI 2.4, 3.5); reporting an increase in alcohol use (OR=2.8; 95% CI 2.3, 3.4); reporting a decrease in exercise because an individual did not feel like it (OR=2.3; 95% CI 1.9, 2.8); obtaining emotional support from family, friends, or coworkers (OR=1.5; 95% CI 1.1, 2.0); being awarded a disability retirement pension (OR=1.5; 95% CI 1.1, 2.2); and the number of deaths in the firehouse where a member was stationed on 9/11 (OR=1.1; 95% CI 1.0, 1.1).

At year 4, in addition to WTC exposure variables, significant correlates of elevated PTSD risk included receiving counseling services (OR=3.5; 95% CI 2.6, 4.3), reporting a decrease in exercise (OR=2.6; 95% CI 2.1, 3.4), reporting an increase in alcohol use (OR=2.2; 95% CI 1.7, 2.9), and reporting a religious affiliation

(OR=1.8; 95% CI 1.4, 2.4). Disability retirement and the number of deaths in a member's firehouse were no longer statistically significant by year 4.

### DISCUSSION

This study documented the prevalence of elevated PTSD risk in a non-self-selected, highly exposed population of 10,074 firefighters. When compared with other rescue/recovery workers, these firefighters experienced the greatest risk to life and, on average, worked four times longer at the WTC site than other groups studied.<sup>36</sup> Using a conservative estimate of elevated PTSD risk requiring both a summary score  $\geq 9$  and attaining the threshold number of symptoms in each domain, as defined by the DSM-IV-TR, the prevalence of elevated PTSD risk remained relatively constant over the first four years (10% to 11%). As previously reported,<sup>28,37</sup> the prevalence of elevated PTSD risk was greater in firefighters who arrived at the site sooner, and who worked for a longer duration at the WTC site. The prevalence was also higher among those who retired with a disability pension—a condition that had not been previously studied in this context. An exposure-response gradient was seen in each year for elevated PTSD risk and in each separate domain of the DSM-IV-TR diagnostic criteria (arousal, re-experiencing, and avoidance/numbing), as well as in those reporting increased difficulty functioning at work or at home.

In a previous study on elevated PTSD risk in other WTC rescue, recovery, and clean-up workers, the

outcome was associated, as in our study, with a 17-fold increase in difficulty functioning at home or at work.<sup>30</sup> Such similarly large associations in these two studies support the inclusion of functional impairment as part of a clinical PTSD diagnosis interview. We also observed work-related stressors, including the loss of firefighter coworkers and the assumption of unaccustomed supervisory responsibilities during the disaster, to be associated with elevated PTSD risk.

In multivariable analyses in each year, except for year 2, we found arrival group to be significantly associated with elevated PTSD risk. In all years, the number of months worked at the WTC site, increased alcohol use, and receiving any counseling services were all significantly associated with elevated PTSD risk. The use of alcohol as a negative way to cope with PTSD has been previously reported in WTC<sup>38</sup> and non-WTC studies.<sup>39,40</sup> Additionally, in a longitudinal study of 469 firefighters intensely exposed to a brushfire disaster, changes in alcohol use patterns (both increases and decreases) were associated with PTSD—results that are consistent with our post-9/11 findings.<sup>41</sup>

In our study, reporting a decrease in exercise habits was associated with elevated PTSD risk in all years except for year 2. The association between elevated PTSD risk and reductions in exercise has not been previously reported for this active population, whose

members typically define themselves by their physical ability. Studies have found that physical activity is associated with improved psychological well-being and other positive benefits.<sup>42,43</sup> On the other hand, substantial change in non-work-related physical activity has been documented following the onset of PTSD.<sup>21</sup> Encouragement for continuation of physical activity, including offering group exercise programs as unique interventions,<sup>21</sup> could be considered, even though some have suggested that the relationship between regular exercise and anxiety and depression is not causal.<sup>44</sup>

Counseling service use remained significantly associated with elevated PTSD risk in years 1 through 4. The strong association could indicate that those expressing symptoms of PTSD are seeking and receiving treatment. Obtaining emotional support was only assessed in year 1, where it was significantly associated with elevated PTSD risk. We believe that this correlation may suggest that our population, with its strong culture of social support, might view seeking help from friends and family as a viable option for mental health stress. In previous work, various forms of social support have been found to be protective against traumatic stress and depressive symptoms, as demonstrated by a study of soldiers returning from Operations Enduring Freedom and Iraqi Freedom.<sup>45</sup> In other populations of veterans, however, the pursuit of mental health services

**Table 3. Adjusted odds ratios and 95% CIs in 10,074 firefighters from the Fire Department of the City of New York for covariates associated with elevated PTSD risk, by year (2001–2005)<sup>a</sup>**

Factors associated with elevated PTSD risk	Year 1 Adjusted odds ratio (95% CI)	Year 2 Adjusted odds ratio (95% CI)	Year 3 Adjusted odds ratio (95% CI)	Year 4 Adjusted odds ratio (95% CI)
WTC arrival: morning of 9/11	3.4 (1.9, 6.3)	1.5 (0.6, 4.1)	2.5 (1.2, 5.2)	3.3 (1.7, 6.2)
WTC arrival: afternoon of 9/11	2.2 (1.2, 3.9)	0.7 (0.3, 1.8)	1.4 (0.7, 2.7)	1.7 (1.0, 3.1)
WTC arrival: day 2	1.2 (0.6, 2.4)	0.6 (0.2, 2.0)	1.2 (0.6, 2.7)	1.5 (0.7, 3.0)
WTC arrival: days 3–14	Ref.	Ref.	Ref.	Ref.
Age on 9/11	Ref.	Ref.	Ref.	Ref.
Duration of >4 months	1.6 (1.3, 1.9)	1.6 (1.1, 2.5)	2.1 (1.6, 2.7)	1.7 (1.4, 2.1)
Disability retirement	1.5 (1.1, 2.2)	2.6 (1.6, 4.3)	1.8 (1.2, 2.8)	NA
Number of deaths in firehouse	1.1 (1.0, 1.1)	1.1 (1.0, 1.2)	NA	NA
Increase in alcohol use	2.8 (2.3, 3.4)	3.2 (2.0, 5.2)	2.4 (1.7, 3.2)	2.2 (1.7, 2.9)
Emotional support	1.5 (1.1, 2.0)	NA	NA	NA
Decrease in exercise habits	2.3 (1.9, 2.8)	NA	2.3 (1.7, 3.1)	2.6 (2.1, 3.4)
Counseling services	2.9 (2.4, 3.5)	4.0 (2.5, 6.4)	4.3 (3.2, 5.7)	3.5 (2.6, 4.3)
Reporting a religious affiliation	NA	NA	NA	1.8 (1.4, 2.4)
Hosmer-Lemeshow goodness-of-fit test	0.23	0.46	0.49	0.38

<sup>a</sup>Odds ratios and 95% CIs were estimated using logistic regression. Arrival group, age, and duration were forced in all models. Covariates displayed remained significant ( $p < 0.05$ ).

CI = confidence interval

PTSD = posttraumatic stress disorder

WTC = World Trade Center

Ref. = referent

NA = not available

appeared to be driven by guilt, which was correlated with PTSD.<sup>46</sup> More research is needed to examine the effect of various counseling and social support resources, as well as individual motivations for seeking out such help.

We were also able to examine the effect of disability retirement on elevated PTSD risk, which has not been previously assessed in this population. Although very few disability retirements were granted for mental health diagnoses, the positive association between retirement disability and elevated PTSD risk could be attributed to the presence of comorbid PTSD in firefighters who were granted disability for physical complaints. Alternatively, disability retirement, often unexpected, removes firefighters from one of their main sources of social support, a consequence that may have a negative impact on their mental health and increase their risk for PTSD symptoms.

Work stressors were found to be of particular relevance. Nearly 20% of the firefighters worked at a firehouse that experienced one or more 9/11-related deaths. For each additional death in a member's firehouse, there was a corresponding 10% increase in the odds of that member having elevated PTSD risk. We also found that firefighters performing supervisory responsibilities during the collapse—tasks that were not normally assigned to them—had almost twice the odds of having elevated PTSD risk than officers trained in supervision. Other studies of WTC workers and responders have found similarly strong correlations between PTSD and performing work at the WTC site that was atypical of individuals' reported occupations (for example, sanitation workers doing rescue and recovery activities at the site<sup>28</sup>). This relationship highlights the importance of not only improving training for workers responding to disaster sites, but also including a leadership component in such training, as some workers may be called on unexpectedly to lead their colleagues.

### Limitations

Our study had several limitations. First, we used a screening tool to determine elevated PTSD risk that, although based on the PCL, has not been validated in populations other than the FDNY.<sup>29</sup> Our measure of elevated PTSD risk was not the same as a PTSD diagnosis, which can only be determined by a psychiatric interview conducted by a trained clinician. However, we used the identical tool at all time points and reported prevalence estimates that were similar to those in other studies.<sup>28</sup>

Second, we do not know the proportion of participants who were being treated successfully for mental health symptoms, which could have caused our prevalence estimates to be underestimated, especially at later dates. Third, symptom and patient information was self-reported and could have resulted in biases in the results. For example, rates of elevated PTSD risk could have been overestimated if reported symptoms were exaggerated due to an interest in workers' compensation, retirement disability, or civil litigation. This possibility, however, seems unlikely, as eight years after the disaster very few mental health disability applications have been received. On the other hand, elevated PTSD risk could have been underestimated due to cultural factors at the FDNY that tend to minimize mental health symptoms. Finally, the data that were used for this study were serial cross-sectional and did not follow individuals across the four years in a longitudinal fashion.

### Strengths

This study also had several strengths. First, the questionnaire was administered to virtually all of the FDNY fire and EMS personnel who survived the attack, thereby minimizing volunteer selection bias and increasing the number of members eligible to participate. Compared with other research, this study examined a large, homogeneous group of highly exposed rescue/recovery workers at the WTC site. More than half of the participants were assessed more than once during this four-year study period. In addition, we had access to certain information that was unavailable in other studies (e.g., the number of coworker deaths, unexpected leadership responsibilities, and retirement disability status), which facilitated the identification of several unique relationships with elevated PTSD risk.

### CONCLUSIONS

This study examined secular trends in elevated PTSD risk after a wide-scale terrorist attack and compared correlates of risk immediately post-disaster and several years later. Significant exposure-response gradients based on arrival time and duration, and associations with disability retirement were found in all measures of PTSD and its corresponding domains. Increased alcohol use and decreased exercise were also important. These findings suggest that simple, self-administered questionnaires can help identify individuals who may be at risk for PTSD so that targeted mental health services, including alcohol counseling and exercise

drills/classes, can be offered as soon as possible. Early identification after a disaster could facilitate earlier interventions to reduce disease burden and severity.

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