Posttraumatic Stress Disorder Following the September 11, 2001, Terrorist Attacks:

A Review of the Literature Among Highly Exposed Populations

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Abstract

The September 11, 2001 (9/11), terrorist attacks were unprecedented in their magnitude and aftermath. In the wake of the attacks, researchers reported a wide range of mental and physical health outcomes, with posttraumatic stress disorder (PTSD) the one most commonly studied. In this review, we aim to assess the evidence about PTSD among highly exposed populations in the first 10 years after the 9/11 attacks. We performed a systematic review. Eligible studies included original reports based on the full Diagnostic and Statistical Manual of Mental Disorders (4th ed., rev.; American Psychiatric Association, 2000) criteria of PTSD among highly exposed populations such as those living or working within close proximity to the World Trade Center (WTC) and the Pentagon in New York City and Washington, DC, respectively, and first responders, including rescue, cleaning, and recovery workers. The large body of research conducted after the 9/11 attacks in the past decade suggests that the burden of PTSD among persons with high exposure to 9/11 was substantial. PTSD that was 9/11-related was associated with a wide range of correlates, including sociodemographic and background factors, event exposure characteristics, loss of life of significant others, and social support factors. Few studies used longitudinal study design or clinical assessments, and no studies reported findings beyond six years post-9/11, thus hindering documentation of the long-term course of confirmed PTSD. Future directions for research are discussed.

Keywords

September 11; 2001; 9/11; posttraumatic stress disorder (PTSD)

Exposure to the trauma of disasters is common. A national survey in the United States suggested that more than 15% of women and 19% of men are exposed to disasters during their lifetime (Kessler, Sonnega, Bromet, Hughes, & Nelson, 1995). Although the consequences of disasters may include a wide range of psychopathology (Norris, Friedman, Watson, et al., 2002), in earlier community studies conducted prior to September 11, 2001, it had been shown that posttraumatic stress disorder (PTSD) is the most common type of

psychopathology experienced in the aftermath of large-scale traumatic events (e.g., Breslau et al., 1998). The disorder involves substantial functional impairment and is often comorbid with other mental health conditions such as depression, generalized anxiety disorder, and substance abuse. For these reasons, PTSD is the most commonly studied mental disorder in the aftermath of disasters (for reviews, see Galea, Nandi, & Vlahov, 2005; Norris, Friedman, Watson, et al., 2002).

Although PTSD symptoms have been documented for centuries, not until 1980 did the American Psychiatric Association officially add PTSD to the third edition of the *Diagnostic and Statistical Manual of Mental Disorders* (*DSM–III;* American Psychiatric Association, 1980) nosologic classification system (Trimble, 1985). The *DSM–III* diagnostic criteria for PTSD were revised in *DSM–III–R* (American Psychiatric Association, 1987), *DSM–IV* (American Psychiatric Association, 1994), and *DSM–IV–TR* (American Psychiatric Association, 2000) and now include exposure to a catastrophic event involving death or injury or threat to one's physical integrity (Criterion A1); a subjective response marked by intense fear, helplessness, or horror (Criterion A2); 17 symptoms in the three symptom clusters of intrusive recollections (Criterion B), avoidant and numbing symptoms (Criterion C), and hyper-arousal symptoms (Criterion D); duration of symptoms for at least one month (Criterion E); and functional limitation as a result of symptoms (Criterion F). Large-scale general population studies have supported the *DSM–IV–TR* notion that exposure to trauma precedes the formation of PTSD symptoms, and the estimated lifetime prevalence of PTSD among U.S. adults from these studies is documented at 8% (10% in women, 5% in men), with great variability depending on the type of trauma experienced (Kessler et al., 1995, 1999).

Terrorist events by design are traumatic events that erode security and safety. In the last decade, such attacks have increased in sophistication and had enormous impact in terms of loss of life and damage (Bongar, 2006). The terrorist attacks on the World Trade Center (WTC) and the Pentagon on the morning of September 11, 2001 (9/11), have been life changing for many individuals (Neria, Gross, Marshall, & Susser, 2006). Immediately following the attacks, three national studies found widespread posttraumatic stress symptoms in the general U.S. population. Within the first week after 9/11, Schuster et al. (2001) conducted a national random digit-dial telephone survey of 560 adults and found that 44% of participants reported substantial stress reactions. One to two months after the attacks, Schlenger et al. (2002) conducted a Web-based study with a nationally representative sample of 2,273 adults and reported a 4.3% prevalence of PTSD that was significantly associated with both the number of hours of television coverage of 9/11 watched and the number of 9/11-related graphic events watched on television. These two studies were followed by a national longitudinal Web-based survey of 2,729 adults conducted by Silver, Holman, McIntosh, Poulin, and Gil-Rivas (2002), who examined demographics, health history, lifetime exposure to stressful events, 9/11 exposures, and coping strategies. In three waves conducted (a) 9–23 days after 9/11, (b) two months after the attacks, and (c) six months after the attacks, the researchers found that within the first month, 12% of individuals reported acute stress symptoms and 8.9% reported symptoms involving functional impairment. The researchers also found that the course of posttraumatic stress symptoms went from 17% at two months to 5.8% at six months postattack. Taken together, these studies presented initial evidence that the 9/11 attacks, whether proliferated by media images or by concerns about safety in times of war and terrorism, were significantly associated with PTSD symptoms in the general U.S. population.

Whereas countless viewers in the United States and worldwide were exposed to the events of 9/11 indirectly, many individuals were highly exposed in the major metropolitan areas of New York City (NYC) and Washington, DC. In NYC alone, the destruction and damage to

the WTC Twin Towers and 35 surrounding buildings resulted in almost 3,000 fatalities, 150,000 jobs lost, and $50 billion to $100 billion in economic costs (Bram, Orr, & Rapaport, 2002). After the attacks, the recovery and cleanup period was lengthy, lasting through June 2003. High exposure to the 9/11 attacks in NYC therefore encompassed a myriad of experiences dependent on such factors as one's specific location on 9/11 (i.e., proximity to the WTC), place of residence (i.e., proximity to lower Manhattan), and participation in rescue and recovery efforts. Accordingly, several research groups have reported on 9/11-related PTSD among highly exposed groups. The objective of this review is to systematically assess the evidence about PTSD following high exposure to the 9/11 attacks and to identify the key challenges in the extant literature.

Method

We obtained scientific articles for this review using a multistep procedure within the time frame of September 2001 (following the 9/11 attacks) to April 2011. First, we performed a search of the peer-reviewed literature published between September 2001 and April 2011 using the MEDLINE (Medical Literature Analysis and Retrieval System Online), PsycINFO, and PILOTS (Published International Literature on Traumatic Stress) databases. Articles were included for initial review if they included (a) *September 11, 2001* either as literal text in the body of an article or as a MeSH (Medical Subject Headings) term (these included entry terms *World Trade Center Attack, 2001, 9-11-2001 Attack,* and *September 11 Terrorist Attacks, 2001*) and (b) keywords for PTSD, including *posttraumatic stress disorder* and *PTSD*. Studies assessing the impact of post-9/11 stressors such as the wars in Iraq and Afghanistan were not included in this review. Studies that focused on other psychiatric disorders (e.g., depression, generalized anxiety disorder, complicated grief, and substance abuse) were not included in this review but are presented briefly in the discussion. This initial search resulted in a generation of 761 articles.

We next limited the articles to epidemiologic studies that focused predominantly on highly exposed groups defined as those living or working within close proximity to the WTC and the Pentagon, first responders, and recovery workers. To date, no studies have been published on reactions among the local population or recovery workers from Shanksville, Pennsylvania, where one plane crashed after hijackers redirected it from Washington, DC. We excluded articles that did not satisfy our selection criteria or were predominantly secondary analyses of previously published epidemiological studies of PTSD among highly exposed populations, unless the findings provided new insight into risk factors. Articles reporting an incomplete assessment of PTSD (e.g., two or three posttraumatic stress symptoms) or focusing on the biology of PTSD were excluded, as were review articles, editorials, commentaries, and case reports. We compared our sample with those studied in previous review articles (i.e., Galea et al., 2005; Neria et al., 2008) to verify that its results were comprehensive.

Our search identified 34 peer-reviewed articles on PTSD among groups highly exposed to the 9/11 attacks that have been published since 2001. We classified these studies as either (a) community studies ($n = 6$) or (b) studies of specific populations ($n = 28$), including rescue and recovery workers ($n = 9$), Pentagon staff ($n = 4$), WTC evacuees ($n = 1$), NYC workers ($n = 2$), primary care patients ($n = 3$), and children and adolescents ($n = 7$). Also, because two studies reported findings from a variety of specific populations (e.g., survivors, rescue workers), we grouped them separately from the other studies of specific populations.

The results of this search are presented in Table 1. The table is sectioned according to the classification described above and provides a summary of each article, including lead author and year of publication, specific sample type, study design (i.e., cross-sectional or

longitudinal), sample size (including information on sample attrition in longitudinal studies), sampling method (i.e., random, systematic, convenience, or mixed), survey type (i.e., face-to-face interview, in-person questionnaire, computer-assisted telephone interview, online questionnaire, or mailed questionnaire), time frame of data collection, PTSD instrument used (e.g., Structured Clinical Interview for *DSM–IV* [SCID; First, Spitzer, Gibbon, & Williams, 1995], Clinician-Administered PTSD Scale [CAPS; Blake et al., 1995], PTSD Symptom Checklist [PCL; Weathers, Litz, Herman, Huska, & Keane, 1993]), PTSD prevalence estimate, and a listing of the correlates of PTSD found for each study.

Findings

Many reports on PTSD have used the term *incidence* rather than *prevalence* because, in most cases, the exposure duration was brief. However, few studies were designed to ensure that the assessment of incidence was indeed carried out among persons without a previous history of PTSD. Consistent with previous reviews (i.e., Galea et al., 2005; Neria et al., 2008), we therefore opted to use the term *prevalence* rather than *incidence* throughout this review. We also note that although many studies reported findings on PTSD, many of these were conducted using checklists. Hence, the results of nonclinical assessments report an approximation of PTSD, that is, probable PTSD.

Community Studies

We identified six original community studies on PTSD post-9/11. Three of these had large samples of over 1,000 individuals living in various parts of NYC (Adams & Boscarino, 2006; DiGrande et al., 2008; Galea et al., 2002, 2003). Two national studies qualified for inclusion because they included residents with direct exposure to the attacks (Schlenger et al., 2002; Silver et al., 2005). Only two of these studies were longitudinal (Adams & Boscarino, 2006; Silver et al., 2005). All of these studies used symptom checklists to approximate PTSD among adults (see Table 1).

Prevalence—In NYC, the initial PTSD prevalence estimates ranged from 11.2% four to eight weeks after the attacks (Schlenger et al., 2002) to (among Manhattan residents only) 7.5% at five to eight weeks post-9/11 (Galea et al., 2002). In a later serial cross-sectional study of NYC residents, the prevalence was estimated to be 2.3% at four months and 1.5% at six months after the attacks (Galea et al., 2003). One year post-9/11, Silver et al. (2005) found high levels of posttraumatic symptoms in 11.2% of individuals who reported direct exposure to the attacks (e.g., being in the WTC or Pentagon, seeing or hearing the attacks in person, or being close to someone who was in the targeted buildings during the attacks). Comparable levels of PTSD (i.e., 12.6%) were reported by DiGrande et al. (2008) two to three years after 9/11 among residents living in lower Manhattan. This corroborated the previous finding of Galea et al. (2002) that in the early wake of the disaster, prevalence of PTSD was 20% among residents living south of Canal Street on 9/11.

Course—In a longitudinal survey representative of adults living in NYC one and two years after 9/11, it was found that the prevalence of PTSD declined from 5% at 12 months after 9/11 to 3.8% at 24 months after 9/11 (rates at both time points were based on the 71% of the baseline sample that was retained at follow-up; Adams & Boscarino, 2006). Also, at 24 months postattack, 3.9% of this sample was identified as having delayed PTSD.

Risk factors—These studies found that a number of factors significantly increased the risk of PTSD, including demographics such as female gender, young age, and Hispanic ethnicity (Adams & Boscarino, 2006; DiGrande et al., 2008; Galea et al., 2002; Schlenger et al., 2002); exposure characteristics such as direct exposure (e.g., injury on 9/11, exposure to the

dust cloud resulting from tower collapses), proximity to the WTC site (Adams & Boscarino, 2006; DiGrande et al., 2008; Galea et al., 2003), and personally witnessing specific horrific events (e.g., individuals falling from buildings; DiGrande et al., 2008); experiencing panic attacks during the attacks (as assessed five to eight weeks post-9/11; Galea et al., 2002); and higher amounts of viewing 9/11-related television coverage on 9/11 and during the few days thereafter (Schlenger et al., 2002). Higher numbers of negative life events during the year before 9/11 were associated with PTSD one year after 9/11, and higher numbers of negative life events experienced after 9/11 were associated with PTSD two years after the attacks. Also, at both one and two years post-9/11, current low self-esteem was found to be associated with PTSD (Adams & Boscarino, 2006).

Specific Populations

We identified 28 studies of specific populations. Of these, 23 were cross-sectional and 5 were longitudinal (see Table 1).

Rescue and recovery workers—Ten publications were identified that focused exclusively on PTSD in rescue and recovery workers within the first five years after 9/11. Three of these studies reported exclusively on fire-fighters (Berninger, Webber, Cohen, et al., 2010; Berninger, Webber, Niles, et al., 2010; Chiu et al., 2011); two reported on disaster relief workers (Evans, Giosan, Patt, Spielman, & Difede, 2006; Jayasinghe, Giosan, Evans, Spielman, & Difede, 2008); two reported on utility workers (Cukor et al., 2011; Evans, Patt, Giosan, Spielman, & Difede, 2009); and two reported on mixed groups of individuals who participated in the rescue, recovery, and/or cleanup operations at the WTC site (Perrin et al., 2007; Stellman et al., 2008). These studies typically involved recruitment of very large samples through either systematic or convenience sampling. All were cross-sectional with the exception of the studies of firefighters conducted by Berninger, Webber, Cohen, et al. (2010) and Berninger, Webber, Niles, et al. (2010), which used longitudinal design up to four years post-9/11. Five studies used the PCL (Weathers et al., 1993) to approximate PTSD prevalence, whereas four studies conducted face-to-face interviews using the CAPS (Blake et al., 1995). Longitudinal assessments were also conducted by Brackbill et al. (2009) in their mixed-samples study that included a very large sample of rescue and recovery workers who were recruited to participate in the World Trade Center Health Registry (WTCHR).

Prevalence: The prevalence of PTSD in rescue and recovery workers (in ascending order of assessment period) was reported as 11.1% at 10 to 61 months after the attacks (Stellman et al., 2008), 5.9% at 17 to 27 months (Evans et al., 2009), 5.8% at 21 to 25 months (Evans et al., 2006), 12.4% at two to three years (Perrin et al., 2007), and 6.8% at three years post-9/11 (Jayasinghe et al., 2008). Among utility workers, prevalence rates of PTSD ranged from 5.9% (Evans et al., 2009) to 8% (Cukor et al., 2011) at 17 to 27 and 10 to 34 months after the attacks, respectively. Among retired firefighters, 22% were found to have symptoms indicative of PTSD four to six years after the attacks (Chiu et al., 2011).

Course: A significant increase in PTSD prevalence was observed in the longitudinal studies of large samples of firefighters conducted by Berninger and colleagues. Specifically, Berninger, Webber, Niles, et al. (2010) first reported an increase in PTSD from 8.6% at zero to six months post-9/11 to 11.1% at three to four years post-9/11 (rates for both assessment periods were based on the 83.3% of the baseline sample that was retained at follow-up). A subsequent study by Berninger, Webber, Cohen, et al. (2010) was conducted on the basis of an expanded version of the same sample studied by Berninger, Webber, Niles, et al. (2010; i.e., using less stringent exclusion criteria). The study by Berninger, Webber, Cohen, et al. (2010) was conducted in four waves and resulted in PTSD rates of 9.8%, 9.9%, 11.7%, and

10.6%, at Years 1, 2, 3, and 4 after the attacks, respectively (of the baseline sample assessed within one year of 9/11, 10.8% was retained at two years, 26.7% was retained at three years, and 40.3% was retained at four years post-9/11). Consistent with these findings, a subset of rescue and recovery workers interviewed as part of the WTCHR also had a significant increase in PTSD prevalence from 12.1% two to three years post-9/11 to 19.5% five to six years post-9/11 (Brackbill et al., 2009).

Risk factors: Multiple factors were found to significantly increase the risk for PTSD in rescue and recovery workers. Jobs such as construction, engineering, and sanitation were found to be associated with the greatest risk for PTSD, as was being an unaffiliated volunteer (Perrin et al., 2007). Increased exposure by way of working at the WTC site demonstrated significant associations with PTSD (Cukor et al., 2011); these exposure factors included early arrival to the WTC site and long duration of time worked there (Chiu et al., 2011; Perrin et al., 2007). Perrin et al. (2007) demonstrated that these factors interacted to increase the risk of PTSD. Loss of a family member or friend in the attacks (Brackbill et al., 2009; Stellman et al., 2008) and 9/11-related job loss (as assessed five to six years post-9/11; Brackbill et al., 2009) significantly increased risk of PTSD in these populations.

Pentagon staff—Four studies on 9/11-related PTSD among Pentagon staff in Washington, DC, were available. All were cross-sectional studies that reported on data collected within the first two years after the attacks.

Prevalence: First, in a study conducted one to four months after the attacks, the prevalence of PTSD in Pentagon workers was observed to be 7.9% (Jordan et al., 2004). This study was followed by a series of three studies conducted by Grieger and colleagues in samples of military and civilian staff at the Pentagon at seven months, 13 months, and 25 months after 9/11. In these three studies, PTSD prevalence was estimated to be 14% at seven months (Grieger, Fullerton, & Ursano, 2003), 23% at 13 months (Grieger, Fullerton, & Ursano, 2004), and 16% at 25 months post-9/11 (Grieger, Waldrep, Lovasz, & Ursano, 2005).

Risk factors: Pentagon staff studies documented increased PTSD risk among women (Grieger et al., 2003) and people with direct exposure to the 9/11 attacks (Grieger et al., 2004). These specific exposures on 9/11 included sustaining injury and witnessing dead bodies (Grieger et al., 2005). Staff who reported higher initial emotional response and peritraumatic dissociation during and shortly after the attacks (as assessed 7 months after 9/11) had increased risk of PTSD in the first few months post-9/11 (Grieger et al., 2003). Also, current PTSD was associated with current perceptions of lower safety at both 7 and 13 months post-9/11 (Grieger et al., 2003, 2004).

WTC evacuees—One study was available on a cohort of civilians who evacuated the WTC Twin Towers on the morning of 9/11 (DiGrande, Neria, Brackbill, Pulliam, & Galea, 2011). This study was cross-sectional and approximated PTSD at two to three years post-9/11 using the PCL (Weathers et al., 1993).

Prevalence: This study found that 15% of WTC evacuees met criteria for PTSD (DiGrande et al., 2011).

Risk factors: PTSD was significantly associated with several specific exposures on 9/11, including being on a floor above the plane impact zones, being caught in the dust cloud that resulted from the tower collapses, personally witnessing horror, sustaining an injury, and working for an employer who was killed in the attacks. The strongest association with PTSD was among individuals with lower income two to three years after 9/11: A gradient was

observed in which survivors making less than $25,000 per year were eight times more likely to have PTSD than were those earning more than $100,000 per year (rates were 49% and 6%, respectively).

NYC workers—In two cross-sectional studies, PTSD was assessed among samples of working individuals in NYC with potential for high exposure to the events of 9/11. Tapp et al. (2005) used a random sampling method to assess PTSD risk among NYC transit workers seven months post-9/11, whereas Thiel de Bocanegra, Moskalenko, and Kramer (2006) used a convenience sample to survey garment workers in the China-town neighborhood 28 months post-9/11. In both samples, the PCL (Weathers et al., 1993) was used to approximate PTSD prevalence.

<u>Prevalence:</u> Tapp et al. (2005) documented a PTSD prevalence of 8% among participants at seven months postattack. The study by Thiel de Bocanegra et al. (2006) predominantly consisted of women who lost their jobs as a result of 9/11. The prevalence of PTSD among this group was 42% more than two years after 9/11.

<u>Risk factors:</u> Exposures related to the events of 9/11 were found to significantly increase risk of PTSD; these included being in the dust cloud that resulted from the tower collapses and knowing a survivor of the attacks (Tapp et al., 2005). In the Chinatown worker population, PTSD was found to be associated with the post-9/11 variables of seeking care from a physician, indicating a desire to receive counseling, and using prescription medication (all assessed 28 months post-9/11; Thiel de Bocanegra et al., 2006).

Primary care patients—Three reports were available on primary care patients in NYC (Neria, Gross, Olfson, et al., 2006; Neria et al., 2008, 2010;). Two of these studies included PTSD findings from cross-sectional surveys conducted between 7 and 16 months post-9/11 (Neria, Gross, Olfson, et al., 2006; Neria et al., 2008), whereas the other included findings from longitudinal assessments made approximately one and four years after the attacks (Neria et al., 2010). All studies used the PCL (Weathers et al., 1993) to approximate PTSD.

<u>Prevalence:</u> The prevalence estimate of PTSD in the entire cohort on which these studies were based was 4.7% seven to sixteen months after 9/11 (Neria, Gross, Olfson, et al., 2006). A subsample of bereaved individuals who lost someone in the attacks had a higher prevalence of 17.1% (Neria et al., 2008).

<u>Course:</u> In a longitudinal analysis, the prevalence of PTSD was shown to decrease from 9.6% one year after the attacks to 4.1% approximately four years post-9/11 (rates at both time points were based on the 46% of the baseline sample that was retained at follow-up; Neria et al., 2010). Most of the respondents with PTSD at baseline (i.e., 89.3%) remitted before follow-up, and most of the PTSD cases at follow-up (i.e., 75%) had late-onset PTSD. Only 1% of the participants met criteria for current PTSD at both time points.

<u>Risk factors:</u> Approximately one year after 9/11, PTSD was associated with Hispanic ethnicity, being born outside of the United States, not being married, pre-9/11 family psychiatric history, and pre-9/11 trauma. In addition, PTSD was found to be associated with a host of current comorbid mental disorders (e.g., depression and anxiety), current impaired functioning, increased current use of mental health medication (assessed 7 to 16 months post-9/11; Neria, Gross, Olfson, et al., 2006), and loss of a known person on 9/11 (Neria, Gross, Olfson, et al., 2006; Neria et al., 2008). Also, at approximately one and four years after 9/11, PTSD was associated with pre-9/11 major depressive disorder and current

impaired functioning. Approximately four years after 9/11, PTSD was associated with current major depressive and anxiety disorders (Neria et al., 2010).

Mixed adult samples—Two articles included findings based on over 71,000 individuals enrolled in the WTCHR. The WTCHR included samples of adults highly exposed to the events of 9/11, including building occupants, people on the street or in transit in lower Manhattan on 9/11, local residents, rescue and recovery workers and volunteers, and schoolchildren and staff. Farfel et al. (2008) reported on PTSD in these groups two to three years post-9/11. A longitudinal follow-up was conducted five to six years post-9/11 (Brackbill et al., 2009). The WTCHR was created using mixed methods that included recruitment lists, random digit dialing, and a media campaign. Individuals were assessed for PTSD using the PCL (Weathers et al., 1993).

Prevalence: The overall prevalence of PTSD among WTCHR participants was first reported at 16.3% two to three years after 9/11 (Farfel et al., 2008). The prevalence was highest (i.e., 19%) among building occupants and people on the street or in transit in lower Manhattan on 9/11.

Course: Brackbill et al. (2009) found a significant increase in PTSD from 14.3% two to three years post-9/11 to 19.1% four to five years post-9/11 (rates for both assessment periods were based on a subsample [$n = 43,032$] of a larger sample in which asthma symptoms were assessed [$N = 46,322$]; in the full sample, 68.1% of the baseline sample was retained at follow-up). In this time range, the greatest increase in PTSD occurred among rescue and recovery workers (12.1% to 19.5%). Building occupants and people on the street or in transit in lower Manhattan on 9/11 continued to have the highest prevalence of PTSD at follow-up (i.e., 23.2% at four to five years post-9/11).

Risk factors: Demographic factors such as Hispanic ethnicity and household income below $25,000 (assessed two to three years post-9/11) increased risk of PTSD. Specific exposures on 9/11 were also strongly associated with PTSD; these included being in the dust cloud that resulted from the tower collapses and sustaining injury. Other correlates of PTSD were evacuation time and time of return home or to work after 9/11 (Farfel et al., 2008). Evacuees who had not returned to live or work in lower Manhattan by two to three years after the attacks had the highest prevalence of PTSD (Farfel et al., 2008). In the longitudinal assessment, 9/11 exposures were strongly associated with long-term PTSD risk; these included intense dust cloud exposure, injury, and personally witnessing horror. However, post-event experiences of 9/11-related job loss and low social support (assessed five to six years post-9/11) were the strongest risk factors (Brackbill et al., 2009).

Children and adolescents—Seven studies of 9/11-related PTSD in NYC children and adolescents met our inclusion criteria. These included six cross-sectional studies and one that was longitudinal (for an expanded review of PTSD in youth populations, see Eisenberg & Silver, 2011, this issue).

Prevalence: In four- to seven-year-old NYC children, PTSD prevalence was estimated at 18% four to five months post-9/11 (Fairbrother, Stuber, Galea, Fleischman, & Pfefferbaum, 2003). In NYC schoolchildren in Grades 4 through 12, PTSD prevalence was assessed six months after 9/11 and estimated at 10.6% by Hoven et al. (2005); Rosen and Cohen (2010) estimated that PTSD prevalence ranged from 7.4% to 26.8% in this population of schoolchildren six months post-9/11. Approximately 10 months after the attacks, prevalence of PTSD was estimated at 14% in younger children up to age 5 years (DeVoe, Klein, Bannon, & Miranda-Julian, 2011) and at 20.4% in children who experienced the death of a

parent because of the attacks (Brown & Goodman, 2005). A very high PTSD prevalence of 35% was found in a sample of Chinatown schoolchildren living near Ground Zero two and a half years after 9/11 (Mullett-Hume, Anshel, Guevara, & Cloitre, 2008).

Course: In a small-scale longitudinal study of children whose parents were killed in the 9/11 attacks, PTSD prevalence was 29.6% at four months and gradually declined to approximately 5% two years after the attacks (retention was not reported for this sample of participants, who entered the study at various points in time; Pfeffer, Altemus, Heo, & Jiang, 2007).

Risk factors: Risk factors for 9/11-related PTSD in four- to seven-year-old NYC children four to five months after the attacks included current 9/11-related parental PTSD, a parent crying in front of a child after 9/11, seeing three or more graphic images of the attacks on television on 9/11 and during the first week thereafter, and being a Manhattan resident (all variables were assessed in parent interviews; Fairbrother et al., 2003). In NYC schoolchildren in Grades 4 to 12, risk factors for 9/11-related PTSD six months postevent included higher exposure to the events of 9/11, female gender, lower grade level, exposure of a family member, and higher numbers of pre-9/11 traumatic experiences (all reported by the schoolchildren; Hoven et al., 2005). Current hypothalamic–pituitary–adrenal (HPA) axis dysregulation (as assessed at six-month intervals between four months and two years post-9/11) was shown to be a risk factor for 9/11-related PTSD in children who experienced the death of a parent because of the WTC attacks (Pfeffer et al., 2007).

Discussion

Terrorism and Mental Health

Although large-scale terrorist acts commonly result in great human and physical destruction, the goal of the attackers, by design, is much broader. Specifically, their aim is to generate fear, terror, intimidation, and mistrust (Comer & Kendall, 2007; Marshall et al., 2007; Neria, Gross, & Marshall, 2006). When communities are struck by terrorism, the experience is likely to differ from that resulting from natural disasters. Natural disasters are usually limited in time and space and are often expected, therefore enabling coordination of rescue efforts, sheltering, and deployment of medical services. By contrast, terrorism usually occurs randomly and unexpectedly with regard to place and time. These differences can affect psychological outcomes among populations highly exposed to terrorist acts (Norris, Friedman, Watson, et al., 2002). In addition, the emotional, social, and political effects of terrorism are likely to be widespread, nonspecific, accumulative, and enduring, and they may affect large communities and influence not just how entire nations cope with the impact of such events but also how they respond to similar threats in the future (Comer & Kendall, 2007).

Burden of PTSD in the Aftermath of the 9/11 Attacks

Research conducted in the past decade demonstrates that the burden of 9/11-related PTSD is substantial in both the short and the long term. However, PTSD burden was not consistent across highly exposed populations. Although overall PTSD levels in the community declined significantly over time after 9/11, prevalence estimates of PTSD increased over time in a number of specific risk groups. For example, in a large cohort of rescue and recovery workers studied longitudinally, PTSD prevalence increased significantly over the first six years post-9/11, reaching 19.5% at five to six years post-9/11 (Brackbill et al., 2009). Similarly, the prevalence of PTSD among a large sample of retired firefighters was found to reach a level of 22% approximately five years after the attacks (Chiu et al., 2011).

Among children living in close proximity to the WTC, PTSD prevalence was estimated to be as high as 35% two and a half years after the 9/11 attacks (Mullett-Hume et al., 2008).

Most research conducted on 9/11-related PTSD was cross-sectional. Among the relatively small number of studies on the course of 9/11-related PTSD over time (Adams & Boscarino, 2006; Berninger, Webber, Cohen, et al., 2010; Berninger, Webber, Niles, et al., 2010; Brackbill et al., 2009; Neria et al., 2010; Pfeffer et al., 2007), comparability between studies is limited due to substantial variations in methodology, including variability in sample types, sample sizes, time frames of assessments, and screening or diagnostic instruments. Also, in the case of the study conducted by Berninger, Webber, Cohen, et al. (2010), there was variation (and an overall reduction) in sample size across time. These variations limit comparability between studies and the drawing of definitive inferences about the course of 9/11-related PTSD. Still, it is important to note that the majority of longitudinal studies found 9/11-related PTSD to decrease over time. Exceptions included studies on firefighters (Berninger, Webber, Cohen, et al., 2010; Berninger, Webber, Niles, et al., 2010) and the Brackbill et al. (2009) WTCHR study, in which rates were shown to increase over time in rescue and recovery workers and volunteers, lower Manhattan residents and office workers, and people who were on the street or in transit in the WTC area on 9/11.

Risk Factors for PTSD

The most consistently documented correlates of PTSD across studies of 9/11-related PTSD were based on exposure to the event. In particular, loss of life of significant others, physical injury, and immediate risk of life were especially predictive of PTSD. Therefore, across samples and studies, survivors and direct victims of the attacks were consistently shown to have increased risk of PTSD compared with individuals in the community. Aside from the observation of the centrality of trauma exposure as a determinant of PTSD, studies reviewed in this article varied considerably in the selection of correlates tested and the models used to assess statistically significant correlates. This suggests a need for caution in drawing inferences about associations of 9/11-related PTSD with various correlates.

Role of Ongoing Stress in PTSD

As described in our Method section, the scope of this review required that we exclude studies that focused specifically on the impact of post-9/11 stressors such as the wars in Iraq and Afghanistan. However, it is important to consider that ongoing stress, including stresses related to the various sequelae of the 9/11 attacks on the WTC, are likely to have played an important role in the course of PTSD symptomatology across time in various highly exposed groups. Such stressors may have included losses and injuries experienced by individuals, community-level and national stressors, and increased stress among nations throughout the world. The role of ongoing stress after 9/11 was particularly salient for individuals who participated in rescue and recovery efforts for several months in the aftermath of the disaster; for these individuals, 9/11 was both a discrete event and an ongoing, drawn-out disaster experience in which their lives and their health were continually in danger. As described in our review of findings (and as shown in the PTSD correlates column of Table 1), a wide range of ongoing stresses that were the direct sequelae of 9/11 was associated with PTSD symptomatology. Although most of the studies in our review did not focus on the role of non-9/11-related stresses experienced after 9/11, Adams and Boscarino (2006) demonstrated that higher PTSD symptomatology two years post-9/11 was associated with experiencing higher numbers of additional (i.e., non-9/11-related) traumatic events one to two years after the attacks. Taken together, these findings suggest that ongoing stresses play a crucial role in the course of disaster-related PTSD symptomatology, whether those stresses result from the direct effects of the disaster itself or from non-disaster-related events experienced in the aftermath of an event such as 9/11.

Role of Indirect Exposure in PTSD

A wide range of potential types of exposure was studied in the wake of the 9/11 attacks, and the risk of PTSD was repeatedly shown to be associated with severity of exposure to the disaster across numerous studies (see Table 1). However, as noted by Neria, Galea, and Norris (2009), disaster research (including 9/11-related research) has frequently involved populations that were not directly exposed to the trauma (e.g., children, elderly individuals, or those exposed to the event through the media). Although in some studies, indirect exposure to the WTC attacks was not shown to be associated with risk of PTSD (e.g., Neria, Gross, Olfson, et al., 2006), findings from large-scale, representative studies reviewed here (Galea et al., 2002; Schlenger et al., 2002; Silver et al., 2002, 2005) provide strong evidence for a probable association between indirect exposure and PTSD. Specifically, findings from nationwide studies have pointed to substantial and enduring emotional reactions across the United States after the 9/11 attacks, suggesting that the effects of this high-impact national trauma were not limited to the communities directly affected and, in fact, were comparable across groups with both direct and indirect exposure to the attacks (Silver et al., 2005).

These findings may challenge one of the core criteria of PTSD (i.e., Criterion A) according to *DSM–IV–TR* (American Psychiatric Association, 2000). The inclusion of this type of exposure is relatively new to the discipline of PTSD research and deserves further attention. The events of 9/11, other terrorist attacks in Europe and Asia, and recent major natural disasters provide further opportunities to examine whether direct exposure to trauma is a necessary condition for PTSD or whether, alternatively, an interaction between a sufficient level of exposure (even indirect) and certain risk factors (e.g., genetic susceptibility) can result in postexposure psychopathology.

Measurement Challenges

Research on large-scale traumatic events involves the assessment of exposure (e.g., type, severity, duration), outcomes (e.g., PTSD, depression, complicated grief), and covariates (see Galea & Maxwell, 2009). Although several instruments are designed to assess PTSD after exposure to trauma, there is little consensus with regard to their differential efficacy. PTSD is a clinical condition regularly assessed by clinical interviewers using the SCID (First et al., 1995) or the CAPS (Blake et al., 1995) as gold standards, but researchers in many 9/11 studies used screening instruments for obtaining information about PTSD symptoms, such as the PCL (Weathers et al., 1993), the Impact of Event Scale (Weiss & Marmar, 1996), and the Child PTSD Symptom Scale (Foa, Johnson, Feeny, & Treadwell, 2001). Although most screening instruments showed acceptable psychometric properties, there is no evident agreement in the PTSD literature in general and the 9/11 literature in particular about which screening instrument is most effective in assessing probable PTSD diagnosis. Similarly, there is a lack of consensus on whether face-to-face interviews are needed for a reliable assessment of PTSD or, alternatively, whether telephone- or Internet-based surveys are similarly reliable.

Research on 9/11-related PTSD has challenged the ways in which mental health researchers assess exposure to trauma. For many individuals, exposure to the events of 9/11 was complex. For example, even within specifically defined groups such as local residents or rescue workers, exposure was fairly heterogeneous (Galea & Maxwell, 2009). Although a number of studies of 9/11-related PTSD in groups directly exposed to the attacks have involved careful assessments of the various aspects of exposure that were most relevant to such directly exposed groups (i.e., type, severity, and duration of exposure; e.g., Berninger, Webber, Cohen, et al., 2010; DiGrande et al., 2008, 2011; Grieger et al., 2005; Perrin et al., 2007), indirect exposure has been more challenging to measure. Thus, it is also more difficult to compare studies of individuals indirectly exposed to the attacks.

Researchers have demonstrated that the relationship between event and outcome (i.e., between the 9/11 attacks and PTSD) may have been further mediated by other factors, including perceived threat, relative risk appraisal (Marshall et al., 2007), and viewing of 9/11-related television footage (Ahern, Galea, Resnick, Kilpatrick, et al., 2002; Ahern, Galea, Resnick, & Vlahov, 2004; Neria et al., 2007; Schlenger et al., 2002). Moreover, much of the research reviewed here has involved measurement of a wide range of confounders that extend far beyond gender, age, marital status, and ethnic origin. These have included initial stress responses (Silver et al., 2002, 2005), panic attacks (Galea et al., 2002), social support, negative life events (Adams & Boscarino, 2006), job type (Perrin et al., 2007), and pre-9/11 mental health problems (Neria et al., 2010). Although systematic covariate assessment is key to understanding associations between exposure and its outcomes, researchers of disaster-related trauma have yet to come to a consensus regarding the best approaches for assessing covariates and mediators. Such consensus is acutely needed both for ruling out alternate explanations of findings and for improving the comparability of various studies of the same disaster event.

One of the greatest challenges in all research on disasters is the possibility of retrospective recall bias in the measurement of key variables. In the immediate aftermath of disasters, it may be both inappropriate and unethical for researchers to assess some of these key variables related to exposure, short-term outcomes, and covariates. Given the inevitable delays in assessing these variables in the wake of disasters such as 9/11, it is likely that retrospective recall bias will continue to be an important (and inevitable) factor to consider in research on all types of disasters. This is particularly the case for highly subjective assessments of acute emotional states experienced at the time of the trauma that are assessed several weeks or months after the event has taken place, such as peritraumatic dissociation around the time of 9/11 (assessed seven months after the event by Grieger et al., 2003) or panic attacks experienced during the event (assessed four to five weeks after 9/11 by Galea et al., 2002). In the intervening weeks or months between the event and the assessment of the event, individuals' perceptions of the trauma are likely to have been cognitively reprocessed (possibly many times over) on the basis of interactions with others, exposure to various types of media, and ongoing personal rumination. Given the profound effects of 9/11 on the entire U.S. nation and nations around the world, it seems likely that all of these factors contributed to the evolution of individuals' ongoing perceptions of 9/11 itself and their personal experiences on that day and thereafter.

9/11-Related Psychopathology Beyond PTSD

The psychological sequelae of the 9/11 attacks have not been limited to PTSD. Although we focused this review on PTSD, there is also a considerable body of research that was conducted in the first 10 years after 9/11 in which it has been shown that other mental health problems have developed in association with the WTC attacks, such as depression, generalized anxiety disorder, and complicated grief. We provide here a brief summary of key findings of such studies.

Major Depressive Disorder (MDD)—A number of studies have focused on MDD after the 9/11 attacks in the NYC area. Estimates of the prevalence of MDD have ranged from 9.7% five to eight weeks after the attacks (Galea et al., 2002) to 12.4% within the first six months after 9/11 (Ahern & Galea, 2006). In a study of adult primary care patients seeking treatment in a large primary care setting in northern Manhattan (Neria et al., 2008), 29.2% of patients who reported knowing someone who died due to the 9/11 attacks also reported experiencing depression one year after 9/11.

Generalized Anxiety Disorder (GAD)—GAD is a chronic and disabling mental disorder characterized by excessive and uncontrollable worrying, anxiety, hypervigilance, and numerous somatic symptoms of anxiety (American Psychiatric Association, 2000). Few studies have focused on GAD after the 9/11 attacks. In their study of adult patients seeking care in a large primary care setting in northern Manhattan, Ghafoori et al. (2009) found the prevalence of GAD in the entire sample to be 10.5% seven to sixteen months after 9/11. Also, in a survey of Pentagon personnel, 26.9% of the respondents screened positive for GAD (Jordan et al., 2004) approximately one to four months post-9/11.

Complicated Grief (CG)—Although sudden traumatic loss is known to be a risk factor for a range of psychopathology, including PTSD (Neria & Litz, 2004; Norris, Friedman, & Watson, 2002; Norris, Friedman, Watson, et al., 2002), CG may be its most prominent outcome. CG is considered to be more severe than normal grief, commonly marked by prolonged yearning for the deceased, bitterness, interpersonal disengagement, and a sense of meaninglessness (Prigerson, Vanderwerker, & Maciejewski, 2008). It is found to be associated with considerable functional impairment, physical and mental health morbidity, lost productivity, suicide, and fewer quality-adjusted life years (for a review, see Lichtenthal, Cruess, & Prigerson, 2004). Symptoms of CG and PTSD may co-occur in the event of traumatic loss (Neria & Litz, 2004), but avoidance of fear-inducing stimuli associated with psychic trauma does not occur with CG after a natural death. Rather, there is a hyperfocus on the loss and reminders of the deceased; a desire for reconnection with the deceased; and, in most cases, comfort and/or longing (as opposed to aversive physiological reactivity) when exposed to symbolic cues that conjure thoughts of the deceased (Neria & Litz, 2004). CG is particularly important to study in the context of disasters, because oftentimes in such events, loved ones are lost suddenly, horrifically, and unexpectedly. After the attacks of 9/11, Neria et al. (2007) found that 43% of a sample of 707 individuals who lost a loved one screened positive for CG two and a half to three and a half years after the terrorist event. Similarly, in a smaller sample ($N = 149$) of those who lost loved ones and were assessed about 18 months after 9/11, Shear, Jackson, Essock, Donahue, and Felton (2006) found that 44% screened positive for CG. These findings underscore the painful, often debilitating, and enduring consequences of traumatic loss in the context of mass violence events.

Resilience and Recovery

Humans possess an impressive capacity to adapt to extremely adverse situations. Most studies of 9/11-related PTSD documented that significant proportions of the samples studied were either not affected or only minimally affected by the attacks. Resilient individuals have been found to manifest mild stress reactions in the immediate aftermath of disasters, but it has been shown that these reactions are not likely to significantly interfere with continued functioning and are typically of short duration (Bisconti, Bergeman, & Boker, 2006; Bonanno, 2004; Bonanno, Field, Kovacevic, & Kaltman, 2002; Bonanno, Galea, Bucciarelli, & Vlahov, 2007; Bonanno, Moskowitz, Papa, & Folkman, 2005; Bonanno, Rennicke, & Dekel, 2005; Ong, Bergeman, Bisconti, & Wallace, 2006). Recovery from initial symptomatology occurs when individuals show elevated levels of psychological symptoms for several months before returning to a pretrauma baseline (Bonanno & Gupta, 2009). The trend toward a decrease in symptomatology over time, which was found for various outcomes after 9/11, including PTSD (Galea et al., 2003; Neria et al., 2010) and depression (Person, Tracy, & Galea, 2006), can be explained by this response pattern. Processes of resilience and recovery provide insight into trajectories in which traumatized individuals do not continue to manifest long-term psychological difficulties. Researchers have identified multiple factors associated with effective coping during exposure to trauma and reduced psychopathology in its aftermath, including personality traits such as attachment style and

hardiness (Neria et al., 2001), cognitive attributional style (Dohrenwend et al., 2004), and a range of biological factors (Haglund, Nestadt, Cooper, Southwick, & Charney, 2007).

Limitations and Concluding Remarks

In this review, we have highlighted several important themes. First, studies conducted in the wake of 9/11 during the past decade have enabled mental and public health researchers to examine various aspects of the associations between exposure to the 9/11 attacks and PTSD. The evidence gathered thus far supports the conclusion that the burden of PTSD among populations exposed to 9/11 has been substantial and enduring. Second, data from the studies reviewed here suggest that PTSD is associated with a range of correlates, including sociodemographic and background factors, event exposure characteristics, emotional states, and social support factors. Third, only a relatively small number of the studies reviewed have involved longitudinal assessments that facilitate documentation of the course of PTSD, including remitted PTSD, chronic PTSD, and late-onset PTSD. A clearer understanding of those trajectories of PTSD and their correlates are invaluable in guiding the implementation of effective intervention strategies, particularly for individuals with chronic or delayed-onset PTSD. Fourth, most of the studies have examined nonrepresentative samples; therefore, patterns of findings may not represent the general population. However, we believe that the focus on specific populations such as the poor (e.g., Neria, Gross, Olfson, et al., 2006; Neria et al., 2010), first responders (e.g., Perrin et al., 2007; Stellman et al., 2008), and children (e.g., Brown & Goodman, 2005; Hoven et al., 2005) was justified given that such individuals tend to be at an increased risk for PTSD after large-scale disasters. Fifth, dropout rates in longitudinal cohorts were relatively high (e.g., Berninger, Webber, Cohen, et al., 2010; Brackbill et al., 2009; Neria et al., 2010). Although the authors of some studies did not address this concern, others compensated for loss of participants in their follow-up by comparing those who were not retained at follow-up with those who were retained (e.g., Adams & Boscarino, 2006; Berninger, Webber, Niles, et al., 2010; Brackbill et al., 2009; Neria et al., 2010; Silver et al., 2002, 2005), which allowed for the examination of possible sample biases related to the attrition. In addition, some longitudinal studies we reviewed have effectively dealt with sample attrition by incorporating nonresponse-adjusted weights based on attrition characteristics (Adams & Boscarino, 2006; Neria et al., 2010). Sixth, because the majority of the studies had screening measures to assess PTSD, prevalence rates in these studies may have been elevated in relation to studies that used structured diagnostic assessments (e.g., Brown & Goodman, 2005; Evans et al., 2009; Jayasinghe et al., 2008). However, it is important to consider that the unique constraints of postdisaster research often justify the use of screening instruments that provide high diagnostic efficiency in spite of being less clinically precise, such as the PCL (the most commonly used instrument in the studies reviewed here; Weathers et al., 1993) or the Impact of Event Scale (Weiss & Marmar, 1996). Seventh, most of the studies used retrospective assessment of exposure and risk factors, which may have introduced a significant retrospective recall bias in the findings. Last, the literature to date has yet to systematically provide guidance with regard to the key psychological, cultural, and biological factors that may shape vulnerability and resilience in the aftermath of large-scale traumatic events such as the attacks of 9/11.

In spite of these limitations, studies of 9/11-related PTSD have significantly advanced disaster research because of their scale (e.g., Brackbill et al., 2009; Farfel et al., 2008; Perrin et al., 2007), their representativeness (e.g., Galea et al., 2002; Silver et al., 2005; Schlenger et al., 2002), and their efficiency in providing highly needed data on PTSD estimates sooner rather than later (e.g., Galea et al., 2002; Silver et al., 2002, 2005; Schlenger et al., 2002). An important factor in these contributions has been the use of highly novel data collection technologies, such as Inter-net-based surveys (e.g., Neria et al., 2007; Schlenger et al., 2002; Silver et al., 2002).

Conducting mental health research in the wake of national disasters such as the 9/11 attacks is especially challenging. The postdisaster environment is unique because of its changing and at times uncontrollable nature, and logistical and environmental challenges are inherent to the conducting of such research in all of its stages, from outlining the research plan to data collection and analysis (Galea & Maxwell, 2009). The large body of work reviewed here is a testimony to the impressive ability of many research teams nationwide to operate in highly disturbed environments and to overcome major logistical difficulties. Future research on the mental health effects of disasters should capitalize on these advances and further investigate longitudinal trajectories of illness and resilience that, when better understood, will inform the development of effective interventions that aim to reduce the mental health burden of affected individuals and enhance the recovery of those who are in need of ongoing mental health care.

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Biographies

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Table 1

Journal Articles Focusing on Posttraumatic Stress Disorder (PTSD) Among Populations Highly Exposed to the Events of September 11, 2001 (9/11)

Source	Sample	Study design	Sample size	Sampling method	Survey type	Time frame of data collection post-9/11	PTSD instrument	PTSD prevalence estimate[a]	PTSD correlates
Community or General Population									
Galea et al., 2002	Manhattan residents	Cross-sectional	1,008	Random	CATI	5–8 weeks	NWS	7.5%	Hispanic ethnicity, 23 prior stressors, panic attack near time of WTC attacks, residence south of Canal Street, event-related loss of possessions
Schlenger et al., 2002	U.S. households, oversample in NYC and Washington, DC	Cross-sectional	2,273	Random	OQ	1–2 mont	hs PCL (cutoff score 50)	NYC = 11.2%; Washington, DC = 2.7%; other major metropolitan areas = 3.6%; rest of United States = 4.0%	Female gender, younger age, direct exposure, amount of viewing 9/11 television coverage
Galea et al., 2003	NYC residents	Cross-sectional	2,752	Random	CATI	4 months, 6 months	NWS	2.3%, 1.5%	Directly affected
Silver et al., 2005	U.S. residents, some directly exposed in NYC and Washington, DC	Longitudinal	1,906 (75% of baseline sample)	Random	OQ	2 weeks, 1 year	At 2 weeks, acute stress disorder (ASD: not PTSD) assessed with SASRQ (*DSM–IV* criteria); at 1 year, PCL (*DSM–IV* criteria)	Directly exposed = 9.3% (ASD), 11.2%; exposed via live television = 12.8% (ASD), 4.7%; no live exposure = 10.4% (ASD), 3.4%	Correlates of higher numbers of PTS symptoms: Higher numbers of acute stress symptoms 2 weeks post-9/11, direct exposure, African American ethnicity, pre-9/11 diagnosis of mental disorder, low education
Adams & Boscarino, 2006	NYC residents	Longitudinal	1,681 (71% of baseline sample)	Random	CATI	1 year, 2 years	NWS	5.0%, 3.8%	Year 1: Younger age, female gender, more 9/11 disaster events, more non–9/11 traumatic events, more negative life events, low social support, low self-esteem; Year 2: Middle age, Hispanic ethnicity, more post-9/11 traumas and negative life events, low self-esteem
DiGrande et al., 2008	Lower Manhattan residents	Cross-sectional	11,037	Mixed	CATI	2–3 years	PCL (*DSM–IV* criteria and cutoff score 44)	12.5%	Older age, female gender, Hispanic ethnicity, low education and income, divorce, 9/11 events: injury, witnessing horror, and dust cloud exposure
Specific Populations First responders and/or rescue and recovery workers									
Evans, Giosan, Patt, Spielman, & Difede, 2006	Disaster relief workers	Cross-sectional	626	Convenience	FTFI	21–25 months	CAPS, PCL (used as continuous measure)	5.8%	Anger, distress, reduced social and occupational functioning
Perrin et al., 2007	Rescue and recovery workers	Cross-sectional	28,962	Mixed	CATI	2–3 years	PCL (*DSM–IV* criteria and cutoff score 44)	12.4%	Job type (higher rates in construction, engineering, and sanitation workers), being an unaffiliated volunteer, earlier start date (except for police), longer duration of time worked at site (except for police), performing tasks not common to one's occupation
Jayasinghe, Giosan, Evans, Spielman, & Difede, 2008	Disaster relief workers	Cross-sectional	1,040	Convenience	FTFI	3 years	CAPS, PCL (used as continuous measure)	6.8%	Anger, depression, psychiatric distress

Source	Sample	Study design	Sample size	Sampling method	Survey type	Time frame of data collection post-9/11	PTSD instrument	PTSD prevalence estimate[a]	PTSD correlates
Stellman et al., 2008	Rescue and recovery workers	Cross-sectional	10,132	Systematic	IPQ	10–61 months	PCL (cutoff score 50)	11.1%	Impaired social functioning, loss of family member or friend in the attacks, disruption of family, work, and social life, behavioral symptoms in workers' children
Evans, Patt, Giosan, Spielman, & Difede, 2009	Utility workers	Cross-sectional	842	Convenience	FTFI	17–27 months	CAPS, SCID	5.9%	Impaired social and occupational functioning, history of trauma, history of panic disorder or depression
Berninger, Webber, Niles, et al., 2010	Firefighters	Longitudinal	5,656 (83.3% of baseline sample)	Systematic	IPQ	0–6 months, 3–4 years	PCL (DSM-IV criteria and nonweighted cutoff score of 9 out of 14 possible items)	8.6%, 11.1%	Impaired functioning
First responders and/or rescue and recovery workers (continued)									
Berninger, Webber, Cohen, et al, 2010	Firefighters	Longitudinal	10,074 total (8,679 at 1 year; retention of baseline sample = 10.8% at 2 years, 26.7% at 3 years, 40.3% at 4 years)	Systematic	IPQ	1 year, 2 years, 3 years, 4 years	PCL (DSM-IV critera and nonweighted cutoff score 9 out of 14 possible items)	9.8%, 9.9%, 11.7%, 10.6%	Earliest arrival at site, prolonged work at site, supervising on site without prior supervisory experience, retirement due to 9/11-related disability, impaired functioning at home and work
Chiu et al., 2011	Retired firefighters	Cross-sectional	1,915	Convenience	IPQ	4–6 years	PCL (cutoff score 39)	22.0%	Earlier arrival at site
Cukor et al., 2011	Utility workers	Cross-sectional	2,960	Convenience	FTFI, IPQ	10–34 months	CAPS, PCL (subsyndromal DSM-IV criteria and cutoff score 50)	8.0%	Psychiatric or trauma history, subjective perception of threat to one's life, higher exposure to the site
Pentagon staff									
Grieger, Fullerton, & Ursano, 2003	Pentagon staff	Cross-sectional	77	Convenience	OQ	7 months	IES	14.0%	Higher initial emotional response, higher peritraumatic dissociation, female gender, lower perceived safety 7 months post-9/11
Grieger, Fullerton, & Ursano, 2004	Pentagon staff	Cross-sectional	212	Convenience	OQ	13 months	IES	23.0%	Direct exposure, lower perceived safety 13 months post-9/11 at home and work, and in usual activities and travel
Jordan et al., 2004	Pentagon staff	Cross-sectional	1,837	Multiple	OQ, IPQ	1–4 months	DSM-IV	7.9%	Reduced daily functioning, less use of counseling services
Grieger, Waldrep, Lovasz, & Ursano, 2005	Pentagon staff	Cross-sectional	267	Convenience	OQ	25 months	PCL (DSM-IV criteria)	16.0%	At Pentagon on 9/11, sustaining injury, witnessing dead bodies, acting as lay counselor to families of the deceased

Source	Sample	Study design	Sample size	Sampling method	Survey type	Time frame of data collection post-9/11	PTSD instrument	PTSD prevalence estimate[a]	PTSD correlates
World Trade Center evacuees									
DiGrande, Neria, Brackbill, Pulliam, & Galea, 2011	WTC towers evacuees	Cross-sectional	3,271	Mixed	CATI	2–3 years	PCL (cutoff score 50)	15.0%	Female gender, minority racial identity, lower income, direct exposure (i.e., higher floor in towers, later evacuation, caught in dust cloud after collapses of towers, witnessing horror, sustaining injury), working for an employer who was killed in the attacks
New York City workers									
Tapp et al., 2005	NYC transit workers	Cross-sectional	269	Random	IPQ, MQ	7.5 months	PCL (scoring criteria not specified)	8.0%	Exposure to the dust cloud after collapses of towers
Thiel de Bocanegra, Moskalenko, & Kramer, 2006	NYC Chinatown workers	Cross-sectional	148	Convenience	FTFI	28 months	PCL (*DSM–IV* criteria)	42.0%	Higher post-9/11 likelihood of visiting physician, receiving prescription drugs, or indicating interest in counseling
Primary care patients									
Neria, Gross, & Marshall, 2006	Manhattan primary care patients	Cross-sectional	930	Systematic	IPQ	7–16 months	PCL (cutoff score 50)	4.7%	At baseline, approximately 1 year after 9/11, PTSD was associated with Hispanic ethnicity, being born outside of the US, not being married, pre-9/11 family psychiatric history, and pre-9/11 trauma; in addition, PTSD was found to be associated with comorbid mental disorder, impaired functioning, and increased use of mental health medication
Neria et al., 2008	Bereaved primary care patients	Cross-sectional	252	Systematic	IPQ	7–16 months	PCL (scoring criteria not specified)	17.1%	Knowing someone who was killed in the attacks
Neria et al., 2010	Manhattan primary care patients	Longitudinal	455 (46% of baseline sample)	Systematic	IPQ	1 year, 4 years	PCL (cutoff score 44)	9.6%, 4.1%	Overall: pre-9/11 major depressive disorder, impaired functioning. Follow-up: major depressive and anxiety disorders
Mixed adult samples									
Farfel et al., 2008	Building occupants, people on street or in transit in lower Manhattan on 9/11, local residents, rescue and recovery workers and volunteers, school children and staff	Cross-sectional	68,444	Mixed	CATI	2–3 years	PCL (cutoff score 44)	16.3%	Hispanic ethnicity, household income below $25,000, sustaining injury
Mixed adult samples (continued)									
Brackbill et al., 2009	Rescue and recovery workers, lower Manhattan residents and office workers, passersby	Longitudinal	43,032 (subsample of 46,322 [68.1% of baseline sample]	Mixed	CATI	2–3 years, 5–6 years	PCL (cutoff score 44)	14.3%, 19.1%	Wave 2 (5–6 years): 9/11- related loss of spouse or job, eligibility group (higher rate in passersby)

Source	Sample	Study design	Sample size	Sampling method	Survey type	Time frame of data collection post-9/11	PTSD instrument	PTSD prevalence estimate[a]	PTSD correlates
			assessed for asthma)						
						Children and adolescents			
Fairbrother, Stuber, Galea, Fleischman, & Pfefferbaum, 2003	NYC children 4–7 years old	Cross-sectional	434	Random	CATI— parent	4–5 months	PRI-C	18.0%	Parental PTSD, parent crying in front of child, seeing 33 graphic images of the disaster on television, Manhattan residence
Brown & Goodman, 2005	Children with WTC parent death	Cross-sectional	49	Convenience	FTFI— child and parent	$M = 10.5$ months	CPSS	20.4%	Traumatic grief
Hoven et al., 2005	NYC public schoolchildren	Cross-sectional	8,236	Systematic	IPQ— child	6 months	DPS	10.6%	Higher exposure, female gender, lower grade level, exposure of family member, trauma history
Pfeffer, Altemus, Heo, & Jiang, 2007	Children with WTC parent death	Longitudinal	79 (retention not reported)	Convenience	FTFI— child and parent	4 months–2 years (time of study entry varied)	K-SADS	29.6% at 4 months, gradual decline to 35% at 2 years	Hypothalamic-pituitary-adrenal axis dysregulation
Mullett-Hume, Anshel, Guevara, & Cloitre, 2008	Chinatown middle school children	Cross-sectional	204	Convenience	IPQ— child	2.5 years	CPSS	35.0%	Higher numbers of non-9/11-related traumas
Rosen & Cohen, 2010	NYC public school children	Cross-sectional	7,832	Systematic	IPQ— child	6 months	DPS	7.4%–26.8%	Lower grade level, direct exposure of family member or friend
DeVoe, Klein, Bannon, & Miranda-Julian, 2011	NYC children 0–5 years old	Cross-sectional	180	Convenience	FTFI— parent	9–13 months	PTSDSSI	14.0%	Direct exposure, trauma history, negative changes in parenting, increased tension between parents

Note. NYC = New York City; CATI = computer-assisted telephone interview; FTFI = face-to-face interview; IPQ = in-person questionnaire; MQ = mailed questionnaire; OQ = online questionnaire; CAPS = Clinician-Administered PTSD Scale; CPSS = Child PTSD Symptom Scale; DPS = Diagnostic Interview Schedule for Children Predictive Scales; IES = Impact of Event Scale; K-SADS = Child Schedule for Affective Disorders and Schizophrenia; NWS = National Women's Study PTSD module; PCL = PTSD Checklist; PRI–C = Posttraumatic Stress Disorder Reaction Index—Child Revision; PTQ = Preschool Trauma Questionnaire; PTSDSSI = PTSD Semi-Structured Interview for Infants and Young Children; SCID = Structured Clinical Interview for *DSM–IV*; SASRQ = Stanford Acute Stress Reaction Questionnaire.

[a] Prevalence reported in accordance with cohort listed.