

POSTTRAUMATIC STRESS DISORDER POST 9/11: A REVIEW OF THE EVIDENCE AND IMPLICATIONS FOR PUBLIC HEALTH POLICY

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Mass fatality incidents due to terrorism are becoming more common. Addressing the mental health needs of the general population and first responders exposed to these attacks is a pressing concern. Following the 9/11 attacks, a wide range of mental and physical health outcomes were reported, including posttraumatic stress disorder (PTSD). The aim of this paper is to provide a broad overview of the existing data on PTSD in civilian and responder samples following the 9/11 terrorist attacks on the World Trade Center and the Pentagon to provide guidance for resource planning purposes. We examine the prevalence and course of illness, including evidence on the persistence and late onset of symptoms among a proportion of the population, and review both personal and event-related risk factors across groups. We discuss brief screening instruments necessary for on-going monitoring, and review interventions focusing on building resilience, preventing symptom development, and treating PTSD symptoms. Overall, the literature suggests a substantial burden of PTSD following mass fatality incidents. The epidemiological evidence highlights the importance of managing the health risks associated with volunteering in response to terror attacks. There is relatively clear guidance for the treatment of PTSD in the general public, although there is a need for greater dissemination of treatments and better access to care. Less is known about prevention and treatment for responders. There is empirical support for several psychotherapeutic interventions for PTSD among these responders, but there is less evidence available to guide primary prevention programs for the public or responders. Planners will need to provide resources for long-term support for mental health following terror events and use a flexible approach for delivering available resources.

Key words: Posttraumatic stress disorder; Terrorist attacks; Resilience; Psychological first aid; Mental health services.

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Over fifteen years have passed since the terrorist attacks on the World Trade Center (WTC) on September 11, 2001. Considerable efforts have been made to understand and treat the health effects experienced by survivors and responders. Despite logistic and methodological challenges, the ongoing research efforts provide insight into prevalence of health problems, including posttraumatic stress disorder (PTSD), and information about risk factors for PTSD and related conditions.

More than a decade of research suggests a substantial burden of PTSD among persons with high exposure to 9/11 (Neria, DiGrande, & Adams, 2011). The aim of this paper is to summarize the literature on post-9/11 PTSD, examining the prevalence, risk factors, and intervention efforts among different groups in the population, including both civilians and first responders.

Given the increase in the prevalence of terror-related mass disasters, knowledge about PTSD following the 9/11 disaster can provide guidance for future disaster preparedness and provision of post-disaster mental health services.

In the immediate aftermath of a traumatic event, individuals may show symptoms of posttraumatic stress, including repetitive re-experiencing of the traumatic event in the form of intrusive and unwanted memories of the trauma; nightmares and flashbacks about the trauma; difficulty modulating arousal as evidenced by insomnia, irritability, angry outbursts, hypervigilance, difficulty concentrating, and exaggerated startle response; avoidance of stimuli associated with the trauma; and general numbing of emotions with a feeling of detachment from others (American Psychiatric Association, APA, 2013). The new Diagnostic and Statistical Manual of Mental Disorders (DSM-5) criteria for PTSD also include additional symptoms such as negative cognitions, a persistent and distorted negative thoughts about the self, others, and the world and self-blame for the event. Other cognitive symptoms can include negative mood, markedly diminished pleasure or interest in activities, and a sense of isolation. To meet criteria for PTSD, the symptoms must cause distress and functional impairment (APA, 2013).

Depending on their frequency and intensity, posttraumatic stress symptoms seen in the first month after the event may lead to a diagnosis of Acute Stress Disorder (ASD). ASD is diagnosed if symptoms including intrusions, negative mood, dissociation, avoidance, and hyperarousal occur within three days to a month following exposure or threatened death, serious injury, among other traumatic experiences (APA, 2013). If sufficient symptoms persist past one month, then a diagnosis of PTSD may be made. PTSD may be diagnosed, even when symptoms emerge long after the initial event (Andrews, Brewin, Philpott, & Stewart, 2007).

There are significant mental and physical health consequences and functional sequelae associated with PTSD. Mental health outcomes associated with PTSD include depression, substance use, and panic disorder (Boscarino, Kirchner, Hoffman, Sartorius, & Adams, 2011). PTSD and depression are both risk factors for significant health problems, including cardiovascular disease, and an array of chronic illnesses and poor health-related quality of life (Boscarino, 2004; Dobie et al., 2004).

EPIDEMIOLOGY OF PTSD FOLLOWING THE WORLD TRADE CENTER ATTACKS

The 9/11 terrorist attacks on the WTC were unprecedented in the USA for their destruction, loss of life, and long-term consequences for survivors. In 2002 the U.S. Congress directed the Center for Disease Control and Prevention (CDC) to establish a regional clinical consortium to provide medical and mental health monitoring of WTC rescue and recovery workers. That same year, the Agency for Toxic Substances and Disease Registry (ATSDR) and the New York City Health Department established the World Trade Center Health Registry (WTCHR) for the purpose of monitoring the health of people directly exposed to the WTC disaster. Today, the registry is an ongoing collaboration with the National Institute of Occupational Safety and Health (NIOSH). WTCHR data provided a unique opportunity to examine long-term health effects of a large-scale disaster (Farfel et al., 2008). Studies emerging from the registry and other sources provide data on the prevalence and risk factors for PTSD following 9/11 in the civilian population as a whole and subgroups within this population (e.g., children and the elderly). These data

are also available on responder groups, including professional and lay first responders and rescue and recovery workers, and other individuals who either worked at the World Trade Center attack site or were in close proximity to it (Stellman et al., 2008).

Prevalence of PTSD in General Public

The reactions of the American public to the 9/11 attack were examined in a national study which investigated PTSD symptom levels in the United States four weeks and eight weeks after the 9/11 attacks (Schlenger et al., 2002). The study employed a web-based epidemiological survey of a nationally representative cross-sectional sample using a PTSD checklist and brief symptom inventory. The study revealed the course of symptoms was relatively brief for many, but not all respondents. Similar findings were obtained in studies of individuals in the New York metro area, with the data suggesting the majority of individuals resolved probably PTSD symptoms within six months (Galea et al., 2003).

Proximity to the attacks affected prevalence. Specifically, the prevalence of probable PTSD was significantly higher in the New York City metropolitan area (11.2%) than in Washington, DC (2.7%), other major metropolitan areas (3.6%), and the rest of the country (4.0%). The overall distress levels across the country were within normal ranges for a general community sample.

The prevalence and course were not the same among all sub-populations, including children and the elderly. Investigators examined the reaction of children to 9/11 by asking parents about the symptoms shown by their children. The incidence of adults indicating that at least one child was upset within one to two months after the attack was highest in the NYC metropolitan area (60.7%) and Washington, DC (54.9%), as compared to the rest of the United States (48.0%). Among the symptoms shown by children and reported by adults, 29.9% were described as irritable, grouchy, or easily upset, and 26.5% were described as fearing separation from their parents. Among the children showing the highest levels of symptoms, 19.8% reported trouble sleeping. The highest level of symptoms were seen in children who had a mean age of 11 years old (Schlenger et al., 2002).

In contrast, studies of the elderly are remarkable for demonstrating the apparent resilience of the elderly population. A longitudinal study examined general distress, posttraumatic stress responses, and fear of future attacks following the 9/11 attacks among a large national sample of U.S. adults aged 18-101 years. The authors found that older age was associated with lower overall levels of general distress, a steeper decline in posttraumatic stress over time, and less change in fear of future terrorist attacks over three years (Scott, Poulin, & Silver, 2013).

First Responders: Rescue and Recovery Workers

Of great concern are the 40,000-92,000 men and women estimated to have been involved in the rescue, recovery, and cleanup operations that followed the WTC terrorist attack. Service in these operations exposed workers to toxic and unsafe working conditions, including smoke, fumes and highly alkaline dust (pH 10-11) (Stellman et al., 2008). In addition to hazardous chemical and physical environmental exposures, the working conditions at the WTC involved expo-

asures to serious psychosocial stressors, including long hours and arduous work, treacherous and chaotic working conditions, fear for personal safety, and handling of body parts and personal effects of victims, or working in close proximity to such operations (Farfel et al., 2008).

A large longitudinal cohort study conducted over the period from 10 to 61 months after the 9/11 attack on the WTC examined 10,132 rescue, recovery, and cleanup workers. The study provides estimates of mental health outcomes, including social and functional impairment and psychiatric comorbidity, as well as perceived symptomatology in worker's children. Of the workers who completed a self-report questionnaire on mental health symptoms, 11% met criteria for probable PTSD, 8.8% met criteria for depression, 5.0% met criteria for probable panic disorder, and 62% endorsed one or more substantial stress reaction symptoms. PTSD prevalence was comparable to that seen in returning Afghanistan war veterans and much higher than in the US general population (4.0%). Point prevalence declined from 13.5 % to 9.7% over the five years of observation (Stellman et al., 2008). Similar rates of PTSD (about 12%) among responders were found in another study of responders to the World Trade Center attacks (Perrin et al., 2007).

The rates for responders are lower than those for civilians. In a meta-analysis of 10 studies of 3,271 to 20,294 participants examining rates of PTSD among different groups, responders (e.g., police, firefighters, rescue/recovery workers, and volunteers) had a lower probable PTSD risk ($OR = 1.61$), compared to civilians (e.g., residents, office workers, and passersby; $OR = 2.71$). The difference between responders and civilians was pronounced for exposures involving physical exposure (e.g., sustained injury, caught or worked in dust cloud) compared to psychosocial exposure (e.g., witnessed horror, lost someone, exposed to human remains) (Liu, Tarigan, Bromet, & Kim, 2014).

Although traditional and trained groups of responders showed a relatively reduced burden of PTSD following exposure to physical trauma in comparison to the general public, lay responders and non-traditional responders were at greater risk. Specifically, police demonstrated the lowest risk of developing PTSD; whereas unaffiliated volunteers, construction workers, and sanitation workers were at greatest risk (Perrin et al., 2007).

A study comparing health outcomes among affiliated and lay volunteers examined 9,974 adult volunteers who completed the WTCR's 2006-2007 survey (Debchoudhury et al., 2011). Affiliated volunteers reported membership in a recognized organization (e.g., American Red Cross). Lay volunteers reported no organizational affiliation and were employed in occupations unrelated to rescue/recovery work. These lay volunteers included members of church groups or community organizations and individuals present in the area immediately following the attack.

Lay volunteers were more likely than affiliated volunteers to have been present in lower Manhattan at the time of the attack, to experience the dust cloud, to have witnessed horrific events and injury on 9/11, and were subsequently more likely to report unmet healthcare needs. Lay volunteers had significantly greater odds than affiliated volunteers of early post-9/11 mental health diagnosis ($OR = 1.6$), chronic PTSD ($OR = 2.2$), or late-onset PTSD ($OR = 1.9$) (Debchoudhury et al., 2011).

The findings suggest that although most individuals remain resilient in the face of an attack, a substantial minority of civilians and first responders have persistent PTSD symptoms which are likely to require intervention. Among the general population, those at relatively higher levels of risk include children, but their needs may not be recognized if their family members are less affected (Schlenger et al., 2002). Additional outreach to identify affected children may be

needed. Among those who responded to the attacks, lay volunteers and responders without emergency response training (e.g., construction workers) were at greater risk than trained police or rescue and recovery workers (Liu et al., 2014). Consequently, disaster planners are increasingly recognizing the need to proactively address issues related to the deployment of volunteers, including the need to rapidly train and protect lay volunteers and provide more effective strategies to deploy these resources (Quevillon, Gray, Erickson, Gonzalez, & Jacobs, 2016; Whittaker, McLennan, & Handmer, 2015).

TRAJECTORY OF SYMPTOMS

Information on the duration of symptoms is necessary to plan for ongoing mental health needs of both the public and those involved in rescue and recovery operations. Large scale longitudinal studies have been employed to assess the persistence of symptoms following 9/11 and the development of new cases over time. The findings suggest PTSD symptoms fluctuate and even increase over time (Brackbill et al., 2009).

A large cohort study examined risk factors for event-related PTSD symptoms as they emerged over a six year period following the 9/11 attacks. Participants included 46,322 exposed adults including rescue/recovery workers, lower Manhattan residents, lower Manhattan office workers, and individuals who were in the area (i.e., passersby) on 9/11. Of the participants with no PTSD history, 23.8% reported PTSD symptoms (indicative of probable PTSD) across both assessment points. Nearly 10% had PTSD symptoms at both assessment points. During the Wave 2 data collection, the highest rates of PTSD symptoms (23.2%) were shown by individuals in the passersby group. Both acute and prolonged exposures were associated with a large burden of PTSD symptoms even five to six years after the WTC attack (Brackbill et al., 2009).

Among enrollees in a longitudinal study who were assessed 10 years following the 9/11 attacks, 15.2% reported symptoms indicative of PTSD, 14.9% reported symptoms of depression, and 10.1% reported symptoms of both. Individuals who had comorbid PTSD and depression had higher 9/11 exposures, low social integration, health-related unemployment, and were more likely to experience at least one additional traumatic life event post-9/11. Persons with comorbid PTSD and depression experienced poorer outcomes on all PTSD-related impairment measures, life satisfaction, overall health, and unmet mental health care needs compared to those with only a single condition (Caramanica, Brackbill, Liao, & Stellman, 2014).

Longitudinal studies also revealed late onset cases among responders to 9/11. Specifically, a total of 10,835 WTC responders, including 4,035 professional police officers and 6,800 non-traditional responders (e.g., construction workers) who participated in the WTC Health Program were evaluated an average of three, six, and eight years after the WTC attacks. Among police responders, longitudinal PTSD symptoms were best characterized by four classes, with the majority (77.8%) in a resistant/resilient trajectory and the remainder exhibiting chronic (5.3%), recovering (8.4%), or delayed-onset (8.5%) symptom trajectories. Among non-traditional responders six classes were identified. Fewer responders were in a resistant/resilient trajectory (58%), and four of the classes accounting for almost 30% of the sample included individuals with persistent or newly emergent symptoms (Pietrzak et al., 2014).

Studies of the course of illness suggest that although the majority of civilians and responders appeared resilient, a subset of individuals have chronic symptoms and are likely to require sustained intervention. Non-traditional responders were more likely to report persistent symptoms. A substantial minority of individuals, particularly those who are not traditional responders (e.g., construction workers or lay volunteers) are at increased risk for late onset symptoms, suggesting that ongoing monitoring of all types of disaster workers will be required (Pietrzak et al., 2014). The existing data suggest resources may be needed for a period substantially beyond the initial incident, with additional services necessary for those with comorbid psychiatric illnesses (Caramanica et al., 2014).

Risk Factors for PTSD

There has been extensive research on both person-level and event-related risk factors for the development of PTSD following mass disasters, including the 9/11 attacks. Studies have examined risks in both the general population and rescue and recovery groups (Brewin, Andrews, & Valentine, 2000; DiGrande et al., 2008; Ozer, Best, Lipsey, & Weiss, 2003; Perrin et al., 2007). In meta-analyses of risk factors for all types of trauma, person-level variables including among others female gender, history of psychopathology, ethnicity, and prior trauma among other variables have been identified as risk factors (Brewin et al., 2000; Ozer et al., 2003). However, risk factors may not be the same for responder populations. For example, gender differences have not appeared in studies of military personnel (Brewin et al., 2000). Prior psychopathology is not consistently associated with risk among police (Carlier, Lamberts, & Gersons, 1997). Here we highlight consistent findings of potentially modifiable risk factors which can provide guidance for targeting intervention and preventive approaches.

Person-Level Factors

Person-level characteristics which have been identified as risk factors for both the general population and responder groups following the 9/11 events include lower levels of education (DiGrande et al., 2008) and lower levels of support during the event (Boscarino & Adams, 2009). The findings for the effect of education on risk for PTSD are consistent with other studies on socioeconomic disparities in health (DiGrande et al., 2008). Individuals with low socioeconomic status are more likely to face other stress exposures, including exposure to other sources of trauma, and they are likely to have reduced access to the social and material resources that may mitigate the effects of stress exposure (Breslau, Chilcoat, Kessler, & Davis, 1998).

Both education and social support also may serve as risk factors for PTSD through their association with emotion regulation capacities. Higher levels of education may be associated with cognitive coping capacities that aid in emotion modulation in response to traumatic events. In particular, cognitive control capacities involved in regulating the focus of attention, shifting perspective, and planning activities have been associated with better emotion regulation (Hofmann, Schmeichel, & Baddeley, 2012). Social support has been well documented to facilitate the ability

to modulate emotional reactivity to stress under certain conditions, and social support can also serve as a source of new coping approaches (Uchino, 2006).

The emotional or self-regulatory capacities associated with higher education may be accessible to others who have not completed higher levels of formal education, if they receive training and gain experience. For example, studies have suggested that the training provided to police and other first responders may also reduce risk for PTSD and increase resilience (Perrin et al., 2007; Pietrzak et al., 2014). First responders (including police, fire, rescue and recovery workers) receive training in approaches to responding to physically and technically demanding situations. These training procedures provide instruction in the deployment of attention to different aspects of the emergency situation and also provide instructions to facilitate planning an effective response. This training may support the cognitive functioning critical to emotion regulation (Brondolo, Wellington, Brady, Libby, & Brondolo, 2008).

However, first responders generally receive minimal training in managing psychosocial or interpersonal stressors associated with disasters. There is some evidence that exposure to distressed individuals (e.g., family members) may exacerbate the effects of exposure to traumatic events on PTSD symptoms (Coleman, Delahanty, Schwartz, Murani, & Brondolo, 2016). This suggests that the training for responders may need to incorporate more efforts to reduce stress associated with interpersonal factors involved in emergency response.

The findings of reduced PTSD symptoms among older adults exposed to trauma also suggest that experience may facilitate emotional regulation (Cherry et al., 2010; Norris & Murrell, 1988). One study examined the degree to which exposure to the 9/11 attacks affected subsequent PTSD symptoms in response to Hurricane Sandy. The findings revealed that prior exposure to the 9/11 attacks was associated with greater resilience to the development of PTSD symptoms among older, but not younger individuals. The resilience of older adults may be partly related to both experience and age-related changes in the capacity to regulate emotions in the face of trauma exposure (Cherry et al., 2010).

Event-Related Risk Factors

Event-related factors are also associated with variations in risk for PTSD. Among adults in the general population, greater proximity to the disaster site was associated with increased risk of symptoms (DiGrande et al., 2008). Among responders, increased risk of PTSD was associated with the magnitude of exposure to the physical demands involved in responding to the event as well as the psychological demands (Stellman et al., 2008). Physical risk factors associated with PTSD symptoms included longer duration of exposure to the event site (e.g., exposure to the pile at the WTC site), longer work hours, engagement in work for which one was not trained, and event-related illnesses (Perrin et al., 2007; Pietrzak et al., 2014). Event-related psychological factors increased risk among responders and included highly emotionally disturbing events (i.e., witnessing traumatic events, losing a friend or loved one) (Liu et al., 2014).

Among responders, groups at highest risk for PTSD include those who sustained injuries, experienced intense dust exposure, witnessed other horrific events on 9/11, engaged in prolonged rescue and recovery work, or experienced event-related losses of a loved one, colleague, or job (Liu et al., 2014). The poorer health outcomes seen in lay volunteers versus trained responders

may reflect earlier, more intense exposure to and lack of protection from physical and psychological hazards, especially for those working on the pile (i.e., site of WTC collapse) (Pietrzak et al., 2014).

Some researchers have suggested event related factors may predispose individuals to different mental health difficulties. Specifically, major depressive disorder (MDD) may develop preferentially in association with loss of life to others. PTSD may be more likely to occur when the individual has experienced or witnessed physical endangerment and injury (North et al., 2015).

Secondary Exposure

The findings also highlight the importance of secondary traumatic exposures (or re-exposure) through the media. Multivariate analyses of the effects of viewing the TV coverage of the 9/11 attacks on the prevalence of PTSD symptoms indicate that both the number of hours of viewing and exposure to disturbing images in coverage were significantly positively associated with PTSD symptoms. For example, television viewing less than four hours per day was associated with a 0.8% likelihood of probable PTSD; whereas those who viewed greater than 12 hours per day had probable PTSD rates as high as 10.1%. The lowest index for television content of disturbing images showed a probable PTSD rate of 1.5% and the highest reached a probable PTSD rate of 11.9 % (Schlenger et al., 2002). Studies of children following other mass disasters (e.g., the Oklahoma City bombing of a federal building) found significant levels of psychological problems related to direct and indirect exposure and to TV viewing, consistent with findings from studies of adults (Pfefferbaum et al., 2001).

Examination of risk factors for PTSD in both the general population and responders highlight the importance of both person-level sociodemographic and health-related factors as well as event-related factors. These findings can facilitate the identification of populations at greatest risk. The evidence also highlights the importance of providing greater training for lay responders, and ongoing training in addressing psychosocial stressors for professional responders. More intensive monitoring and intervention with those work directly at the site for prolonged periods may also be needed (Liu et al., 2014). The examination of risk factors also provides insights into approaches to intervention. The protective effects of education, training, and social support indicate it may be critical to include programs which use a variety of approaches to strengthen situation-specific emotional regulation capacities of high risk groups.

SCREENING AND MONITORING

PTSD screening has been recommended to occur immediately and at regular intervals post-disaster in consideration of the divergent trajectories of PTSD (Maslow et al., 2015). Brief screening instruments for PTSD could help identify individuals needing early referral for counseling following events. Ongoing screening will be necessary to identify newly emergency symptoms and to monitor those with persistent symptoms.

Several validated screening measures have been developed. The U.S. Department of Veterans Affairs (2017) offers a list of these measures. A number of these measures have been used in large scale screening efforts. For example, researchers developed New York PTSD Risk Score measure using longitudinal data collected in New York City after the 9/11 attack and other traumatic events. This instrument is simple to administer and outperformed other brief screening tools (Boscarino et al., 2011). This measure encompasses five domains, including core PTSD symptoms, sleep disturbance, access to care status, depression symptoms, and trauma history. PTSD symptomatology is measured using a self-report checklist including 17 items. Another measure, the Trauma Screening Questionnaire (TSQ) is a brief screening instrument for post-traumatic stress disorder that is easily administered. PTSD can be predicted effectively with as few as ten Yes/No questions about re-experiencing and arousal symptoms (Brewin et al., 2002). The use of a clear threshold allied to a Yes/No answer can simplify matters for respondents and practitioners. Recent work in military populations supports the use of very brief measures (e.g., four items), particularly if individuals who are identified as at high risk for PTSD can receive more intensive follow-up (Steele, Benassi, Chesney, Nicholson, & Fogarty, 2014).

Additional work is needed to facilitate rapid assessment of the public and responders. Brief measures may be helpful for rapid screening of large populations. More elaborated measures may be needed to evaluate comorbidity and to identify impairments in functionality and health. New technologies which improve ease of administration, including the web and mobile apps, may be increasingly valuable in permitting clinicians to rapidly assess large numbers of individuals after an attack.

Mental Health Services and Evidence-Based Best Practice

Multiple interventions to address PTSD are needed, including interventions to build resilience prior to trauma exposure, to prevent PTSD in those who have been traumatized, and to reduce symptoms and improve functioning in those with PTSD. Different interventions strategies may be needed for children and adults. Targeted interventions may be needed for both traditional responder groups and for lay or non-traditional responders. The bulk of the evidence has emerged from studies across different types of trauma, with much less evidence available on post 9/11 interventions.

Currently, reviews suggest that there is not an adequate evidence base to support any specific pre-trauma intervention to improve resilience and prevent PTSD in high risk or other populations (Howlett & Stein, 2016; Skeffington, Rees, & Kane, 2013). Acute post-trauma PTSD prevention has evolved considerably, but there are still gaps in knowledge. Recommended practices shifted away from the use of psychological debriefings in the acute post-trauma period to the implementation of Psychological First Aid (PFA). However, the literature does not yet provide empirical support for the effectiveness of these interventions in preventing PTSD (North & Pfefferbaum, 2013).

There is evidence for the effectiveness of specific clinical interventions in the prevention and treatment of PTSD. Systematic reviews suggest that brief trauma-focused cognitive behavioral therapies (CBTs) may be helpful in preventing PTSD in those who have been recently exposed to trauma and are experiencing acute symptoms (Roberts, Kitchiner, & Kenardy, & Bisson,

2009). Other studies also support the role of prolonged exposure and cognitive processing therapies in the post-trauma period for individuals displaying symptoms (Shalev et al., 2012), and the use of stepped-care interventions including both case management and cognitive behavior therapy (Kearns, Ressler, Zatzick, & Rothbaum, 2012).

A Cochrane review of the treatment of adults with chronic PTSD from different sources indicates support for individual and group trauma-focused cognitive behavior therapy and individual eye-movement desensitization and reprocessing. There is still a concern about drop-out from these active treatments, and the overall quality of evidence supporting these interventions requires improvement (Bisson, Roberts, Andrew, Cooper, & Lewis, 2013). For children, evidence indicates support for both cognitive behavior therapy and trauma-focused cognitive behavioral therapy for children who have suffered different types of trauma (Cary & McMillen, 2012; McDermott & Cobham, 2014; Wethington et al., 2008).

Post 9/11, there were substantial mental health interventions for the general population offered almost immediately after the attacks (Pandya, 2013). Many programs integrated medical and nonmedical services, as widely recommended (North & Pfefferbaum, 2013). Acute services included debriefings and other single-time outreach interventions. Post-acute phase interventions included community outreach with the goal of addressing normative psychological sequelae. At the time of 9/11, Federal Emergency Management Agency (FEMA) monies were not available for formal treatments. However, since 9/11, Project Liberty, a primary provider of disaster mental health services, has incorporated brief, evidence-based interventions for trauma-related problems in their outreach work. Given the pressing need for services, there was limited rigorous empirical evaluations of effectiveness of these services in reducing PTSD following 9/11 (Pandya, 2013).

There are gaps in resources for the prevention and treatment of PTSD. Some evidence suggests that internet versions of preventive PTSD interventions may be effective and may permit wider dissemination of evidence-based interventions for adults (Amstadter, Broman-Fulks, Zinzow, Ruggiero, & Cercone, 2009). However, additional research is needed to examine the specific groups for whom these interventions are effective and to identify the types of interventions which can best be offered via the internet (Lewis, Roberts, Bethell, & Bisson, 2015).

The resource issues are more complex for children. The evidence suggests that post 9/11 children were less likely to receive needed mental health interventions. An epidemiological survey by the New York Board of Education conducted six months after 9/11 found that 22% of children had received some form of counseling and more than half of this counseling (58%) was delivered in the schools (Stuber et al., 2002). However, it was the parent's level of distress rather than the child's behavioral symptoms that was associated with whether or not children received counseling in this study. These findings suggest that there is a large number of children who may have had psychological problems that could have benefited from referral to counseling services, and that the barriers to the use of these services need to be identified (Marshall & Galea, 2004; Stuber et al., 2002).

The evidence base supporting interventions for preventing and treating PTSD in responder populations is still limited (Haugen, Evces, & Weiss, 2012). There have been insufficient trials in the USA and insufficient evaluations of interventions focused on responder population to clarify the best practices (Haugen, Splaun, Evces, & Weiss, 2013). However, researchers have developed general principles and accompany techniques for an integrative approach for the treatment of PTSD in 9/11 first responders (Haugen et al., 2013). The techniques utilized include (a) an

emphasis on meaning making, particularly regarding the traumatic event; (b) focus on the most affect-laden components of the traumatic exposure; and (c) identifying and challenging the implicit strategies used by individuals to avoid discussion of components of their traumatic memories and the attendant negative affect. For each intervention, a theoretical rationale and presumed mechanism of operation are presented. The interventions are components of a cohesive, integrative treatment approach combining prototypic elements of psychodynamic and cognitive behavioral therapies tailored to this population.

Additional research suggests that targeted treatment of PTSD symptoms may provide the most benefit, and that treatment of dysphoria-related symptoms in disaster relief workers may have the most benefit for social and occupational functioning (Ruggero et al., 2013). Web-based versions of intervention including these components have been conducted with medical examiner personnel, one group of responders to mass fatality events (Brondolo, Kaur, Brondolo, Schwartz, & Delahanty, 2017).

In sum, there is still limited evidence for interventions to improve pre-trauma resilience in the general population or the responder groups (Haugen et al., 2013). In the acute aftermath of trauma, psychological first aid is commonly provided, although evidence is still needed to support this approach in the prevention of PTSD. There are good evidence-based approaches for PTSD prevention in symptomatic individuals and for PTSD treatment in children and adults receiving support, with strategies incorporating a trauma focus and cognitive behavioral exercises.

DISCUSSION

Epidemiological data suggest that the 9/11 mass fatality terror attacks were associated with high levels of immediate symptoms across the population, much of which resolved over time. Children are more likely to show symptoms, and elderly are less likely. Trained responders are less likely than the civilian population to develop PTSD, but a substantial minority, possibly as much as 10-12%, demonstrate persistent symptoms. Untrained responders (e.g., lay responders or construction workers) are more likely to show PTSD symptoms and less likely to have these symptoms resolved.

Common and consistently reported risk factors for PTSD in both the general population and the responders with exposure to the 9/11 attack suggest that high risk populations and exposure can be identified, and this knowledge may improve resources allocation (Liu et al., 2014). Socioeconomic disparities in PTSD highlight the need to devote resources to underserved or more vulnerable populations following disasters (DiGrande et al., 2008). Secondary exposures, including excessive viewing of media presentation of the traumatic event, increased risk (Schlenger et al., 2002). Psychological interventions are available, although the evidence on effective approaches is clearer for the treatment of PTSD in the general population in contrast to the primary prevention of PTSD (Howlett & Stein, 2016). More work must be done to evaluate pharmacotherapy for prevention of and intervention for PTSD (Krystal et al., 2017). There are significant unmet mental health needs even 10 years after 9/11 (Ghuman, Brackbill, Stellman, Farfel, & Cone, 2014).

PTSD does not just affect the responders. Disruptions of family, work and social life, and higher rates of behavioral symptoms in children of workers were significant risk factors for the

development of PTSD (Stellman et al., 2008). Interventions providing greater family support may be needed. PTSD in children is frequently not recognized, and greater outreach is needed. The more resilient elderly may be able to play a role in providing guidance and support to others.

Researchers have advocated for flexible approaches to resources to manage children's mental health in the post-period (McDermott & Cobham, 2014). Possible approaches include increased training of professionals, expanded intervention opportunities (e.g., in school), and potentially expanded training for a broader range of professionals capable of some intervention (e.g., teachers; Gelkopf & Berger, 2009), as well as expanded intervention modalities (e.g., via the web or apps; McDermott & Cobham, 2014).

More research is needed to characterize late-onset PTSD, its risk factors and predictors of traumatic symptom resolution and resilience. Our present knowledge of the trajectory of PTSD makes the case for PTSD screening in the acute and post-acute phase of disasters. However, the optimal screening tools for PTSD have yet to be determined and would likely vary according to the particular setting in which they are utilized. Comorbid mental health disorders such as depression need to be identified, as persons with comorbid PTSD and depression experienced poorer outcomes (Caramanica et al., 2014). Integrating medical and nonmedical services may help overcome barriers to seeking mental health services, including stigma and lack of mental health access, while simultaneously addressing physical ailments shown to increase the risk of PTSD (North & Pfefferbaum, 2013).

Limiting the amount and content of exposure to disturbing images in media coverage deserves more attention in preventing PTSD in both adults and children. Disaster planners, public health officials, and media outlets need to consider the negative effects of media coverage in disasters. The general public should be encouraged to reduce their media exposure risk, and exercise particular caution when regulating children's exposure to the media.

Immediate assistance should be proximal and non-intrusive. Support, compassion, and watchful waiting may be the best course for many. Non-intrusive screening such as use of brief screening instrument is recommended to identify individuals who are in need of additional services. Stepped care provides treatment to those that need it and at the level required. In the post-acute phase, resources need to be made available for more resource-intensive psychiatric treatment for the fraction of survivors who develop psychiatric illness (Pandya, 2013). New web-based approaches may extend the reach of interventions, but the evidence base supporting these interventions for PTSD prevention and treatment in those who have been traumatized by terror events is still incomplete. Despite the promise shown by some interventions, additional work is needed to provide an evidence base supporting prevention and intervention strategies for both professional and lay responders.

The risk of PTSD among exposed civilians and lay volunteers is gaining attention. Use of lay volunteers needs to be more effectively managed and volunteers need to be afforded the same protections from physical and psychological hazards as professional rescue/recovery workers. Lay volunteers must be provided with site specific training, regardless of prior disaster experience, to limit exposure to specific hazards. They must be familiarized with safe operating procedures, including use of appropriate personal protective equipment. When exposure to toxic substances is suspected, agencies charged with monitoring workers should extend this function to volunteers. Physical and mental health screening, counseling and referral services must be made available to all exposed rescue/recovery workers, lay volunteers, and civilians at risk.

CONCLUSIONS

Large scale disasters such as the WTC attack are associated with chronic impairment of mental health and social functioning in exposed individuals at high risk. Proactive approaches to planning for the psychological and medical stressors facing personnel involved in all phases of a disaster or mass fatality event are needed (Brondolo et al., 2008). The use of health registries offers a valuable tool to monitor the physical and mental health consequences of disasters in order to better understand long-term effects, allocate resources, assess interventions, and improve future disaster planning. Substantial research is underway to understand the underlying mechanisms, including biological, psychological, genetic, and social factors which contribute to the development of PTSD (Howlett & Stein, 2016). These studies will help guide future prevention and intervention efforts. Attention should be paid to variables that affect responders' stress exposure and recovery, including work hours and the duration of time in the most high-risk environments. Long-term surveillance and treatment programs are required and must be incorporated in pre-disaster mental health planning.

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