

# Mental Health Consequences of Disasters

Emily Goldmann and Sandro Galea

Department of Epidemiology, Mailman School of Public Health, Columbia University, New York, NY 10032-3727; email: egoldmann@gmail.com, sgalea@columbia.edu

Annu. Rev. Public Health 2014. 35:169–83

First published online as a Review in Advance on October 25, 2013

The *Annual Review of Public Health* is online at [publhealth.annualreviews.org](http://publhealth.annualreviews.org)

This article's doi:  
10.1146/annurev-publhealth-032013-182435

Copyright © 2014 by Annual Reviews.  
All rights reserved

## Keywords

psychopathology, posttraumatic, post-disaster

## Abstract

We present in this review the current state of disaster mental health research. In particular, we provide an overview of research on the presentation, burden, correlates, and treatment of mental disorders following disasters. We also describe challenges to studying the mental health consequences of disasters and discuss the limitations in current methodologies. Finally, we offer directions for future disaster mental health research.

## INTRODUCTION

Disasters are large-scale events that are often unexpected and cause death, trauma, and destruction of property (48, 50). Although there is no consistent definition of disasters in the literature, researchers generally agree that disasters share three key characteristics of large-scale traumatic events. First, disasters threaten harm or death to a large group of people, regardless of the actual extent of lives lost (48). Second, they affect social processes, causing disruption of services and social networks and communal loss of resources (42, 50). Third, they involve secondary consequences, namely identifiable mental and physical health outcomes, among those affected (48). In this review, we focus on the potential mental health consequences of disasters.

Disasters affect millions of people around the globe every year. There is, on average, at least one disaster every day worldwide, and the frequency and human impact of disasters have been increasing owing to climate change and growing population density (43). In 2005, ~162 million people were affected by disasters globally (57); in 2010, this estimate increased to more than 330 million (58). Some areas of the world are more affected than others, with almost three-quarters of those affected by disasters worldwide living in China in 2010. Death toll varies by disaster, but deaths generally constitute a very small proportion of those affected. For example, only 0.1% of the 330 million individuals affected by disasters in 2010 were killed (58). A large US community study reported that 13–19% of adults experience a disaster in their lifetime (13, 33).

Studies frequently categorize disasters into three types: natural disasters (e.g., floods); human-made, nonintentional technological disasters (e.g., the nuclear accident at Chernobyl); and human-made, intentional acts such as mass violence and terrorism [e.g., the September 11, 2001, World Trade Center (WTC) attacks] (50, 61). Some evidence, though contested, indicates that the type of disaster influences the burden of mental health consequences in the affected population; human-made technological disasters and mass violence tend to have a more pronounced psychological impact than do natural disasters (23, 50). From a population health point of view, it may be more useful to consider the characteristics of the event rather than the cause, given that different types of disasters can have much in common. Additionally, some disasters are multi-type, such as the events in Fukushima, Japan, in 2011, which involved both natural and technological disasters (43). Therefore, in this article we move beyond labeling disasters by cause and focus rather on the aspects of the disaster experience that can be linked to the mental health consequences of these events.

We have long known that violent and life-threatening events can have psychological consequences (6). The field of disaster mental health has strong roots in research on the mental health consequences of war, specifically stemming from the experiences of World War I, World War II, and the Holocaust (61). Disaster mental health research has evolved over the years, beginning with studies in the 1940s of the symptoms and management of acute grief and other neuropsychological symptoms among those who had suffered the loss of a loved one and among victims of the Cocoanut Grove night club fire (1, 39). In 1950, Tyhurst (66) coined the term “disaster syndrome” as the period right after a disaster when exposed persons are “dazed, stunned, unaware, frozen, or wandering aimlessly,” symptoms that can affect up to 20–25% of those exposed and generally resolve with time. The 1960s and 1970s saw growing interest in how disasters could influence communities and result in large-scale effects, as well as interest in the mental and physical health consequences of different types of disasters, the influence of context on risk to mental health, and the distinct needs of different types of disaster victims. Studies also began to incorporate population-based epidemiologic methods during this period (61).

In 1980, posttraumatic stress disorder (PTSD) was added to the third edition of the *Diagnostic and Statistical Manual of Mental Disorders* (DSM-III), largely stemming from recognition of the mental health burden borne by veterans of the Vietnam War, which clarified and intensified

interest in posttraumatic mental health conditions. The addition of PTSD to the DSM and the development of structured diagnostic instruments based on DSM criteria facilitated growth in research concerned with the consequences of traumatic events, including disasters (63). Approximately coincident with this development, the International Society of Traumatic Stress Studies (ISTSS) was established to bring together researchers to develop disaster planning and response strategies. Interest in developing interventions to prevent or reduce psychopathology after disasters grew, leading to techniques such as psychological debriefing and psychological first aid (61). Research and practice in the area progressed rapidly through the 1990s, as organizations such as the World Health Organization (WHO) developed planning and response guides to disasters, researchers launched publications devoted to the study of traumatic stress, and the field expanded its reach to include terrorism, epidemics, and the role of ongoing stressors in vulnerability to psychopathology after disasters. Studies in the past decade have been characterized by rigorous epidemiologic methods and the development of evidence-based guidelines for early intervention and response to mass violence (61).

In this review, we describe the current state of the field of disaster mental health research. We do not provide an exhaustive synthesis of the extant literature, which has already been presented in several excellent review articles and books (23, 47, 48, 50, 51, 56). Rather, we aim to provide an overall picture of what we have learned from decades of research on the presentation, burden, correlates, and treatment of mental disorder following disasters. We also describe challenges to studying disaster-related psychopathology and limitations in our current methodologies and offer directions for future research.

## POST-DISASTER PSYCHOPATHOLOGY

Exposure to disasters has been associated with a variety of mental health consequences (50). Although the majority of individuals cope well in the face of a disaster (53), a substantial proportion experience some psychological impairment (50), and a smaller proportion will go on to develop mental disorders. Studies have documented the prevalence of various types of psychopathology following different types of disasters, from natural disasters such as Hurricane Katrina (31) to the September 11, 2001, WTC attacks (19). In this section, we describe the manifestations and burden of mental illness that have been observed after disasters.

### Resilience

Studies of traumatic event experience have shown that most people who experience an event do not develop psychopathology (9, 53). Having the capacity to continue functioning after a traumatic event is common and characteristic of normal coping and adaptation (5, 6). This phenomenon has become known as “resilience” and is an emerging concept in the disaster mental health literature (6, 53). Research on resilience advanced in the 1970s, as researchers noted a preponderance of healthy development among children exposed to substantial hardship (6, 41). There is a growing consensus, however, that resilience does not indicate the complete absence of any psychological symptoms after traumatic event exposure; rather, it describes the ability to “bounce back” (35, 53). Resilience has been documented in populations exposed to disasters (6, 53, 60). Resilient individuals generally experience distress for a short period and quickly return to pre-disaster levels of functioning (50), distinguishing them from those who experience a longer period of dysfunction and a more gradual return to baseline functioning (“recovery”) (4).

Although most work in this area has relied on cross-sectional assessments, more recent work has capitalized on longitudinal samples that allow investigators to document the course of

---

**MDD:** major depressive disorder

---

symptomatology over time (53). In one such study, Pietrzak and colleagues examined the course of PTSD and other mental disorders in Galveston, Texas, following Hurricane Ike at three post-hurricane time points. They found that ~7% of participants had symptoms of PTSD at baseline. This prevalence declined over time, with most symptoms resolving by the follow-up interviews, demonstrating resilience as a common post-disaster outcome (60).

### Posttraumatic Stress Disorder

PTSD is a mental illness that can follow exposure to a traumatic event and is characterized by reexperiencing of the event through nightmares and/or flashbacks; avoidance of stimuli reminiscent of the event and numbing of emotional responses; and symptoms of hyperarousal (e.g., being particularly watchful or on guard) (2). PTSD is the only disorder whose diagnosis is predicated on the experience of a traumatic event and is, therefore, one of the most commonly occurring (and studied) post-disaster psychopathologies (23, 48, 50). Post-disaster burden can be substantial; one review of the literature estimates the prevalence of PTSD at 30–40% among direct victims, 10–20% among rescue workers, and 5–10% in the general population (23, 48, 50). The prevalence of PTSD is also particularly high among children directly exposed to a disaster (48). Prevalence estimates vary greatly between studies owing to differences in factors such as disaster type, degree of exposure, and methods of measurement; studies of children exposed to sudden, unexpected acts of mass violence report PTSD prevalence in up to 100% of those studied (27).

### Major Depressive Disorder

Major depressive disorder (MDD) is one of the most common mental illnesses in the general population (29), characterized by sadness and loss of pleasure or interest in things once enjoyed, as well as a combination of other symptoms such as changes in sleep and weight, difficulty concentrating, and irritability (2). In disaster research, depression is, after PTSD, the second most commonly studied post-disaster mental health condition (50); however, owing to its large burden in the general population, it may be the most prevalent post-disaster disorder. Studies report a range of MDD prevalence estimates after disasters because prevalence estimates depend on factors such as MDD prevalence in the study population prior to the disaster, symptom measurement, sampling design, degree of disaster exposure, and post-disaster social support (40). For example, 5% of the Texas population affected by Hurricane Ike met criteria for MDD in the month following the storm (65), whereas almost one in ten adult New Yorkers showed symptoms of MDD in the month following the WTC attacks (20).

### Substance Use Disorder

Substance use disorders are characterized by problematic alcohol or drug use that results in difficulty fulfilling obligations in work, home life, or school; legal issues; difficulties in social relationships; involvement in dangerous situations; increased tolerance; symptoms of withdrawal; and unsuccessful efforts to quit (2). These conditions have been less frequently studied after disasters than has PTSD or MDD. Some studies have observed increases in the use of alcohol, drugs, and cigarettes after a disaster, and some evidence shows that disaster victims use substances, particularly alcohol, as a coping strategy (69). For example, ~15% of Oklahoma City bombing survivors reported using alcohol to cope with their experience (55). Studies have also demonstrated increased use of alcohol, cigarettes, and marijuana in the period following the WTC attacks, with almost 10% of New Yorkers reporting increased cigarette use, almost 25% reporting increased

alcohol use, and 3% reporting increased marijuana use (71). Despite some evidence of substance use problems after disasters, however, a recent review of the literature argues that the prevalence of substance use disorders does not increase substantially after a disaster and that problematic use is found primarily among those with prior substance use problems or those who developed other psychopathology in response to the disaster (50, 69).

## Other Psychological Symptoms

In addition to these disorders, other psychological sequelae of disasters have been described. Studies have reported elevated prevalence of generalized anxiety disorder (GAD) among those affected by a disaster, although it is less commonly studied than PTSD and depression (42). Death anxiety, panic disorder, and phobias have also been reported among disaster victims, although few epidemiologic studies have focused on these conditions (50). Given the potential for sudden loss of a loved one in a disaster situation, studies have also evaluated the burden of prolonged grief disorder (PGD) in disaster-affected populations (40). Additional post-disaster symptoms documented include nonspecific psychological distress, perceived stress, *ataques de nervios* (in a study in Puerto Rico), suicidality, and remorse (21, 50).

Somatic symptoms also manifest in the aftermath of disasters; these may be associated with psychological distress. For example, exposed persons frequently report sleep disruption, due to feelings of grief over loss and anxiety about disaster reoccurrence and ongoing threats or due to symptoms of depression or PTSD (45, 68). Disasters have been found to precipitate other physical symptoms such as headache, fatigue, abdominal pain, and shortness of breath. The prevalence of these symptoms varies by study, from 3% to 78% in one review. Although physical symptoms generally subside over time, some persist for years following the disaster (74). For example, women who survived the Chernobyl disaster continued to report significantly greater physical symptoms more than a decade after the accident compared with controls (11).

## Comorbidity

The disorders discussed here rarely present in isolation, in the general population (30) and in the post-disaster environment. Disaster-related PTSD is often accompanied by symptoms of other anxiety disorders, MDD, and substance use disorders (42). For example, more than half of all survivors of both the Oklahoma City bombing and the WTC attacks who met criteria for PTSD were also identified as having major depression (20, 55). Chiu and colleagues (15) describe three potential explanations for the high prevalence of PTSD and depression comorbidity following a traumatic event such as a disaster: Both disorders are psychological consequences of traumatic exposure, suffering with PTSD brings on secondary depression, and symptoms that characterize the two conditions overlap (15). Those with comorbid psychological disorders are generally more impaired than those with only one condition and are at greater risk for chronic disorder (42, 69).

## Course

At this point, the burden of mental disorders after disasters has been well documented, and interest in the course or trajectory of psychological symptoms following disasters is growing. Evidence from longitudinal studies suggests that post-disaster symptoms of mental health problems reach their peak in the year following the disaster and then improve, but in many studies symptoms persisted for months and years for some participants (49). Norris et al. (53) have suggested four distinct symptom trajectories: resistance, resilience, recovery, and chronic dysfunction. Resistance

is defined as experiencing no symptoms of mental illness or only mild symptoms after the disaster. Resilience, described in detail above, is characterized by symptoms of mental disorder in the period immediately following the disaster that rapidly decline after a short while. Recovery differs from resilience such that symptoms that present after the disaster decrease gradually after a longer period of suffering. Finally, chronic dysfunction describes moderate or severe symptoms whose levels remain stable over time, and it is found only in a relatively small proportion of persons exposed to a traumatic event (6). Although rare (49), there is some evidence of delayed dysfunction, in which symptoms develop not immediately following the disaster but after some time (53). Persons with delayed reactions tend to have high levels of symptoms right after the disaster that may not be severe enough to meet full criteria for a disorder but may worsen over time and develop into full-blown disorder (6).

## **RISK FACTORS FOR POST-DISASTER PSYCHOPATHOLOGY**

Consistent with life-course epidemiologic perspectives (37), characteristics or experiences of individuals before, during, and after a disaster may influence mental health outcomes and interact to produce psychopathology. Therefore, we divide this section into pre-, peri-, and post-disaster factors and discuss how they may increase vulnerability to mental illness.

### **Pre-Disaster Risk Factors**

Good evidence has demonstrated that prior mental health problems, female gender, and younger age are key pre-disaster risk factors for post-disaster mental illness. Just as history of mental illness strongly predicts subsequent episodes of illness in nondisaster settings (28), those with prior mental health problems are at greater risk, as compared with other disaster survivors, of having psychological symptoms after the disaster (50). Pre-disaster mental illness is consistently associated with post-disaster PTSD (48), depression (40), substance use disorders (69), and reduced likelihood of resilience (6) and explains much of the variance in post-disaster mental health outcomes (69).

Psychological outcomes such as PTSD and depression are generally worse for female disaster survivors (23, 48), with the exception of alcohol and other substance use disorders, which are more prevalent among men after a disaster (69). Women are also less likely than men to be resilient in the post-disaster period (6). This gender difference has been observed in both adults and children and in developed and developing countries regardless of the type of disaster (50), reflecting the greater prevalence of mood and anxiety disorders among women and elevated prevalence of substance use disorders among men in the general population (32).

Children exposed to disasters are particularly vulnerable to psychological problems, most commonly symptoms of anxiety (e.g., PTSD, panic, phobias) and depression but also acute stress reactions and adjustment disorder (27). Elevated vulnerability among children may be a function of their being less equipped to cope with what they have experienced (49). Among adults, older age tends to be protective against depression (40), substance use (69), and less consistently, PTSD (23) after disasters. Middle-aged adults are generally at greatest risk of developing psychopathology, perhaps owing to having more chronic life stress and burdens and needing to support others (50). The effect of age on disaster-related psychopathology, however, may vary between settings with different cultural, economic, and social structures (42, 50).

Other pre-disaster factors that have been associated with greater risk of psychopathology after disasters are low socioeconomic status (6, 23, 40, 50, 69), minority ethnic status (23, 50), and low social support or poor relationships (23, 40, 48). Personality characteristics such as neuroticism, trait worry, and avoidance coping have also been associated with poor mental health outcomes



after disasters, whereas higher perceived ability to cope and self-efficacy, optimism, hardiness, and flexible adaptive responses have been associated with less psychological distress and greater resilience (48, 50). Being single has been linked to higher risk of depression after disasters (40), although some data suggest that being married is a risk factor for post-disaster psychopathology among women (but protective for men) (50). Having children has also been associated with greater risk of poor mental health outcomes (50), perhaps because of greater concern, responsibilities, and stress during and after the disaster. Finally, some evidence shows that having experienced traumatic or stressful events prior to the disaster puts an individual at greater risk for post-disaster mental health problems (40, 48) and reduces the likelihood of resilience (6).

It is important to note that some of the pre-disaster risk factors described above may be associated with greater risk of post-disaster psychopathology because they elevate risk or intensity of disaster exposure or because they leave an individual more vulnerable to the psychological consequences of the disaster experience. A combination of both increased exposure and vulnerability may also contribute to the role these factors play in shaping the risk of post-disaster psychological consequences. A burgeoning body of research aims to further elucidate the mechanisms through which these pre-disaster factors influence post-disaster psychopathology (34).

### **Peri-Disaster Risk Factors**

Persons who live in a community where a disaster has occurred may differ in their degree of exposure to the event. They may be affected directly, being present at the disaster site, or indirectly, having loved ones present at the disaster site or seeing images of the disaster in the media (23, 70). The degree or severity of this exposure is, above all, the most predictive factor of post-disaster mental illness. Studies measure disaster exposure in various ways: as the number and intensity of disaster-related events, the type of disaster, duration of exposure, death toll, and proximity to where the disaster occurred. Regardless of how it is measured, greater or more intense exposure consistently and strongly predicts higher risk of psychopathology, often showing a dose-response relationship (40, 43, 48, 50). Most measures of disaster exposure may be seen as proxies for the extent to which an individual experienced extremely stressful or traumatic events during the disaster such as life threat, injury, and witnessing of horrific events such as death of or harm to others (50). Consequently, disasters that are accompanied by a large death toll generally result in higher prevalence of psychopathology in the population because a large proportion of survivors has likely witnessed and personally experienced life-threatening and other traumatic events and may have lost loved ones (54). That the risk of developing mental health problems after disaster increases with the number of traumatic events experienced during the disaster likely explains the higher prevalence of psychopathology among those directly affected compared with rescue workers and others in the general population (many of whom may be indirectly affected or not affected at all). This may also explain why the prevalence of psychopathology is generally higher in populations that experience a human-made technological disaster or act of mass violence than among those exposed to a natural disaster (50). Population sampling after natural disasters is often more difficult than after more contained human-made events, and studies of these events tend to include a larger area of exposure, which may also comprise less affected persons who are less likely to develop mental illness (23, 48).

### **Post-Disaster Risk Factors**

Two post-disaster factors are key predictors of the development and course of disaster-related mental illness: post-disaster life stressors and social support. Ongoing stressors such as job loss,

property damage, marital stress, physical health conditions related to the disaster, and displacement are often experienced by those affected by a disaster and can increase vulnerability to post-disaster mental health conditions, including PTSD (23) and depression (40, 49, 50). Experiencing ongoing stressors after a disaster may also influence the course of psychopathology in the long term. A study of Hurricane Ike survivors found that these post-disaster stressors were associated with posttraumatic stress symptoms and functional impairment not just at the baseline interview but also at two follow-up interviews over the subsequent 18 months (14).

Low levels of and reductions in social support are also associated with post-disaster psychological symptoms (50), as well as disorders such as PTSD (23), MDD, and PGD (40) and, less consistently, with increased substance use (69). Greater social support resources have also been associated with resilience (6). Nondisaster population studies consistently report that higher levels of social support—in particular, perceived social support—may protect against the development of mental illness in the face of stressful events (10, 59). Social support may function as a buffer against negative psychological consequences of stressful events by influencing how an individual reacts to and copes with her experience (25, 73). Displacement, death, and disruption of communication in the wake of a disaster can result in loss of pre-disaster social networks and support or reductions in the quality of social support, particularly when it is most needed (40, 50).

### **A Note on Differential Psychopathology**

In general, the factors that emerge in studies as predictive of post-disaster psychopathology are similar across types of mental illness studied. However, evidence shows that the determinants of mental illness may vary by type of disorder. Norris et al. (52) suggest that peri-event risk factors—namely, degree of disaster exposure—play a more significant role in the development of PTSD, whereas post-disaster factors are more predictive of depression. More specifically, one study of Hurricane Ike victims found that PTSD was strongly predicted by events experienced during and immediately after the disaster. Depression, however, was more a function of personal vulnerability (e.g., low socioeconomic status) and life stressors (65). These findings provide insight into the potential mechanisms through which disaster experience may influence various mental health outcomes and suggest areas where intervention may prevent or reduce the severity and course of disaster-related mental illness.

## **PREVENTION, TREATMENT, AND RECOVERY**

Just as characteristics or conditions before, during, and after a disaster can influence the development of psychopathology, interventions conducted during the pre-, peri-, and post-disaster periods can improve mental health outcomes. In this section, we review various actions that might be taken prior to, during, and after disasters to prevent, reduce the severity of, and treat mental disorders and promote recovery.

### **Pre- and Peri-Disaster: Anticipating and Preparing for Disasters**

The key functions of pre-disaster preparation efforts are to prevent or minimize exposure to potentially traumatic disaster-related events and reduce likelihood of additional post-disaster stressors, which are both associated with post-disaster mental disorders. Local governments and communities can reduce the likelihood and severity of disaster exposure in several ways. First, real estate development in particularly vulnerable locations can be discouraged and building regulations modified to prevent collapse. There is often greater devastation, injury, death, and housing loss after



natural disasters when they are experienced in low-income countries because these regulations are not present or enforced (43). Developing disaster-ready infrastructure that can prevent property destruction, injury, and death (e.g., building sea walls to prevent flooding during hurricanes) can substantially reduce the impact of disasters (36). Communities can also develop and test response methods that are adaptable to different disaster situations and implement them quickly when a disaster strikes, building on knowledge gained during previous disasters (43). Local governments can also provide incentives for power and water companies to build more robust systems to prevent extended loss of electricity, heat, and running water, which can serve as ongoing stressors in the aftermath of disasters. Finally, in the case of natural disasters, mandatory evacuation of areas anticipating substantial exposure can reduce the number of people exposed to disasters. Availability of shelters that are stocked with appropriate supplies and staffed to respond to physical and behavioral health needs during a disaster is essential in this regard.

### **Post-Disaster: Preventing and Treating Mental Health Conditions**

Post-disaster interventions have been developed to assist disaster survivors in different phases of the disaster aftermath, all with the goals of preventing the development of and treating symptoms of psychopathology. Interventions in the acute phase directly following the disaster are designed to promote survivors' safety and stability and to help them cope with their experiences (12). One such intervention, psychological debriefing or critical incident stress debriefing, was developed in the 1980s for emergency responders and has been used with other victims of trauma (46). The technique is applied within 48 h of the traumatic event, during which victims are asked to describe the event and their emotional responses to it in detail. They are also given suggestions of methods to relieve stress (12). Intervention studies, however, have found that this method does not prevent psychopathology and, by strengthening memories of the traumatic event, may impair the natural recovery process and even worsen symptoms (44). Therefore, it is no longer recommended in the immediate aftermath of traumatic event exposure (12, 49).

Psychological first aid (PFA) has become the preferred post-disaster intervention, with three goals: Secure survivors' safety and basic necessities (e.g., food, medical supplies, shelter), which promotes adaptive coping and problem solving; reduce acute stress by addressing post-disaster stressors and providing strategies that may limit stress reactions; and help victims obtain additional resources that may help them cope and regain feelings of control. PFA does not encourage victims to recount their trauma directly after their experience but rather aims to improve coping skills without causing additional distress. PFA has shown promise and has already been adopted by some government agencies, but empirical studies that evaluate its effectiveness are still needed (12).

Addressing modifiable stressors, promoting calm, alleviating stress, and helping victims return to pre-disaster routines and functioning may also be effective as an early intervention (14, 62). It has been suggested that helping victims with their social needs in the immediate aftermath of a disaster should be prioritized over trying to treat mental health problems, with the exception of individuals with urgent psychiatric needs, who should be referred to mental health services as soon as possible (12). Additionally, in light of evidence of an association between disaster-related media exposure and mental disorders such as PTSD (48) and substance use (69), communicating information about disasters in such a way as to reduce fear and promote calm may reduce psychological distress in populations (6).

Once the initial post-disaster period has ended and safety and security have been restored, identifying those at risk of developing psychopathology and preventing or treating nascent psychological symptoms become priorities (12). Cognitive-behavioral therapy (CBT) has gained strong empirical support for treating and preventing posttraumatic disorders (12, 49). During CBT,

individuals are taught techniques for coping with and managing anxiety to help them gain a sense of mastery over their fear and to reduce symptoms of arousal. Often the therapist asks the individual to imagine the traumatic experience and describe it in detail or to be exposed to situations that are reminiscent of the event. This technique, often referred to as exposure therapy, helps victims address thoughts or situations that produce fear and avoidance in a safe environment. This treatment has proven efficacious for victims of different types of trauma, including disaster exposure (12).

Although most disaster victims will regain functioning without an intervention (12), some will require longer-term treatment for psychological conditions (17). CBT has garnered the most support in treatment of PTSD, and some evidence indicates that it can also be helpful to treat comorbid depression and other anxiety disorders (3, 17). However, only a few randomized controlled trials have used CBT for disaster survivors, and not many studies have evaluated the impact of CBT on mental health in the long term (38). Psychiatric medications, namely selective serotonin reuptake inhibitors (SSRIs), have also effectively treated PTSD with and without comorbid depression (26).

### Use of Services

General population studies find that only a small proportion of those with PTSD seek treatment following traumatic events, and often years pass between the onset of symptoms and treatment seeking (7, 72). McFarlane et al. (42) found similar results among disaster victims. Only 6% of persons affected by Hurricane Katrina received mental health services within 4–6 months of the disaster, mostly in the general medical service sector (18). A review of post-disaster mental health care utilization reported that the need for services (measured, for example, by the presence of PTSD or depression symptoms) is consistently related to treatment use. Middle-aged adults (compared with younger or older adults), women (compared with men), whites (compared with blacks and Hispanics), persons with more intense disaster exposure, those who experienced panic attacks during the disaster, and those with more severe PTSD were more likely to use mental health services. Having difficulty sleeping, reporting more days with poor mental or physical health, having close relationships with individuals who died in the disaster, and reporting increased alcohol use were associated with mental health care use among those less directly exposed to a disaster (17, 18).

Health care service delivery may be challenging in the post-disaster environment and often requires coordination and cooperation among levels of government, health services programs, schools, media, and community organizations (49). Also, there may not be enough mental health service providers available in the aftermath of a disaster. One promising alternative is to provide Internet-based CBT. This type of treatment would not require direct input from a therapist and could be anonymous and easy to access if Internet service is available. Initial evidence suggests that web-based programs may help reduce post-disaster psychological problems and may provide therapy to those who would not otherwise receive it (12).

## CHALLENGES TO STUDYING MENTAL HEALTH CONSEQUENCES OF DISASTERS

Studies of post-disaster psychopathology face substantial logistical and methodological challenges owing to the unexpected nature of disasters and the population displacement and service disruption that often follow these events. Logistic complications arise from the inability to plan in advance, changing conditions in the affected area, and the difficulty of assembling an effective research team

and obtaining necessary resources quickly (22). For example, in the aftermath of a disaster, the location of the affected population and the extent of evacuation may be unknown. Pre-disaster maps and population statistics may not reflect the current situation in the impacted area, making it difficult to ascertain the study population and forcing researchers to gather additional data to aid study planning and design. Investigators may have to rely on interviewers who may be unfamiliar with the research area, with sampling, and with interviewing techniques and may require extensive training. Obtaining funding and required approval from an institutional review board may also be a challenge and may require the primary investigator to cobble together disparate resources (22).

The disaster context introduces additional methodological challenges, over and above the challenges that affect all studies of mental health, in four key areas: defining the target population, obtaining a representative sample of affected persons from this population, implementing an appropriate study design, and measuring key constructs. The first challenge lies in identifying the correct sampling frame, which generally comprises all persons affected by the disaster. The sampling frame may be even more difficult to identify in natural disasters, when the geographic area of impact is larger and less defined (23). Choice of the study population will likely influence study results; selecting a larger area or population may include more indirectly exposed persons in the sample population and result in lower estimates of the burden of post-disaster mental disorders. Additionally, because large numbers of persons may evacuate the disaster-affected area, it may be difficult to know who was in the area before and during the disaster, particularly if they were not residents or employees of businesses in the area (22).

The second challenge lies in finding potential participants and completing interviews. Widespread displacement and communication breakdown may make it difficult to reach persons who have experienced the disaster, and if they can be reached, they may be consumed with recovery efforts and may not agree to participate in research (24). Oftentimes, studies must settle for convenience or treatment-seeking samples (43), which can introduce selection bias into and limit generalizability of study results. Door-to-door, in-person studies may be a good option if communication systems are not functioning. Telephone or Internet-based studies, which are cheaper, can be implemented from a distance and may also reach displaced persons (via cell phone); these may be better options if phone and Internet services are functioning. However, persons without Internet or phone services will be excluded and estimates may not represent the target population (22). Certain populations, such as children, minority groups, nonnative speakers, homeless persons, transient youth, and migrant populations, may be particularly difficult to reach after a disaster (22, 67). Exclusion of these groups may influence the representativeness of the study findings and, if these groups are particularly vulnerable to post-disaster psychopathology, may result in underestimation of the disaster's impact on the community's mental health. These issues may also result in low response rates, particularly when there has been substantial displacement, which could bias results.

Third, cross-sectional, post-disaster-only study designs are most frequently used in disaster studies (22, 49, 50). These studies are limited by temporal ambiguity regarding the association between exposure and outcome; i.e., it is difficult to determine whether the disaster exposure preceded the mental health outcome. Additionally, it is difficult to say if the disaster caused the observed psychological conditions or if they simply reflect pre-disaster burden because the study did not assess psychopathology in the sample prior to the disaster. To address these limitations, researchers may ask questions about the timing of symptom onset. If data are available, researchers can also compare findings to estimates of the mental health burden in the population prior to the disaster using data from recent community studies. Additionally, researchers might determine the impact of a disaster on a community by using unaffected communities as control groups. However, retrospective assessments of previous mental health history are subject to recall bias,

and comparisons between affected and nonaffected communities (or between pre- and post-disaster environments in the same community) may be confounded by unmeasured differences in the two populations (22). Prospective or longitudinal studies are less likely to suffer from these limitations and are particularly useful for studying trajectories of long-term psychopathology. Although they are becoming more common in the field of disaster mental health research, these types of studies are time consuming, can be expensive, and often require additional weighting to prevent bias due to differential attrition by certain characteristics (22).

Finally, measurement of disaster exposure, mental health outcomes, and other covariates poses challenges to disaster mental health researchers. Exposure to potentially traumatic events is disaster-specific and often measured differently between studies, making it difficult to compare experiences and mental health consequences or to generalize findings to all disaster-affected populations (22). Additionally, most instruments that assess symptoms of mental disorder have been developed and validated in the United States (23, 48) and may lack cultural relevance and validity in areas impacted by disasters worldwide. Collaborating with local researchers may aid research efforts.

## **DIRECTIONS FOR FUTURE RESEARCH**

Four areas in the field of disaster mental health may benefit most from further research. First, studies that shift their focus from post-disaster prevalence of mental illness, which has been examined extensively, to longitudinal assessments of disaster victims to further elucidate disorder trajectories stand to make a contribution (23, 48, 49). These studies can help us understand what factors are associated with different courses of mental illness, which can help us identify the most vulnerable populations and inform tailored interventions (48). Second, the field needs studies that evaluate a wider range of psychopathology than has currently been studied. For example, although most studies assess symptoms of PTSD after disasters, few studies have focused on other anxiety disorders such as GAD and panic disorder (42). These studies can address the potential for comorbid conditions (69); this kind of assessment would likely represent a more accurate picture of post-disaster functioning than does consideration of single disorders.

Third, additional studies are needed of interventions that aim to prevent or reduce symptoms of mental illness among disaster victims (42, 49). Although some interventions have been deemed efficacious in randomized controlled studies, effectiveness studies are needed to evaluate how well interventions work in the general population with practicing clinicians (38) and how well they prevent or reduce comorbid depression and substance use disorders (8, 17). Fourth, the field would benefit from studies that evaluate a broad range of potential risk factors at multiple levels, from biological and genetic characteristics that may predispose some disaster victims to poor mental health outcomes to other individual- and macro-level factors that increase vulnerability to mental disorders. Studies that examine how genetic and environmental characteristics interact to produce disease, as well as studies aimed at understanding how environmental insults can “get under the skin” or influence how our genes behave, have been applied to the study of mental disorders such as PTSD, depression, and substance use disorders (16, 64). This line of research may prove a fruitful avenue of inquiry into how disasters affect population mental health.

## **DISCLOSURE STATEMENT**

The authors are not aware of any affiliations, memberships, funding, or financial holdings that might be perceived as affecting the objectivity of this review.

## LITERATURE CITED

1. Adler AB. 1943. Neuropsychiatric complications in victims of Boston's Coconut Grove disaster. *JAMA* 123:1098–101
2. Am. Psychiatr. Assoc. 2000. *Diagnostic and Statistical Manual of Mental Disorders*. Washington, DC: APA. 4th ed. Text rev.
3. Bisson JI, Ehlers A, Matthews R, Pilling S, Richards D, Turner S. 2007. Psychological treatments for chronic post-traumatic stress disorder: systematic review and meta-analysis. *Br. J. Psychiatry* 190:97–104
4. Bonanno GA. 2004. Loss, trauma, and human resilience: Have we underestimated the human capacity to thrive after extremely adverse events? *Am. Psychol.* 59:20–28
5. Bonanno GA. 2005. Resilience in the face of potential trauma. *Curr. Dir. Psychol. Sci.* 14:135–38
6. Bonanno GA, Gupta S. 2009. Resilience after disaster. See Ref. 47, pp. 145–60
7. Boscarino JA, Galea S, Ahern J, Resnick H, Vlahov D. 2002. Utilization of mental health services following the September 11th terrorist attacks in Manhattan, New York City. *Int. J. Emerg. Ment. Health* 4:143–55
8. Brady KT, Killeen TK, Brewerton T, Lucerini S. 2000. Comorbidity of psychiatric disorders and post-traumatic stress disorder. *J. Clin. Psychiatry* 61:22–32
9. Breslau N, Kessler RC, Chilcoat HD, Schultz LR, Davis GC, Andreski P. 1998. Trauma and posttraumatic stress disorder in the community: the 1996 Detroit Area Survey of Trauma. *Arch. Gen. Psychiatry* 55:626–32
10. Brewin CR, Andrews B, Valentine JD. 2000. Meta-analysis of risk factors for posttraumatic stress disorder in trauma-exposed adults. *J. Consult. Clin. Psychol.* 68:748–66
11. Bromet EJ, Gluzman S, Schwartz JE, Goldgaber D. 2002. Somatic symptoms in women 11 years after the Chernobyl accident: prevalence and risk factors. *Environ. Health Perspect.* 11:625–29
12. Bryant RA, Litz B. 2009. Mental health treatments in the wake of disaster. See Ref. 47, pp. 321–35
13. Burkle FM Jr. 1996. Acute-phase mental health consequences of disasters: implications for triage and emergency medical services. *Ann. Emerg. Med.* 28:119–28
14. Cerdá M, Bordelois PM, Galea S, Norris FH, Tracy M, Koenen KC. 2012. The course of posttraumatic stress symptoms and functional impairment following a disaster: What is the lasting influence of acute versus ongoing traumatic events and stressors? *Soc. Psychiatry Psychiatr. Epidemiol.* 48:385–95
15. Chiu S, Niles JK, Webber MP, Zeig-Owens R, Gustave J, et al. 2011. Evaluating risk factors and possible mediation effects in posttraumatic depression and posttraumatic stress disorder comorbidity. *Public Health Rep.* 126:201–9
16. Dick DM. 2011. Gene-environment interaction in psychological traits and disorders. *Annu. Rev. Clin. Psychol.* 7:383–409
17. Difede J, Cukor J. 2009. Evidence-based long-term treatment of mental health consequences of disasters among adults. See Ref. 47, pp. 336–49
18. Elhai JD, Ford JD. 2009. Utilization of mental health services after disasters. See Ref. 47, pp. 366–86
19. Farfel M, DiGrande L, Brackbill R, Prann A, Cone J, et al. 2008. An overview of 9/11 experiences and respiratory and mental health conditions among World Trade Center Health Registry enrollees. *J. Urban Health* 85:880–909
20. Galea S, Ahern J, Resnick H, Kilpatrick D, Bucuvalas M, et al. 2002. Psychological sequelae of the September 11 terrorist attacks in New York City. *N. Engl. J. Med.* 346:982–87
21. Galea S, Brewin CR, Gruber M, Jones RT, King DW, et al. 2007. Exposure to hurricane-related stressors and mental illness after Hurricane Katrina. *Arch. Gen. Psychiatry* 64:1427–34
22. Galea S, Maxwell AR. 2009. Methodological challenges in studying the mental health consequences of disasters. See Ref. 47, pp. 579–93
23. Galea S, Nandi A, Vlahov D. 2005. The epidemiology of post-traumatic stress disorder after disasters. *Epidemiol. Rev.* 27:78–91
24. Galea S, Tracy M. 2007. Participation rates in epidemiologic studies. *Ann. Epidemiol.* 17:643–53
25. Guay S, Billette V, Marchand A. 2006. Exploring the links between posttraumatic stress disorder and social support: processes and potential research avenues. *J. Trauma. Stress* 19:327–38
26. Jeffreys M. 2012. *Clinician's Guide to Medications for PTSD*. Washington, DC: Natl. Cent. PTSD. <http://www.ptsd.va.gov/professional/pages/clinicians-guide-to-medications-for-ptsd.asp>

27. Kar N. 2009. Psychological impact of disasters on children: review of assessment and interventions. *World J. Pediatr.* 5:5–11
28. Karstan J, Hartman CA, Smit JH, Zitman FG, Beekman ATF, et al. 2011. Psychiatric history and sub-threshold symptoms as predictors of the occurrence of depressive or anxiety disorder within 2 years. *Br. J. Psychiatry* 198:206–12
29. Kessler RC, Berglund P, Demler O, Jin R, Merikangas KR, Walters EE. 2005. Lifetime prevalence and age-of-onset distributions of DSM-IV disorders in the National Comorbidity Survey Replication. *Arch. Gen. Psychiatry* 62:593–602
30. Kessler RC, Chiu WT, Demler O, Merikangas KR, Walters EE. 2005. Prevalence, severity, and comorbidity of 12-month DSM-IV disorders in the National Comorbidity Survey Replication. *Arch. Gen. Psychiatry* 62:617–27
31. Kessler RC, Galea S, Jones RT, Parker HA, Hurrir. Katrina Community Advis. Group. 2006. Mental illness and suicidality after Hurricane Katrina. *Bull. World Health Organ.* 84:930–39
32. Kessler RC, McGonagle KA, Zhao S, Nelson CB, Hughes M, et al. 1994. Lifetime and 12-month prevalence of DSM-III-R psychiatric disorders in the United States. *Arch. Gen. Psychiatry* 51:8–19
33. Kessler RC, Sonnega A, Bromet E, Hughes M, Nelson CB. 1995. Posttraumatic stress disorder in the National Comorbidity Survey. *Arch. Gen. Psychiatry* 52:1048–60
34. Kimerling R, Mack KP, Alvarez J. 2009. Women and disasters. See Ref. 47, pp. 203–17
35. Klein R, Nicholls R, Thomalla F. 2003. Resilience to natural hazards: How useful is this concept? *Environ. Hazards* 5:35–45
36. Klinenberg E. 2013. Adaptation. *New Yorker*, Jan. 7, pp. 32–37
37. Kuh D, Ben-Shlomo Y, Lynch J, Hallqvist J, Power C. 2003. Life course epidemiology. *J. Epidemiol. Community Health* 57:778–83
38. Levitt JM, Hoagwood KE, Greene L, Rodriguez J, Radigan M. 2009. Mental health care for children in the wake of disasters. See Ref. 47, pp. 350–64
39. Lindemann E. 1944. Symptomatology and management of acute grief. *Am. J. Psychiatry* 101:141–48
40. Maguen S, Neria Y, Conoscenti LM, Litz BT. 2009. Depression and prolonged grief in the wake of disasters. See Ref. 47, pp. 116–30
41. Masten AS. 2001. Ordinary magic: resilience processes in development. *Am. Psychol.* 56:227–38
42. McFarlane AC, Van Hooff M, Goodhew F. 2009. Anxiety disorders and PTSD. See Ref. 47, pp. 47–66
43. McFarlane AC, Williams R. 2012. Mental health services required after disasters: learning from the lasting effects of disasters. *Depress. Res. Treat.* 2012:1–13
44. McNally RJ, Bryant RA, Ehlers A. 2003. Psychological debriefing and its alternatives: a critique of early intervention for trauma survivors. *Psychol. Sci. Public Interest* 4:45–79
45. Mellman TA, Kulik-Bell R, Ashlock LE, Nolan B. 1995. Sleep events among veterans with combat-related posttraumatic stress disorder. *Am. J. Psychiatry* 152:110–15
46. Mitchell JT. 1983. When disaster strikes... the critical incident stress debriefing process. *J. Emerg. Med. Serv.* 8:36–39
47. Neria Y, Galea S, Norris FH, eds. 2009. *Mental Health and Disasters*. New York: Cambridge Univ. Press
48. Neria Y, Nandi A, Galea S. 2008. Post-traumatic stress disorder following disasters: a systematic review. *Psychol. Med.* 38:467–80
49. Norris F, Friedman MJ, Watson PJ. 2002. 60,000 disaster victims speak: Part II. Summary and implications of the disaster mental health research. *Psychiatry* 65:240–60
50. Norris F, Friedman MJ, Watson PJ, Byrne C, Kaniasty K. 2002. 60,000 disaster victims speak: Part I. An empirical review of the empirical literature: 1981–2001. *Psychiatry* 65:207–39
51. Norris FH. 2005. *Range, Magnitude, and Duration of the Effects of Disasters on Mental Health: Review Update 2005*. Dartmouth, NH: Dartmouth Med. Sch., Natl. Cent. Posttrauma. Stress Disord.
52. Norris FH, Perilla JL, Riad JK, Kaniasty K, Lavizzo EA. 1999. Stability and change in stress, resources, and psychological distress following natural disaster: findings from Hurricane Andrew. *Anxiety Stress Coping* 12:363–96
53. Norris FH, Tracy M, Galea S. 2008. Looking for resilience: understanding the longitudinal trajectories of responses to stress. *Soc. Sci. Med.* 68:2190–98



54. Norris FH, Wind LH. 2009. The experience of disaster: trauma, loss, adversities, and community effects. See Ref. 47, pp. 29–46
55. North CS, Nixon SJ, Shariat S, Mallonee S, McMillen JC, et al. 1999. Psychiatric disorders among survivors of the Oklahoma City bombing. *JAMA* 282:755–62
56. Norwood AE, Ursano RJ, Fullerton CS. 2000. Disaster psychiatry: principles and practice. *Psychiatr. Q.* 71:207–26
57. Off. US Foreign Diast. Assist. (OFDA)/Cent. Res. Epidemiol. Diast. (CRED). 2006. *EM-DAT: The International Disaster Database*. Louvain-la-Neuve, Belg.: Univ. Cathol. Louvain <http://www.cred.be/emdat>
58. Off. US Foreign Diast. Assist. (OFDA)/Cent. Res. Epidemiol. Diast. (CRED). 2010. *EM-DAT: The International Disaster Database*. Louvain-la-Neuve, Belg.: Univ. Cathol. Louvain <http://www.cred.be/emdat>
59. Ozer EJ, Best SR, Lipsey TL, Weiss DS. 2003. Predictors of posttraumatic stress disorder and symptoms in adults: a meta-analysis. *Psychol. Bull.* 129:52–73
60. Pietrzak RH, Tracy M, Galea S, Kilpatrick DG, Ruggiero KJ, et al. 2012. Resilience in the face of disaster: prevalence and longitudinal course of mental disorders following Hurricane Ike. *PLoS One* 7:1–14
61. Raphael B, Maguire P. 2009. Disaster mental health research: past, present, and future. See Ref. 47, pp. 7–28
62. Shalev AY. 2004. Further lessons from 9/11: Does stress equal trauma? *Psychiatry* 67:174–77
63. Tohen M, Bromet E, Murphy JM, Tsuang MT. 2000. Psychiatric epidemiology. *Harv. Rev. Psychiatry* 8:111–25
64. Toyokawa S, Uddin M, Koenen KC, Galea S. 2012. How does the social environment ‘get into the mind’? Epigenetics at the intersection of social and psychiatric epidemiology. *Soc. Sci. Med.* 74:67–74
65. Tracy M, Norris FH, Galea S. 2011. Differences in the determinants of posttraumatic stress disorder and depression after a mass traumatic event. *Depress. Anxiety* 28:666–75
66. Tyhurst JS. 1951. Individual reactions to community disaster: the natural history of psychiatric phenomena. *Am. J. Psychiatry* 107:764–69
67. Unger JB, Kipke MD, Simon TR, Montgomery SB, Johnson CJ. 1997. Homeless youths and young adults in Los Angeles: prevalence of mental health problems and the relationship between mental health and substance abuse disorders. *Am. J. Community Psychol.* 25:371–94
68. Ursano RJ, Fullerton CS, Benedek DM. 2009. What is psychopathology after disasters? Considerations about the nature of the psychological and behavioral consequences of disasters. See Ref. 47, pp. 131–42
69. van der Velden PG, Kleber RJ. 2009. Substance use and misuse after disaster. See Ref. 47, pp. 94–115
70. Vlahov D, Galea S, Ahern J, Rudenstine S, Resnick H, et al. 2006. Alcohol drinking problems among New York City residents after the September 11 terrorist attacks. *Subst. Use Misuse* 41:1295–311
71. Vlahov D, Galea S, Resnick H, Ahern J, Boscarino JA, et al. 2002. Increased use of cigarettes, alcohol, and marijuana among Manhattan, New York, residents after the September 11th terrorist attacks. *Am. J. Epidemiol.* 155:988–96
72. Wang PS, Lane M, Olfson M, Pincus HA, Wells KB, Kessler RC. 2005. Twelve-month use of mental health services in the United States: results from the National Comorbidity Survey Replication. *Arch. Gen. Psychiatry* 62:629–40
73. Williams R, Joseph S. 1999. Conclusions: an integrative psychosocial model of PTSD. In *Post-Traumatic Stress Disorders: Concepts and Theory*, ed. W Yule, pp. 297–314. Chichester, UK: Wiley
74. Yzermans CJ, van den Berg B, Dirkzwager AJE. 2009. Physical health problems after disasters. See Ref. 47, pp. 67–93



# Contents

## **Symposium: Generating Rigorous Evidence for Public Health: Alternatives to Randomized Design**

Commentary: Generating Rigorous Evidence for Public Health:  
The Need for New Thinking to Improve Research and Practice  
*Ross C. Brownson, Ana V. Diez Roux, and Katherine Swartz* ..... 1

Evaluation of Systems-Oriented Public Health Interventions:  
Alternative Research Designs  
*Robert W. Sanson-Fisher, Catherine A. D'Este, Mariko L. Carey,  
Natasha Noble, and Christine L. Paul* ..... 9

Combining the Power of Stories and the Power of Numbers:  
Mixed Methods Research and Mixed Studies Reviews  
*Pierre Pluye and Quan Nha Hong* ..... 29

Practice-Based Evidence in Public Health: Improving Reach,  
Relevance, and Results  
*Alice Ammerman, Tosha Woods Smith, and Larissa Calancie* ..... 47

## **Epidemiology and Biostatistics**

Microbial Origins of Chronic Diseases  
*Lisa M. Gargano and James M. Hughes* ..... 65

Can We Say What Diet Is Best for Health?  
*D.L. Katz and S. Meller* ..... 83

Epigenetics: Relevance and Implications for Public Health  
*Laura S. Rozek, Dana C. Dolinoy, Maureen A. Sartor,  
and Gilbert S. Omenn* ..... 105

Implementing Health Reform: Improved Data Collection and the  
Monitoring of Health Disparities  
*Rashida Dorsey, Garth Graham, Sherry Glied, David Meyers,  
Carolyn Clancy, and Howard Kob* ..... 123

Hearing Loss in an Aging American Population: Extent, Impact, and Management <i>Kathleen E. Bainbridge and Margaret I. Wallhagen</i> .....	139
Commentary: Generating Rigorous Evidence for Public Health: The Need for New Thinking to Improve Research and Practice <i>Ross C. Brownson, Ana V. Diez Roux, and Katherine Swartz</i> .....	1
Evaluation of Systems-Oriented Public Health Interventions: Alternative Research Designs <i>Robert W. Sanson-Fisher, Catherine A. D'Este, Mariko L. Carey, Natascha Noble, and Christine L. Paul</i> .....	9
Combining the Power of Stories and the Power of Numbers: Mixed Methods Research and Mixed Studies Reviews <i>Pierre Pluye and Quan Nba Hong</i> .....	29
 <b>Environmental and Occupational Health</b>	
Biological Diversity and Public Health <i>Aaron S. Bernstein</i> .....	153
Mental Health Consequences of Disasters <i>Emily Goldmann and Sandro Galea</i> .....	169
Millions Dead: How Do We Know and What Does It Mean? Methods Used in the Comparative Risk Assessment of Household Air Pollution <i>Kirk R. Smith, Nigel Bruce, Kalpana Balakrishnan, Heather Adair-Rohani, John Balmes, Zoë Chafe, Mukesh Dherani, H. Dean Hosgood, Sumi Mehta, Daniel Pope, Eva Rebfuess, and others in the HAP CRA Risk Expert Group</i> .....	185
Nature and Health <i>Terry Hartig, Richard Mitchell, Sjerp de Vries, and Howard Frumkin</i> .....	207
Precarious Employment: Understanding an Emerging Social Determinant of Health <i>J. Benach, A. Vives, M. Amable, C. Vanroelen, G. Tarafa, and C. Muntaner</i> .....	229
 <b>Public Health Practice</b>	
Aligning Leadership Across Systems and Organizations to Develop a Strategic Climate for Evidence-Based Practice Implementation <i>Gregory A. Aarons, Mark G. Ehrhart, Lauren R. Farabnak, and Marisa Sklar</i> .....	255
Personal Belief Exemptions From School Vaccination Requirements <i>Douglas S. Diekema</i> .....	275

Public Health and Media Advocacy <i>Lori Dorfman and Ingrid Daffner Krasnow</i> .....	293
Practice-Based Evidence in Public Health: Improving Reach, Relevance, and Results <i>Alice Ammerman, Tosha Woods Smith, and Larissa Calancie</i> .....	47
<b>Social Environment and Behavior</b>	
Why Do Americans Have Shorter Life Expectancy and Worse Health Than Do People in Other High-Income Countries? <i>Mauricio Avendano and Ichiro Kawachi</i> .....	307
Health Promotion in Smaller Workplaces in the United States <i>Jeffrey R. Harris, Peggy A. Hannon, Shirley A.A. Beresford, Laura A. Linnan, and Deborah L. McLellan</i> .....	327
Improving Adolescent Health Policy: Incorporating a Framework for Assessing State-Level Policies <i>Claire D. Brindis and Kristin Moore</i> .....	343
Peer Support in Health Care and Prevention: Cultural, Organizational, and Dissemination Issues <i>Edwin B. Fisher, Muchieb Maggy Coufal, Humberto Parada, Jennifer B. Robinette, Patrick Y. Tang, Diana M. Urlaub, Claudia Castillo, Laura M. Guzman-Corrales, Sayaka Hino, Jaimie Hunter, Ariana W. Katz, Yael R. Symes, Heidi P. Worley, and Cuirong Xu</i> .....	363
Social Movements in Health <i>Theodore M. Brown and Elizabeth Fee</i> .....	385
<b>Health Services</b>	
Community Health Workers in Low-, Middle-, and High-Income Countries: An Overview of Their History, Recent Evolution, and Current Effectiveness <i>Henry B. Perry, Rose Zulliger, and Michael M. Rogers</i> .....	399
Metrics for Assessing Improvements in Primary Health Care <i>Kurt C. Stange, Rebecca S. Etz, Heidi Gullett, Sarah A. Sweeney, William L. Miller, Carlos Roberto Jaén, Benjamin F. Crabtree, Paul A. Nutting, and Russell E. Glasgow</i> .....	423
Scale, Causes, and Implications of the Primary Care Nursing Shortage <i>Logan MacLean, Susan Hassmiller, Franklin Shaffer, Kathleen Robrbaugh, Tiffany Collier, and Julie Fairman</i> .....	443

The Growth of Palliative Care in the United States <i>Mark T. Hughes and Thomas J. Smith</i> .....	459
Top-Down and Bottom-Up Approaches to Health Care Quality: The Impacts of Regulation and Report Cards <i>Dana B. Mukamel, Simon F. Haeder, and David L. Weimer</i> .....	477
Hearing Loss in an Aging American Population: Extent, Impact, and Management <i>Kathleen E. Bainbridge and Margaret I. Wallbagen</i> .....	139

## Indexes

Cumulative Index of Contributing Authors, Volumes 26–35 .....	499
Cumulative Index of Article Titles, Volumes 26–35 .....	505

## Errata

An online log of corrections to *Annual Review of Public Health* articles may be found at <http://www.annualreviews.org/errata/publhealth>