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Responses to Natural Disasters

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Glossary

Convenience sampling: Sample gathered based on availability and ease

Externalizing disorders: Disorders characterized by antisocial tendencies, aggression, impulsivity and disruptive behaviors

Peritraumatic Dissociation: Feeling disconnected from one's surroundings immediately following a traumatic event

Posttraumatic growth: Potential positive aspects of experiencing a negative event; outcomes may include improved relationships with others, spiritual growth, increased feelings of personal strength, the development of new interests, and focusing on new opportunities

Probability sampling: Sample is representative of the population of interest

Purposive sampling: Non-representative subsample chosen due to a specific set of features or experiences

Resiliency: Protective factors that allow people to thrive after adverse events

Self-efficacy: Belief in one's ability to effectively solve problems and deal with challenges

Stratified random sample: Random samples drawn from segments of the population organized by common characteristics (e.g., demographic attributes, region of residence)

Key Points

- Exposure to natural disasters is associated with a range of psychological outcomes including posttraumatic Stress Disorder (PTSD), depression, anxiety, global distress, and physical health problems

- The magnitude of destruction, and person-level indicators such as demographic characteristics (age, gender, ethnicity, marital status), socioeconomic status, and pre-disaster mental health tend to be correlated with post-disaster outcomes.

- Although methodological limitations tend to define much of the existing research, studies with improved designs (e.g., representative samples, longitudinal designs) have been conducted

- Children as well as babies who developed in utero during disasters experience particular vulnerabilities

- The escalating threat of climate change and associated disasters necessitates continued inquiry

Abstract

Natural disasters such as earthquakes, tornados, hurricanes, tsunamis, wildfires, and mudslides occur frequently and correlate with psychosocial outcomes including Posttraumatic Stress Disorder (PTSD), depression, anxiety, global distress, and physical health problems. As the climate crisis escalates, natural disasters will likely increase in frequency and intensity. While many people display great resiliency in the wake of these community disasters, deleterious outcomes have been associated with a variety of factors including type of disaster, magnitude of destruction, and person-level indicators such as demographic characteristics (age, gender, ethnicity, marital status), socioeconomic status, and pre-disaster mental health. Although studied less frequently, responses to natural disasters have been examined in child populations; effects may persist for decades. Longitudinal assessments are less common than cross-sectional studies, yet they are critical for understanding adaption and distress over time. Logistical difficulties such as obtaining rapid funding and ethics approval generate challenges for conducting research on natural disasters; variability in measurement tools, populations evaluated, sampling designs, and temporal assessments have hindered cross-study comparisons. Improved methodologies and standardized assessment instruments may help elucidate variability in responses, with the hope of better understanding psychosocial responses and informing outreach services.

Introduction

Natural disasters are increasing in number and severity, and are experienced by a substantial segment of the world's population. Recent data estimates the worldwide prevalence natural disaster exposure at more than 50% (CRED, 2018). As the climate crisis escalates and the global population becomes more urbanized, this threat will likely increase: 58% of individuals in urban areas are exposed to a natural disaster annually, and tend to be more highly impacted compared to rural areas (Danan, 2019). In 2021, natural disasters, such as earthquakes, tornadoes, and storms caused approximately 10,000 fatalities and approximately $280 billion in loss and damages worldwide (Munich Re, 2022). In 2021, 724 deaths and over $1 billion in property and crop damages were directly related to extreme weather events in the United States alone (National Oceanic and Atmospheric Administration, 2022). Disasters often impact large geographic areas and may have long-term consequences for individuals and their communities (Norris *et al.*, 2002) in terms of economic well-being (Fang et al., 2019) and both physical (Benevolenza & DeRigne, 2019) and mental health (Chen et al., 2020; Garfin et al., 2022). As such, there has been a growing interest in understanding responses to natural disasters and in generating empirical research that guides evidence-based humanitarian outreach efforts and post-disaster service provision.

Historical Context

Formal empirical studies of natural disasters began following the 1972 Buffalo Creek flooding (Lifton & Olson, 1976), before trauma-related mental disorders were included in nosologies of psychiatric maladies. This highly destructive flood, resulting from a collapsed dam, destroyed all homes and businesses in its path and killed 125 people. Residents took legal action against the coal company that owned the collapsed dam; plaintiffs were then studied as

part of the lawsuit. Through this process, researchers noted that a common constellation of symptoms was present in disaster survivors; many reported fears and anxiety about death, psychic numbing, sleep disturbances, nightmares and an inability to escape imagery of the event (Lifton & Olson, 1976). Some degree of psychiatric impairment continued two years post-disaster in over 80% of survivors assessed (Titchener & Kapp, 1976). Given that the sample was highly exposed and involved in litigious disaster-related actions, these findings could not be widely extrapolated to characterize all disaster survivors. However, they highlighted the potentially severe and long-lasting repercussions of exposure to natural disasters, and marked the genesis of trauma research and treatment specific to such events.

Subsequently, McFarlane and collaborators (1984) began a series of longitudinal studies that followed survivors of the 1983 Ash Wednesday Australian Bushfires. Findings indicated that psychiatric problems emerged in several phases, beginning with an initial acute stress response. Similar to studies of the residents of Buffalo Creek, research on this disaster suggested that psychosocial problems may persist in some survivors for years after the precipitating event (McFarlane, 1987). Over the next three decades, psychosocial outcomes have been studied in response to a myriad of natural disasters, including hurricanes, volcanoes, earthquakes, floods, wildfires, and tornados. Recent review articles indicate that hundreds of samples have been collected on hundreds of disasters across a variety of psychosocial outcomes, yet making comparisons between studies is often difficult, given extensive variability in disaster severity, sampling designs, the lack of proper controls, populations assessed, and measurement instruments used (Beaglehole *et al.,* 2018; Golitaleb *et al.,* 2022). Despite these limitations, the growing field of natural disaster research has the potential to inform clinical and policy recommendations, as government and non-governmental organizations, community members,

and service providers seek to best allocate limited resources to survivors, with the hope of alleviating suffering and helping afflicted communities rebuild and return to their pre-disaster functioning.

Commonly Studied Outcomes

Studies of responses to natural disasters tend to focus on several key psychosocial outcomes. Since its inclusion in the Diagnostic and Statistical Manual of Mental Disorders (DSM)-III, the most common is *Posttraumatic Stress Disorder (PTSD).* Briefly, as outlined in the DSM-V (American Psychiatric Association, 2013), diagnostic criteria for PTSD requires that one must have been directly (or indirectly) exposed to a trauma involving actual or threatened death or injury to self or other, which could include witnessing an event, learning that it happened to a close other, or repeated exposure to details of the event (not via the media) (Criterion 1A). Individuals must exhibit one or more re-experiencing/intrusion symptom (e.g., flashbacks, reliving the trauma), one or two avoidance symptoms (e.g., avoidance of distressing memories, thoughts or feelings), two or more negative alterations in cognition and mood (e.g., persistent negative emotional state, anhedonia, trouble remembering parts of the event) and two or more hyperarousal symptoms (e.g., easily startled, feeling on edge, trouble sleeping or angry outbursts) to satisfy Criteria B, C, D, and E respectively. Symptoms must persist for at least one month (Criteria E) and cause significant impairment in functioning (Criteria F) (American Psychiatric Association, 2013). The DSM-5 included changes to the diagnosis of PTSD. Of note, in the DSM-IV version, there were three diagnostic clusters of PTSD symptoms, rather than four, and a less clear definition of what constitutes a traumatic event (American Psychiatric Association, 2000). Some researchers and clinicians assess partial or sub-threshold PTSD even when symptoms don't meet threshold criteria for a PTSD diagnosis (Lai, Chang, Connor, Lee, &

Davidson, 2005), or use continuous measures to assess posttraumatic stress (PTS) symptoms (Garfin *et al.*, 2022). Self-report instruments like the 20-item Posttraumatic Disorder Checklist for DSM-5 (PCL-5) are used to calculate both probable-PTSD diagnoses and scores reflecting symptom severity (Bovin *et al*., 2016; Martínez-Levy *et al.,* 2021). Thus, these self-report instruments may be particularly useful in post-disaster settings where it may be advantageous to capture a wide range of responses, and where ease of administration is paramount.

During a natural disaster or in its wake, many individuals experience peritraumatic dissociative experiences (that is, feeling disconnected from oneself or one's surroundings immediately following a traumatic event). Peritraumatic dissociation is one of the most robust predictors of subsequent PTSD (Ozer, Best, Lipsey, & Weiss, 2003) and of long-term distress more generally (Holman & Silver, 1998) in the aftermath of disaster. A study conducted by Kannis-Dymand and colleagues (2018) on individuals who experienced earthquakes or floods in Australia found that peritraumatic dissociation was associated with increased PTSD symptoms. Although, this study included a large sample size of 835 participants, the study utilized a convenience sampling method, which is unsystematic. Such issues were echoed in a recent systematic review of dissociation and disaster exposure: while included studies on balance demonstrated an association between dissociation and post-disaster distress, the methodological limitations of many of the reviewed studies precluded strong overall inferences (Canan & North, 2019).

Disaster victims most commonly report PTSD re-experiencing and arousal symptoms, subsequent avoidance symptoms, which do not require immediate evaluation and are less frequently endorsed, may tend to characterize symptom profiles of individuals who meet full diagnostic criteria for post-disaster PTSD (Norris *et al.*, 2002; Sprang & LaJoie, 2009) and may

help predict persistence of elevated PTSD over time (Marx & Sloan, 2005). This is consistent with other research suggesting that avoidant coping strategies such as distraction, denial, blame, or thought suppression may be linked to a higher likelihood of developing PTS (Rosenthal, Cheavens, Lynch, & Follette, 2006; Silver, Holman, McIntosh, Poulin, & Gil-Rivas, 2002; Theleritis *et al.,* 2020) and that avoidance symptoms may mediate the relationship between trauma exposure and the development of PTSD after a disaster.

PTSD has been studied in post-disaster populations with a wide range of exposure levels (Bal, 2008) and has been linked with social, financial, and physical health problems. PTSD exhibits high comorbidity with other psychological problems (Amaya-Jackson *et al.*, 1999). One of the psychological problems that exhibits the most comorbidity with PTSD is major depression disorder (Horesh *et al.,* 2017). In addition to causing suffering at an individual level, such symptomatology can lead to lost work days, ultimately causing significant deleterious effects on the economy (Schofield *et al.*, 2011). The economic burden of post-disaster mental health ailments may be particularly salient with repeated exposure to severe natural disasters (e.g., hurricanes, heatwaves, wildfries), which escalate in the context of the climate crisis (Nakabayasi, 2022). These repercussions may be particularly salient in the post-disaster context, when communities must simultaneously rebuild the damaged or destroyed physical infrastructure, economic engine, and social capital that may have been damaged or destroyed in the wake of the disaster.

PTSD prevalence rates tend to increase following a natural disaster, as seen after a series of hurricanes struck Puerto Rico in 2017 (Scaramutti *et al,,* 2019). However, estimates of post-disaster PTSD prevalence rates have varied greatly, depending on the magnitude of the destruction, the time since disaster, sample representativeness, and measurement instrument

employed. For example, 18 months after the 2005 earthquake in Pakistan and Kashmir, a study of tent-dwelling individuals reported that 55% of women and 33% of men suffered from PTSD (Naeem *et al.*, 2011). Given that tent dwellers might be those most heavily impacted by the disaster, such studies provide an illustration of how the most severely impacted indiviudals may respond to disasters, but limit inferences regarding broader impacts. A randomly selected sample of adults after the 1999 Taiwanese earthquake yielded PTSD prevalence rates between 10% and 19% (Lai *et al.*, 2005). Similarly, a probability-based representative sample of adults residing near the epicenter of the 2010 Chilean earthquake estimated a 18.9% prevalence (Garfin, Silver *et al*., 2014). Yet other stringent survey techniques employed by garnering a stratified random sample of participants two months after the 2004 Sumatra earthquake resulted in much lower prevalence rates of PTSD: 12% of displaced and 7% of non-displaced persons met criteria for probable-PTSD (Van Griensven *et al.*, 2006). In contrast, a recent study found that that the prevalence rate for PTSD after the 2015 Nepal Earthquake was 24.1% (Adhikari Baral & KC, 2019). It is difficult to assess whether variability in these prevalence rates is due to qualitative features of the disaster, cultural differences, or other factors (e.g., timing of the assessments, measures employed to assess PTS, etc.).

Acute Stress Disorder (ASD), a frequent precursor to PTSD, has been studied less frequently due to logistical difficulties in conducting early assessments soon after natural disasters (e.g., gaining funding and ethics approval). ASD occurs within the first month following a traumatic event and also differs from PTSD in that it requires experiencing at least three dissociative symptoms (numbing or detachment, lower awareness of surroundings, derealization, depersonalization, dissociative amnesia). Given that dissociative symptoms often predict PTSD following a trauma, ASD can serve as a useful tool for identifying individuals who

may be at elevated risk for developing PTSD or health problems in the future (Holman *et al.*, 2008). ASD assessments may be particularly important in post-disaster settings, where large segments of the population are exposed to a traumatic event, but not all will go on to develop PTSD. Recent, prospective, longitudinal research on repeated exposure to hurricanes found that early traumatic stress symptoms were associated with subsequent PTS (Garfin *et al.*, 2022). Of note, some researchers have criticized the utility of the ASD diagnosis, given that it was developed primarily to predict a subsequent disorder (PTSD), and not all people who meet criteria for ASD ultimately come to meet criteria for subsequent PTSD and vice versa (see Bryant, 2006, for a discussion). However, a systematic review of prospective studies found that acute stress responses, including ASD were associated with increased rates of physical, mental, and psychosocial health problems over time (Garfin *et al.,* 2018).

　　Depression is the second most common outcome measure studied in post-disaster settings. Major Depressive Disorder (MDD) is characterized by a constellation of symptoms including negative affect and anhedonia. MDD and depressive symptomatology can be evaluated using diagnostic criteria or through continuous measures of symptom severity (Norris, 2005a). Studies consistently find elevated rates of depression following natural disasters, as well as increases in related symptoms such as suicide and feelings of remorse (Warheit, Zimmerman, Khoury, Vega, & Gil, 1996). Suicide rates and depression both increased a year after Hurricane Irma, a hurricane that hit Florida Keys in 2017 (Torres-Mendoza *et al.,* 2017). Meta-analytic findings demonstrate the wide range of depression following natural disasters, with rates ranging from 5.8% to 54.0% (Tang *et al.,* 2014). Differences in assessment instrument – the former using clinical interviews and the later using a questionnaire – illustrate the inherent difficulty in making cross-study comparisons given divergent assessment tools.

Generalized anxiety, a construct separate from PTSD, is also commonly studied in survivors of natural disasters, and is included in the literature as both continuous measurements of symptomatology and full DSM diagnoses. Increased anxiety has been observed after floods in Kentucky (Phifer, 1990), cyclones in Orissa (Kar, Jagadisha, Sharma, Murali, & Mehrotra, 2004), earthquakes in Armenia (Goenjian *et al.*, 2000), the 2004 tsunami in Thailand (Hussain, Weisaeth, & Heir, 2011), and the 2017 hurricane in Florida Keys (Torres-Mendoza *et al.,* 2021). Since anxiety can be experienced as fear of the trauma occurring again (Terr, 1981), this outcome is especially relevant for natural disaster research, as many areas that experience natural disasters are at risk for repeated exposures (e.g., coastal areas susceptible to annual hurricanes or flooding, regions that lay over fault lines experience multiple earthquakes and aftershocks). Furthermore, since high anxiety does not necessitate a diagnosis of PTSD (Van Griensven *et al.*, 2006), measuring anxiety as a separate construct can help capture the range of distress responses. This may be especially relevant for continuous measures of anxiety; symptoms of anxiety may be distressing for individuals, even when not severe enough to warrant clinical diagnosis.

Global or non-specific distress often encompasses constructs such as somatization (experiencing psychological distress in the form of physical complaints), anxiety, general negative affective, or perceived stress (Thompson, Norris, & Hanacek, 1993); elevated levels of global distress have been evident years after the precipitating disaster (Guarnaccia, Canino, Rubio-Stipec, & Bravo, 1993). Nonspecific distress can be measured using symptom checklists such as the Brief Symptom Inventory (BSI, Derogatis, 2001) that concurrently evaluate symptoms of anxiety, depression and somatization; such measures have indicated elevated distress responses in a number of short- and long-term studies following earthquakes (Bland *et al.*, 2005; Kulkarni & Pole, 2008) and hurricanes (Norris & Uhl, 1993). Other investigations

using structured or clinical interviews have also reported heightened levels of general distress symptomatology after disasters (Goenjian, 1993). Measures of non-specific distress may be especially useful in the post-disaster setting, as it might be advantageous to understand psychological afflictions in people who may not otherwise meet criteria for DSM diagnoses, which by definition entail severe and specific expressions of psychiatric problems.

Increases in *physical health complaints*, such as cardiorespiratory (e.g., chest pain, difficulty breathing), neurological (e.g., headache, dizziness), and gastrointestinal (e.g., stomach pain, heartburn) problems have also been reported after natural disasters (Keskinen-Rosenqvist, Michélsen, Schulman, & Wahlström, 2011; Neria *et al.*, 2008; Norris *et al.*, 2002; (Torres-Mendoza *et al.,* 2021). Sleep disturbances (Titchener & Frederic, 1978) and elevated cortisol (Takahashi et al., 2021), a physical indicator of elevated stress responses, have also been linked with disaster exposure. Increases in negative physical health outcomes could be a result of people being displaced from their home after a natural disaster. According to Jang and colleagues (2020) there is an association between diseases such as malaria and diabetes among people who are suddenly moved from their residence. Although psychosocial assessments of disaster survivors do not frequently include questions relating to physical health, given the potential correlation between deteriorated health and natural disasters, such information should be incorporated into future post-disaster inquires.

Heightened *substance use* was reported after Hurricanes Katrina and Rita (Cepeda, Valdez, Kaplan, & Hill, 2010), after the 2004 Indian Ocean tsunami (Vetter, Rossegger, Rossler, Bisson, & Endrass, 2008), and after the 2010 Chilean earthquake (Garfin, Juth, *et al*., 2014. Theorists posit this may be due to the "self-medication hypotheses" as individuals seek to cope with the negative event, or a "social vulnerability framework," where factors associated with the

disaster (e.g., economic losses, lack of infrastructure) create conditions more likely to elicit substance use (Kopak & Van Brown, 2020). However, such increases in substance use were not seen after the Great Midwestern Floods of 1993 (North, Kawasaki, Spitznagel, & Hong, 2004) and alcohol sales did not increase after the Great Hanshin earthquake in Japan (Shimizu *et al.*, 2000). Thus, the relationship between substance use and disasters is complex and not fully understood.

Because distress abates over time among the majority of disaster survivors, there is an increased awareness that assessments of *positive adjustment*, such as resiliency and posttraumatic growth, should be assessed alongside negative outcomes (Bonanno, 2004). Posttraumatic growth (PTG) is defined as the positive effects of experiencing a trauma (Tedeschi & Calhoun, 1996). Potential positive outcomes may include feelings of personal strength, developing new interests, focusing on new opportunities, improved relationships with others, spiritual growth and a greater appreciation of life. PTG tends to correlate with increased stress and higher scores of PTS, which suggests that focusing on ways to increase PTG may be especially relevant to those with significant trauma exposure (Pooley, Cohen, O'Connor, & Taylor, 2013). Indeed, after Hurricane Sandy, storm exposure correlated with both PTSD and PTG (Schneider *et al.,* 2019).

Another psychological resource, self-efficacy, or one's perception of one's ability to cope with adverse events (Bandura, 1977; Schwarzer & Jerusalem, 1995), has been linked with more positive psychological adjustment after natural disasters (Benight, 2004), lower stress scores in disaster-prone areas (Miller, Paton, & Johnston, 1999), and to a lower probability of developing PTSD following a disaster (Luszczynska, Benight, & Cieslak, 2009). Victims who have experienced a natural disaster have reported finding it helpful to use their own strength or engaging in religious practices as coping strategies for post-disaster problems (Hollifield *et al.,*

2018). Future research should continue to explore coping, growth and post-event benefit finding as protective factors.

Risk and Protective Factors

Demographic characteristics, including gender, have been extensively studied in relation to post-disaster outcomes. In most research, post-disaster, women report more severe psychiatric symptoms (including depression and PTSD) compared to men (Norris *et al.*, 2002). Examples include findings obtained after the 2004 Sumatra earthquake and tsunami, where females reported more anxiety and depression (Van Griensven *et al.*, 2006), and after Hurricane Mitch (Caldera, Palma, Kullgren, & Penayo, 2001) and the 2015 Nepal Earthquake (Adhikari Baral and KC, 2019), where females also reported higher prevalence of PTSD. However, a gender effect is not universally seen across all studied dimensions of maladjustment. For example, compared to women, men are significantly more likely to abuse alcohol after a disaster (Dooley & Gunn, 1995; McMillen, North, & Smith, 2000). One explanation for women's poorer outcomes is that women may interpret traumatic events differently than men (Norris *et al.*, 2002), and may either experience events as more distressing or be more likely to endorse symptoms of distress when probed. Such effects may be particularly relevant in cultures with more pronounced gender differences, an important consideration in international contexts.

Marital status is also a frequently studied indicator of post-disaster outcomes, with mixed findings. Three years after the 1999 Taiwanese earthquake, married individuals reported better quality of life than individuals who were not married (Wu *et al.*, 2006) and two months after the 1987 Ecuadorian earthquake, single, separated or widowed individuals were more likely to be distressed (Lima *et al.*, 1989). Furthermore, a meta-analysis found that being unmarried had a significant correlation with depression following a natural disaster (Tang *et al.,* 2014). In

contrast, research conducted 10-14 months after the Lockerbie disaster indicated that marital status was a risk factor for distress (Brooks & McKinlay, 1992). Potential interaction effects between gender and marital status have also yielded inconclusive results: in some studies, marital status was a risk factor primarily for women, whereas other studies have found the opposite (Norris *et al.*, 2002). Findings after Hurricane Hugo suggested that marital stress may be a potential mechanism for such contradictory findings; since interpersonal difficulties may be intensified after a disaster, over time chronic marital difficulties may increase one's overall level of distress (Norris & Uhl, 1993). Studies that assess specific characteristics of partner relationships, in addition to marital status categorically, may help contextualize nuances.

Findings regarding age, have also been mixed. In general, middle aged adults exhibit worse outcomes and older individuals tend to be more resilient (Logue, Hansen, & Struening, 1981; Phifer, 1990; Thompson *et al.*, 1993). Some research has examined potential "inoculation effects" in older adults, whereby past experience with some disaster buffers people from the potential psychological consequences of future disasters (Norris & Murrell, 1988). Norris and colleagues (2002) suggested that middle-aged adults may have more daily stress (e.g., mortgage payments, taking care of children or elderly parents), which may compound the impact of disaster exposure and counteract the potential inoculation effects derived from negative events experienced in their youth. However, not all studies have supported these hypotheses. More recent studies have reported that older adults are more likely to exhibit worse outcomes. According to a narrative review, the dependent elderly population is more vulnerable psychological problems after a disaster (Makwana, 2019). For example, after the 2015 Nepal earthquakes elderly adults were most likely to exhibit PTSD symptoms (Adhikari Baral & KC, 2019). A possible reason for older adults experiencing higher levels of PTSD symptomatology

may be due to the elderly needing more assistance and finding it more difficult to obtain what they lost. Younger individuals were found to be less depressed before and after the 1994 Northridge earthquake (Carr *et al.*, 1997), whereas a study of responses to the 1989 Newcastle earthquake found that adults older than 65 were more likely to have PTSD, despite reporting less severity of exposure to the actual trauma (Ticehurst, Webster, Carr, & Lewin, 1996). Other studies have indicated younger adults (Epstein, Fullerton, & Ursano, 1998; Palinkas, Downs, Petterson, & Russell, 1993) are more at risk for distress. Other research has suggested that correlations between disaster-related distress responses and age may vary according to type of stressor experienced, temporal occurrence of subsequent stressors, and age at event occurrence (Scott, Poulin, & Silver, 2013). The impact of culture is also critical to consider. Clearly, delineating the relationships between age and post-disaster distress needs further elucidation.

Lower socio-economic status (SES), frequently operationalized as income, education, or occupational status, has been consistently correlated with greater post-disaster maladjustment (Caldera *et al.*, 2001; Norris *et al.*, 2002; Phifer, 1990). After Hurricane Irma more than half of the people who reported needing mental health services stated that the cost of those services made it difficult to obtain them (Torres-Mendoza *et al.,* 2021). Measures of SES have been linked with greater psychological distress following the 1999 Taiwanese earthquake (Chen *et al.*, 2007), the 2008 Wenchuan earthquake (Xu & Wu, 2011), and the 2005 Pakistani earthquake (Naeem *et al.*, 2011). Of note, the study of the Pakistani earthquake did not find consistent results across all measures of SES; this finding may have resulted from confounds such as amount of property lost or low SES variability in the population assessed. Interaction effects between disaster-related stressors and low-SES have been demonstrated, such that low-SES individuals are impacted exponentially (Galea *et al.*, 2007; Ginexi *et al.*, 2000; Phifer, 1990).

This suggests that it may be the associated consequences of low SES that may be drive the link between economic disadvantage and negative outcomes.

Pre-event mental health problems are consistently correlated with PTSD and other forms of maladjustment post-disaster (Garfin *et al.,* 2022; Madianos & Evi, 2010; Norris *et al.*, 2002). Typically, with some exceptions (see Garfin *et al.*, 2022), retrospective reports are used to assess prior psychopathology (e.g., Caldera *et al.*, 2001), which is unfortunate given inherent problems with potentially inaccurate reporting of past events. However, prospective studies in which mental health is measured pre-disaster have also supported this relationship. For example, a sample of 1,735 Iowa residents assessed one year before and 1-3 months after the 1993 Midwest Floods found strong and independent effects of prior mental health on post-disaster distress (Ginexi *et al.*, 2000). Prior to the Northridge earthquake, 66 children were assessed for a variety of mental health problems; results indicated that pre-existing anxiety was a strong predictor of PTSD symptoms one year after the earthquake (Asarnow *et al.*, 1999). People who meet pathological levels of avoidance symptoms and full PTSD criteria are generally more likely to have had prior mental health problems (McMillen *et al.*, 2000) suggesting that the tendency to implement avoidant coping strategies after a disaster may be a function of previous maladaptive responses to threatening environments.

Social support has been a key factor predicting positive health outcomes following a natural disaster (Kaniasty, 2020). For example, greater social support was associated with lower PTSD symptoms among Indigenous members who have experienced hurricanes (McKinley *et al.,* 2019). Additionally, social support was negatively associated with psychological distress in victims who experienced a major fire in Buffalo Creek, Colorado in 1996 (Benight, 2004). After the 2004 Sri Lanka tsunami, most participants found it helpful to cope with their social support

network, including family and friends (Hollifield *et al.,* 2008). Yet one study conducted on a random sample of 751 adults in China found receiving social support was correlated with greater depression symptoms after a natural disaster (Hall *et al.,* 2016). On explanation for that counterintuitive finding could be differential cross-cultural perceptions of receiving social support. Another reason is that those who seek more social support may have also been more affected by the natural disaster (Kaniasty, 2020). Finally, for most people there is an optimal amount of support that is salutary, but too much support, can be experienced as burdensome, rather than helpful.

Event-exposure Characteristics

In general, distress responses are linked with severity of exposure, although always in a linear dose-response relationship (Neria *et al.*, 2008). Living in more severely distressed geographic areas was associated with more depression and PTSD following the 1999 Turkish earthquake (Kilic & Ulusoy, 2003); similar correlations were obtained after the 1994 Kentucky flooding (Phifer, 1990). Type of dwelling (i.e., tall apartment building that sways), which could intensify the experience of the earthquake, has been linked with distress following the 1999 Taiwanese earthquake (Chen *et al.*, 2007). Furthermore, there were higher than average prevalence rates of PTSD and depression symptoms following a tsunami seen in Sri Lanka, a place that has been filled with war and poverty (Hollifield *et al.,* 2018). Yet some studies have not found such associations; for example, neither neighborhood nor housing damage predicted depression scores following the Northridge earthquake (Knight, Gatz, Heller, & Bengtson, 2000). It may be that subsequent stressors, which may occur either as a result of the disaster (e.g., relocation) or due to other factors in the individual's life (e.g., loss of a loved one to an unrelated illness) may be the mechanism whereby natural disaster experiences are intensified.

Indeed, number of stressors experienced often positively correlates with negative outcomes (Briere & Elliott, 2000; Norris *et al.*, 2002; Thompson *et al.*, 1993).

The World Health Organization World Mental Health Surveys found that personal secondary stressors (e.g., job loss, disability) occurring after natural disasters tend to be associated with affective and anxiety disorders (Kessler *et al.*, 2012). More specifically, Galea and collaborators (2007) found that after Hurricane Katrina, practical problems occurring as a result of the disaster, such as physical adversity, were linked with more post-hurricane distress. These findings suggest that it is not merely the magnitude of the actual disaster, but the cumulative effect of the stressful events experienced in the aftermath, that drive the distress response. Indeed, a longitudinal study of repeated exposure to Hurricanes in Florida found that event-exposure characteristics (including property loss, injury, and media-based exposure) were associated with mental health ailments, and that these effects sensitized individuals to respond more negatively to future disasters (Garfin *et al*., 2022). This is particularly important in the context of escalating climate threats leading to increased repeated exposure.

Property and financial loss

Loss of property has been explored as a potential factor influencing post-disaster psychosocial outcomes (Garfin *et al.,* 2022; Garfin, Silver *et al*., 2014). A study of 6412 survivors assessed 2 years after the Chi-Chi earthquake in Taiwan indicated that both full and partial destruction of property, as well as living in a prefabricated house, was associated with increased risk of PTSD (Chen *et al.*, 2007). Earthquake-related financial loss has been linked to poorer mental health in Italy, and deleterious effects of this loss persisted for over a decade (Bland *et al.*, 2005). Major property damage was predictive of both life satisfaction and probable PTSD after the 2005 earthquake in Pakistan (Naeem *et al.*, 2011). In contrast, home ownership,

which could intensify the individual economic cost of a disaster, was not related to distress after the 1999 Turkish earthquake (Kilic & Ulusoy, 2003); this study failed to address financial loss specifically, so inferences were speculative. Property loss and financial difficulties could be another proxy for chronic strain, which has been associated with elevated levels of distress (Baum, 1990; Dura, Stukenberg, & Kiecolt-Glaser, 1990) and the development of PTSD in particular (Garfin et al., 2022; Green *et al.*, 1994; McFarlane & Van Hooff, 2009). Financial loss during a disaster may leave survivors vulnerable to developing mental health problems (Makwana, 2019). A meta-analysis found that the loss of property or work significantly predicted depression after a natural disaster (Tang *et al.,* 2014). Measurement instruments that more specifically measure these effects are necessary for a more comprehensive documentation of this relationship.

Personal loss and injury

Injury and threat to life are often included in post-disaster assessments, and they exhibit strong correlations with PTSD, perhaps not surprising since a PTSD diagnosis requires that one experience or witness a traumatic event. Physical injury has been linked with a variety of other negative outcomes in both the short and long-term (Norris *et al.*, 2002). After the Chi-Chi earthquake, seeking medical services (a proxy for personal injury) was associated with PTSD (Chou *et al.*, 2005). Three years after the Chi-Chi earthquake, death or injury of a family member was related to role limitations due to emotional problems, but not global mental health (Wu *et al.*, 2006); loss of friends or relatives was predictive of PTSD 17 years after Buffalo Creek (Green *et al.*, 1994). According to Makwana (2019), the death of a loved one during a disaster leaves victims vulnerable to mental health problems due to victims being left with a sense of insecurity. Conversely, one month after the Marathwada earthquake in Western India, whereas

destruction of possessions and destruction of home were associated with PTSD, death of a relative, injury to a relative, personal hospitalization or injury to self were not correlated (Sharan, Chaudhary, Kavathekar, & Saxena, 1996); similar relationships were observed after the 2005 Pakistani earthquake (Naeem *et al.*, 2011). Such variability in research findings highlights the failure of empirical research to support a universal process for dealing with grief and loss (Wortman & Silver, 1989).

Longitudinal Reactions

In general, people's distress following natural disasters abates over time (Norris, Friedman, & Watson, 2002). Nevertheless, deleterious psychological consequences persist in a minority of individuals and may continue to impact the community for years and even decades after initial exposure. For example, two years after the 1999 Chi-Chi Taiwanese earthquake, over 20% of a sample of 6,412 survivors met criteria for probable PTSD (Chen *et al.*, 2007), although given this study's cross-sectional design, it is difficult to determine how these individuals fared initially, or how their symptoms changed over time. Longitudinal research suggests that exposure to subsequent stressors (including disasters and individual negative life events) portends increased psychological distress over time (Garfin *et al.,* 2022). Fifty years after exposure to a series of highly devastating earthquakes that occurred near the island of Cephallonia, Greece, adult survivors (age 62-86 at the time of assessment) reported present-day persistent reliving symptoms and a lasting impact of this experience on their daily lives (Lazaratou *et al.*, 2008). Such findings emphasize that natural disasters may leave a lifetime legacy in some survivors.

In addition, linear declines in symptomatology do not necessarily occur. Behavioral disorders did not decrease significantly over the 18-month period that followed the Australian bushfires (McFarlane, 1987), and 20 years later, survivors were more likely than non-exposed

individuals to meet lifetime prevalence for anxiety disorders; 75% of bushfire survivors endorsed some degree of long-term bushfire related distress (McFarlane & Van Hooff, 2009). PTS symptoms remained elevated during a three-year assessment period following the 1988 Armenian earthquake, although depression symptoms decreased in severity (Goenjian *et al.*, 2000). Some studies have found complex relationships between the time since the disaster and PTSD symptom severity. For example, following Hurricane Hugo, assessments at 6- and 30-months post-disaster indicated that intrusion and arousal symptoms declined over time, but avoidance symptoms increased (Norris, Perilla, Riad, Kaniasty, & Lavizzo, 1999). Evidence also suggests that PTSD may have a delayed onset, thus further highlighting the importance of longitudinal designs (Carty, O'Donnell, & Creamer, 2006).

Children's Responses to Natural Disasters

A growing body of work has examined children's responses to disasters (Eisenberg & Silver, 2011; Masten & Osofsky, 2010). Disasters have been linked to long term adjustment problems (Broberg, Dyregrov, & Lilled, 2005) including, PTSD, among children. One study found that 5-14% of children develop PTSD following a natural disaster (Dyregrov *et al.,* 2018); another study of children highly exposed to the 2010 Chilean earthquake found 25.6% met criteria for probable PTSD (Garfin, Silver, Gil-Rivas, *et al.*, 2014). Moreover, like in adults, post-disaster psychiatric problems can be highly comorbid: in a sample of 333 children, following the Lushan Earthquake, ASD symptoms predicted both PTSD and depressive symptoms, and PTSD symptoms predicted the onset of depressive symptoms Cheng *et al.,* 2020). The notion of childhood PTSD is widely accepted, although symptom presentation may be different among children, and may be even more severe than among adults (Bulut *et al.*, 2005; Dyregrov & Yule, 2006; Norris *et al.*, 2002).

Psychopathology and general distress may be critical components of the post-disaster response in children and may have negative repercussions in other domains of functioning. Children's exposure to community disasters has been linked to personality change and school problems (Terr, 1979), decreased academic motivation (Widyatmoko, Tan, Seyle, Mayawati, & Silver, 2011), elevated delinquency (Norris *et al.*, 2002), cognitive difficulties (Shannon, Lonigan, Finch, & Taylor, 1994), conduct disorder, and antisocial behavior (Chimienti, Nasr, & Khalifeh, 1989). A longitudinal study of 19,627 children who survived the 8.8 magnitude Chilean earthquake found that severity of earthquake exposure as well as individual level adverse childhood experiences was associated with worsened classroom adaptation (Dutta *et al.*, 2022). Similar to studies of adult reactions to disaster, prevalence rates have varied markedly as a function of assessment tool used, severity of the disaster, country of disaster, age of children, and time since the precipitating event. Children from poor countries are disproportionately affected by natural disasters (Kousky, 2016). Therefore, it is important that children at higher risk of developing health problems after a natural disaster are identified to intervene and prevent further problems.

As with adult populations, variability in post-disaster adjustment in children has been examined as a function of demographic, event-exposure and pre-existing psychological characteristics (Rowe, La Greca, & Alexandersson, 2010). Demographic variables such as age, gender, and ethnicity are frequently cited as significant predictors of PTS and other forms of distress among children (for an extensive review, see meta-analysis by Furr, Comer, Edmunds, & Kendall, 2010). Girls tend to exhibit worse outcomes compared to boys (Lonigan, Shannon, Finch, Daugherty, & Taylor, 1991). For example, following the Lushan Earthquake, girls were more likely to experience PTSD or depressive symptoms when compared to boys (Cheng *et al.,*

2020). Worse outcomes among girls has been documented cross-culturally in studies conducted in China (Fan, Zhang, Yang, Mo, & Liu, 2011; Zhang *et al.*, 2010), Greece (Groome & Soureti, 2004; Roussos *et al.*, 2005), and Turkey (Sahin, Batıgün, & Yılmaz, 2007). Minority status (Groome & Soureti, 2004) and younger age (Endo, Shioiri, & Someya, 2009; Laor *et al.*, 2002) have been implicated as risk factors for greater distress after earthquakes, although age effects are not universally supported empirically (Pynoos *et al.*, 1993). Interaction effects between disaster exposure and age may drive contradictory findings: after the 1999 Athens earthquake, younger children were more vulnerable in the most distressed regions, but were less distressed than older children in the less damaged areas (Groome & Soureti, 2004).

Children's distress responses have also been associated with the presence of physical injury, the amount of trauma exposure (Cheng *et al.,* 2020; Garfin, Silver, Gil-Rivas, *et al.*, 2014), concurrent adversity (Dutta et al., 2022), death of a family member (Hsu, Chong, Yang, & Yen, 2002) and post-earthquake relocation (Kilic, Kilic, & Aydm, 2011). Yet findings do not evidence a strict dose-response relationship between exposure and outcomes. One year after the 2008 Chinese earthquake, a representative sample of children from more highly exposed areas exhibited more mental health problems when compared to children with lower levels of exposure (Zhang *et al.*, 2010). Similar findings were reported in school-aged and adolescent children five months after the 1999 Athens earthquake (Groome & Soureti, 2004), three months after the Ano Liosia Greek earthquake (Roussos *et al.*, 2005) and six months after the 1988 Armenian earthquake (Goenjian *et al.*, 1995). In contrast, researchers who studied a representative sample of 200 children after the 1999 Marama earthquake did not find a direct relationship between exposure and distress; children from both high and low impact areas demonstrated similar prevalence rates and severity of PTSD (Bulut *et al.*, 2005). Similarly, after Hurricane Andrew,

children in high vs. low impact schools were not statistically different in presenting rates of PTSD, although children in more high-impact areas indicated higher overall PTS (Shaw *et al.*, 1995). Thus, relationships among disaster exposure and a range of child outcomes are complex and multiply determined by individual, community, cultural, and social factors.

Prior mental health and pre-existing psychological vulnerabilities have been less extensively studied in child populations, but available findings have linked certain psychological predispositions to poorer post-disaster outcomes. Children with higher trait anxiety and negative affectivity prior to Hurricane Katrina were more at risk for post-disaster PTSD (Weems *et al.*, 2007), although the small sample size in this study (N=52) limits generalizing its findings. Similarly, children assessed 3 months after Hurricane Andrew who had higher preexisting trait anxiety exhibited higher scores on the arousal subscale of PTSD post-disaster (Lonigan, Shannon, Taylor, Finch, & Sallee, 1994). Nonetheless, retrospective reporting precludes causal inferences.

Disaster exposure has been associated with internalizing and externalizing problems (characterized by antisocial or disruptive behaviors) in children. However, the relationship between PTS and externalizing disorders, is less clear (Rubens *et al.,* 2018). Three months after Hurricane Andrew, pre-existing anxiety and hyperactivity, but not conduct problems, predicted PTS symptoms; at 7 months, only pre-existing anxiety predicted distress (LaGreca, Silverman, Vernberg, & Prinstein, 1996). Similarly, a study of 100 children referred to an inner-city psychiatric facility indicated that externalizing symptoms did not correlate with PTSD post-trauma (Silva *et al.*, 2000). In sum, results suggest that it might be pre-existing internalizing symptoms, rather than externalizing ones, that are associated with PTSD in children following a

traumatic event. More research that incorporates pre-disaster psychological assessments with longitudinal follow-ups is needed to further elucidate these relationships.

A variety of potential protective factors may help buffer children from some of the deleterious consequences of natural disasters. Children's reported levels of social support have been negatively correlated with distress post-disaster (Dubow, Tisak, Causey, Hryshko, & Reid, 1991). After Hurricane Katrina, caregiver warmth was positively correlated with coping competency (Kilmer & Gil-Rivas, 2010). To address children's mental health needs, children should be quickly reunited with their parents and promptly restart school, even as the community rebuilds infrastructure (Kousky, 2016), highlighting the importance of a support system and a routine for children in the post-disaster context. Of importance, few studies have implemented designs where multiple respondents report on child responses to disaster; such methods may be a fruitful area in which to focus future research.

Although longitudinal assessments are limited in studies of children, persistent deleterious effects of disaster have been documented in extant research. For example, while a prospective study conducted after Hurricane Andrew found that levels of PTSD declined between 3- and 10-months post-disaster (LaGreca *et al.*, 1996), PTSD prevalence was still elevated, compared to base rates in general population (Dyregrov & Yule, 2006). After the massive 2008 earthquake in China rates of PTSD in children decreased over time, while depression increased (Dyregrov *et al.,* 2018). Distress in children did not greatly abate 18 months post-Australian bushfires (McFarlane, Policansky, & Irwin, 1987) and remained elevated 20 years post-disaster (McFarlane & Van Hooff, 2009). Similar findings were reported after Buffalo Creek; 37% of youth surveyed had probable-PTSD 2 years post-disaster (Green *et al.*, 1991), and a 17-year follow-up indicated lasting repercussions for adult mental health (Green *et al.*, 1994).

In addition to a general lack of longitudinal post-disaster studies with children, those that do exist tend to have small sample sizes, highlighting an area for future research.

Pregnancy and Natural Disasters

Exposure to natural disasters during pregnancy can have long lasting effects on children. Pregnant women face unique challenges during and after a natural disaster. Pregnant women who experience natural disaster face poor access to proper health care, psychological stress, and exposure to harmful contaminants (Callaghan *et al.,* 2007). These challenges can increase adverse health outcomes for the developing child. Some immediate physical effects seen after a natural disaster are increases in low birth weight, complications during labor, and preterm births (Kousky, 2016). Furthermore, after Hurricane Katrina, the infant mortality rate for affected areas was 9.4 per 1,000 live births, notably higher than the national average of 7.0 (Callaghan *et al.,* 2007). Exposure to natural disasters during pregnancy may also affect children psychologically long-term. Children who were exposed to a natural disaster prenatally during the weeks 14-22 of pregnancy were more likely to develop certain physical abnormalities such as fingertip ridge counts (i.e., "dermatoglyphic asymmetry), associated with schizophrenia (King *et al.,* 2009).

Methodological Concerns

Conducting research on natural disasters entails a unique set of challenges. In order to provide the most useful information to policy makers, clinicians, and service providers, it is important to conduct longitudinal studies that include acute, short-term, and long-term assessments using large and representative segments of the population. However, logistical difficulties often preclude such designs. Barriers to conducting methodologically stringent and widely applicable post-disaster research include: obtaining rapid ethics board approval, garnering sufficient funding in a truncated time period, making contacts in the field, accessing distressed or

demolished communities, and recruiting participants who are engaged in managing the personal repercussions of the disaster or have relocated due to damaged or destroyed homes. Access to pre-data, essential to making strong inferences, is rare (for exceptions, see Asarnow *et al.*, 1999; Bravo, Rubio-Stipec, Canino, Woodbury, & Ribera, 1990; Garfin et al., 2022). Given that it is hard to predict exactly when and where a disaster may occur, most studies with pre-measures are the result of researchers accessing a population previously enrolled in a study prior to the occurrence of the disaster. Thus, some studies compare prevalence rates of mental health problems between an exposed group and a control group. Beaglehole and colleagues (2018) conducted a meta-analysis of mental health problems with 27 studies that utilized validated measures and compared mental health problem rates to a control group. More rigorous studies may provide more accurate prevalence rates for mental health problems after a natural disaster. An additional problem in the disaster literature is that those most at risk for post-disaster problems (i.e., children, minorities, populations in developing countries) are often even more difficult to access, enroll, and evaluate (Norris, 2005b) in research studies. For example, assessing individuals in developing countries is difficult due to lack of cross-validation of psychiatric measurements, in addition to the inherent problem of accessing rural or displaced populations (Widyatmoko *et al.*, 2011).

Much of the disaster research historically has focused on convenience samples (Norris, 2005a), although recent research has used probability-based samples with longitudinal designs (Garfin *et al.,* 2022). Other common sampling types include census (used more often in developed nations), purposive (used in developing nations), and clinical (used least commonly in studies of natural disasters) designs. Since children are most commonly accessed in school settings, convenience samples comprise the majority of the samples for this group. Convenience

samples provide useful preliminary information on responses to disaster, but more stringent techniques will provide stronger empirical evidence to make scientific inferences and policy and clinical recommendations. Fortunately, more methodologically rigorous post-disaster research is emerging. Although the vast majority of assessments are still cross-sectional in nature (Norris, 2005a), and only a few studies have followed people for a decade or longer after the initial event (Green *et al.*, 1994; Lazaratou *et al.*, 2008), research incorporating longitudinal designs is growing (Jia *et al.*, 2013; Knight *et al.*, 2000; van Griensven *et al.*, 2006; Wang *et al.*, 2000). Although acute assessments (< 1 month post disaster) are still rare, the majority of studies commence within six months, providing useful information for short- and medium-term psychosocial outreach efforts.

As alluded to earlier, one glaring problem in the field is the vast number of assessment tools commonly employed. Many researchers use clinical structured or semi-structured interviews; among these, different interviews are employed, making comparative findings across studies challenging. For example, the National Institute of Mental Health (NIMH) Disaster Interview Schedule/Disaster Supplement (Robins & Smith, 1983), the Mini-International Neuropsychiatric Interview (Sheehan *et al.*, 1998), and the Structured Clinical Interviews for DSM-IV (SCID; First, Spitzer, Gibbon, & Williams, 1997) are all commonly used in post-disaster settings, often yielding divergent estimates. A variety of questionnaires are also available. Some, such as the child-specific UCLA-Posttraumatic Stress Reaction Index (UCLA-PTSD RI-1; Pynoos, Rodriguez, Steinberg, Stuber, & Frederick, 1998), can be administered via interview or in an online survey format. Researchers often decide what tool to implement based on a combination of cost, time constraints, and available personnel. For example, self-administered online surveys are cheaper and faster to administer to large populations, and require

less project staff when compared to interviews. However, interviews may be preferred to ascertain more complex diagnoses, more nuanced information, or when assessing children or illiterate populations.

Policy Issues, Recommendations, and Future Directions

A potential reason for an increase in natural disasters in recent years is likely due to climate change (Munich Re, 2022). Climate change has risen temperatures worldwide exacerbating natural disasters such as hurricanes, heat waves, wildfires, and typhoons and making them more prevalent. Increases in global temperatures, as well heatwaves have been found to be associated with increases in mental health problems including psychological distress (Vergunst & Berry, 2021). For example, Silveira and colleagues (2021) found significantly increased rates of PTSD and depression among individuals who were directly exposed to the 2018 Camp Fire, California's deadliest wildfire. Yet, adults are not the only ones affected by climate change. Vergunst & Berry (2021) argue that individuals mental health is affected since before people are born and continue to be affected as they grow due to vulnerabilities while developing. Efforts to decrease climate change such as the Paris Agreement, could help decrease natural disasters and the problems that arise thereafter. However, in the absence of political will to enact change, policy makers will be tasked with finding ways to address an escalating mental health crisis.

Given the robust findings linking natural disasters to psychosocial problems that may persist long after the structural debris has been cleared, evidence-based policies are essential to appropriately meet the short- and long-term needs of a distressed population. However, interventions and service provisions to minimize PTSD and other forms of psychological distress can be costly and labor intensive (DiMaggio, Galea, & Richardson, 2007; Feeney, Goldberg,

Blumenthal, & Wallack, 2005). Identifying populations most in need – and timing appropriate delivery of services – is essential to maximize limited relief funds. While the decade following the 9/11 terrorist attacks ushered in a plethora of research that has helped guide evidence-based interventions to help minimize post-disaster maladjustment (Watson, Brymer, & Bonanno, 2011), methodological limitations in many post-disaster studies have precluded researchers' ability to endorse definitive recommendations for targeting specific populations most at-risk (Bonanno, Brewin, Kaniasty, & Greca, 2010). As such, an ongoing problem for humanitarian relief organizations is how to connect the immediate post-disaster response from government and non-governmental agencies with the short- and long-term psychological, social and health services needs of the community (Psychology Beyond Borders, 2010).

Current state-of-the-art research recommends that interventions be targeted towards specific populations in temporally appropriate sequences (Vernberg *et al.*, 2008). First, prevention policies should be implemented in preparation for a potential disaster. These law and public policy-related efforts should help mitigate potential harm and additional trauma exposure from natural disasters before they occur (e.g., making sure emergency plans are in place, building structures with appropriate integrity to withstand earthquakes). Secondary prevention is then delivered within days of the event. Whereas psychological debriefing, or having people verbally process the trauma in an individual or group setting, appears to be inefficacious at reducing symptoms and may even exacerbate distress responses (Rose, Bisson, Churchill, & Wessely, 2009), providing information and social support can help survivors cope with the immediate aftermath of the disaster (Hobfoll *et al.*, 2007). Providing concrete assistance in the form of food, rest, and facts, can be especially helpful. Within the first few weeks after the disaster, survivors should be evaluated for high risk of future problems; those who show high

likelihood of future distress (e.g., endorse high ASD symptomatology) should be followed and be targeted with available services should symptoms continue (Shalev *et al.*, 2012).

Further recommendations for interventions post-disaster focus on maintaining awareness of the importance of being sensitive to the enormous variability in response, both immediately and over time. It is not uncommon for many people to experience distress in the immediate aftermath, and thus clinicians and community members should avoid pathologizing normal responses to abnormal events; natural recovery processes will generally occur in a majority of individuals. Assistance is best received when it comes from people in the community (e.g., churches, community groups). Public service announcements are helpful to inform people about services, to understand that feelings of distress are normative, and to encourage people to seek professional assistance if symptoms persist.

Research on natural disasters continues to grow in terms of number and sophistication of research techniques. Methodological advancements such as increased sample size and representativeness, particularly with respect to studies of children, will help generalize findings to broader populations. While challenging, research with disadvantaged populations, particularly in developing nations, is needed to inform international humanitarian relief efforts, especially since disasters in developing nations tend to incur greater death, destruction, and economic hardship. Standardizing preferred instruments for use in the field and validating measures for use in international settings is also needed. The development of recommendations for researchers seeking to choose the most appropriate instrument given a particular disaster, population, and methodological design would be of great benefit to the field. More longitudinal studies are essential in order to evaluate the potential for delayed-onset PTSD and to examine the likely

interaction between exposure to disaster and subsequent life stressors on psychological and physical health.

In sum, while the past five decades have advanced knowledge in the field of post-disaster responses, continued innovations in methodology will further enhance our understanding of this important topic. A body of methodologically rigorous research will enable the development of stronger evidence-based recommendations for policy makers, clinicians, and community members seeking to ameliorate the deleterious psychological consequences of exposure to natural disasters.

List of Relevant Web Pages

Federal Emergency Management Agency (FEMA) www.fema.gov

International Society for Traumatic Stress Studies www.istss.org

National Center for PTSD www.ptsd.va.gov

Center for Research on the Epidemiology of Disasters CRED) https://www.cred.be/

References

Adhikari Baral, I. and K.C, B., 2019. Post traumatic stress disorder and coping strategies among adult survivors of earthquake, Nepal. *BMC Psychiatry*, 19(1).

Amaya-Jackson, L., Davidson, J., Hughes, D., Swartz, M., Reynolds, V., George, L. and Blazer, D., 1999. Functional impairment and utilization of services associated with posttraumatic stress in the community. *Journal of Traumatic Stress*, 12(4), pp.709-724.

American Psychiatric Association., 2013. *Posttraumatic Stress Disorder*.

Asarnow, J., Glynn, S., Pynoos, R.S., Nahum, J., Guthrie, D., Cantwell, D.P. and Franklin, B., 1999. When the earth stops shaking: Earthquake sequelae among children diagnosed for pre-earthquake psychopathology. *Journal of the American Academy of Child & Adolescent Psychiatry*, *38*(8), pp.1016-1023.

Bal, A., 2008. Post-traumatic stress disorder in Turkish child and adolescent survivors three years after the Marmara earthquake. *Child and Adolescent Mental Health*, 13(3), pp.134-139.

Bandura, A., 1977. Self-efficacy: Toward a unifying theory of behavioral change. *Psychological Review*, 84(2), pp.191-215.

Baum, A., 1990. Stress, intrusive imagery, and chronic distress. *Health Psychology*, 9(6), pp.653-675.

Beaglehole, B., Mulder, R., Frampton, C., Boden, J., Newton-Howes, G. and Bell, C., 2018. Psychological distress and psychiatric disorder after natural disasters: systematic review and meta-analysis. *The British Journal of Psychiatry*, 213(6), pp.716-722.

Benight, C., 2004. Collective efficacy following a series of natural disasters. *Anxiety, Stress, Coping*, 17(4), pp.401-420.

Benevolenza, M.A. and DeRigne, L., 2019. The impact of climate change and natural disasters on vulnerable populations: A systematic review of literature. *Journal of Human Behavior in the Social Environment*, *29*(2), pp.266-281.

Bland, S., Valoroso, L., Stranges, S., Strazzullo, P., Farinaro, E. and Trevisan, M., 2005. Long-term follow-up of psychological distress following earthquake experiences among working italian males. *Journal of Nervous and Mental Disease*, 193(6), pp.420-423.

Bonanno, G., 2004. Loss, trauma, and human resilience: have we underestimated the human capacity to thrive after extremely aversive events? *American Psychologist*, 59(1), pp.20-28.

Bonanno, G., Brewin, C., Kaniasty, K. and Greca, A., 2010. Weighing the Costs of Disaster. *Psychological Science in the Public Interest*, 11(1), pp.1-49.

Bovin, M.J., Marx, B.P., Weathers, F.W., Gallagher, M.W., Rodriguez, P., Schnurr, P.P. and Keane, T.M., 2016. Psychometric properties of the PTSD checklist for diagnostic and statistical manual of mental disorders–fifth edition (PCL-5) in veterans. *Psychological assessment*, *28*(11), p.1379.

Bravo, M., Rubio-Stipec, M., Canino, G., Woodbury, M. and Ribera, J., 1990. The psychological sequelae of disaster stress prospectively and retrospectively evaluated. *American Journal of Community Psychology*, 18(5), pp.661-680.

Briere, J. and Elliott, D., 2000. Prevalence, characteristics, and long-term sequelae of natural disaster exposure in the general population. *Journal of Traumatic Stress*, 13(4), pp.661-679.

Broberg, A., Dyregrov, A. and Lilled, L., 2005. The Goteborg discotheque fire: posttraumatic stress, and school adjustment as reported by the primary victims 18 months later. *Journal of Child Psychology and Psychiatry*, 46(12), pp.1279-1286.

Brooks, N. and McKinlay, W., 1992. Mental health consequences of the Lockerbie disaster. *Journal of Traumatic Stress*, 5(4), pp.527-543.

Bryant, R., 2006. Acute stress disorder. *Psychiatry*, 5(7), pp.238-239.

Bulut, S., Bulut, S. and Tayli, A., 2005. The dose of exposure and prevalence rates of post traumatic stress disorder in a sample of Turkish children eleven months after the 1999 Marmara earthquakes. *School Psychology International*, 26(1), pp.55-70.

Caldera, T., Palma, L., Penayo, U. and Kullgren, G., 2001. Psychological impact of the hurricane Mitch in Nicaragua in a one-year perspective. *Social Psychiatry and Psychiatric Epidemiology*, 36(3), pp.108-114.

Callaghan, W., Rasmussen, S., Jamieson, D., Ventura, S., Farr, S., Sutton, P., Mathews, T., Hamilton, B., Shealy, K., Brantley, D. and Posner, S., 2007. Health concerns of women and infants in times of natural disasters: lessons learned from Hurricane Katrina. *Maternal and Child Health Journal*, 11(4), pp.307-311.

Canan, F. and North, C., 2019. Dissociation and disasters: A systematic review. *World Journal of Psychiatry*, 9(6), pp.83-98.

Carr, V., Lewin, T., Webster, R. and Kenardy, J., 1997. A synthesis of the findings from the Quake Impact Study: a two-year investigation of the psychosocial sequelae of the 1989 Newcastle earthquake. *Social Psychiatry and Psychiatric Epidemiology*, 32(3), pp.123-136.

Carty, J., O'Donnell, M. and Creamer, M., 2006. Delayed-onset PTSD: A prospective study of injury survivors. *Journal of Affective Disorders*, 90(2-3), pp.257-261.

Cepeda, A., Valdez, A., Kaplan, C. and Hill, L., 2010. Patterns of substance use among Hurricane Katrina evacuees in Houston, Texas. *Disasters*, 34(2), pp.426-446.

Chen, C., Tan, H., Liao, L., Chen, H., Chan, C., Cheng, J., Chen, C., Wang, T. and Lu, M., 2007. Long-term psychological outcome of 1999 Taiwan earthquake survivors: a survey of a high-risk sample with property damage. *Comprehensive Psychiatry*, 48(3), pp.269-275.

Chen, S., Bagrodia, R., Pfeffer, C., Meli, L. and Bonanno, G., 2020. Anxiety and resilience in the face of natural disasters associated with climate change: A review and methodological critique. *Journal of Anxiety Disorders*, 76, p.102297.

Cheng, J., Liang, Y., Fu, L. and Liu, Z., 2020. The relationship between PTSD and depressive symptoms among children after a natural disaster: A 2-year longitudinal study. *Psychiatry Research*, 292, p.113296.

Chimienti, G., Nasr, J. and Khalifeh, I., 1989. Children's reactions to war-related stress. *Social Psychiatry and Psychiatric Epidemiology*, 24(6), pp.282-287.

Chou, F.H.C., Su, T.T.P., Chou, P., Ou-Yang, W.C., Lu, M.K. and Chien, I.C., 2005. Survey of psychiatric disorders in a Taiwanese village population six months after a major earthquake. *Journal of the Formosan Medical Association*, *104*(5), pp.308-317.

CRED., 2018. Natural Disasters 2017. Centre for Research on the Epidemiology of Disasters CRED. https://www.cred.be/natural-disasters-2017.

Danan, G., 2019. *Exposure and vulnerability to natural disasters for world's cities*. United Nations Department of Economic and Social Affairs.

https://www.un.org/en/development/desa/population/publications/pdf/technical/TP2019-4.pdf

Derogatis, L.R., 2001. *Brief symptom inventory 18*. Baltimore: Johns Hopkins University.

DiMaggio, C., Galea, S. and Richardson, L.D., 2007. Emergency department visits for behavioral and mental health care after a terrorist attack. *Annals of Emergency Medicine*, *50*(3), pp.327-334.

Dooley, E. and Gunn, J., 1995. The psychological effects of disaster at sea. *The British Journal of Psychiatry*, *167*(2), pp.233-237.

Dubow, E.F., Tisak, J., Causey, D., Hryshko, A. and Reid, G., 1991. A two-year longitudinal study of stressful life events, social support, and social problem-solving skills: Contributions to children's behavioral and academic adjustment. *Child Development*, *62*(3), pp.583-599.

Dura, J.R., Stukenberg, K.W. and Kiecolt-Glaser, J.K., 1990. Chronic stress and depressive disorders in older adults. *Journal of Abnormal Psychology*, *99*(3), p.284.

Dutta, A., Felipe, P., Peña, F., Holcomb, J. M., Loreto, L., Sqicciarini, A. M., Canenguez, K. M., Bergman, P., Riobueno-Naylor, A., Farley, A. M., Simonsohn, A., Garfin, D. R., Silver, R. C., Benheim, T. S., Guzmán, J., Jelinek, M. S., & Murphy, M. J., 2022. Earthquake exposure, adverse childhood experiences, and psychosocial functioning in Chilean children: A longitudinal study. *Journal of Traumatic Stress.*

Dyregrov, A. and Yule, W., 2006. A review of PTSD in children. *Child and Adolescent Mental Health*, *11*(4), pp.176-184.

Dyregrov, A., Yule, W. and Olff, M., 2018. Children and natural disasters. *European Journal of Psychotraumatology*, *9*(sup2), p.1500823.

Eisenberg, N. and Silver, R.C., 2011. Growing up in the shadow of terrorism: youth in America after 9/11. *American Psychologist*, *66*(6), p.468.

Endo, T., Shioiri, T. and Someya, T., 2009. Post-traumatic symptoms among the children and adolescents 2 years after the 2004 Niigata–Chuetsu earthquake in Japan. *Psychiatry and Clinical Neurosciences*, *63*(2), pp.253-253.

Epstein, R.S., Fullerton, C.S. and Ursano, R.J., 1998. Posttraumatic stress disorder following an air disaster: a prospective study. *American Journal of Psychiatry*, *155*(7), pp.934-938.

Fan, F., Zhang, Y., Yang, Y., Mo, L., & Liu, X., 2011. Symptoms of posttraumatic stress disorder, depression, and anxiety among adolescents following the 2008 Wenchuan earthquake in China. *Journal of Traumatic Stress* 24, 44–53

Fang, J., Lau, C.K.M., Lu, Z., Wu, W. and Zhu, L., 2019. Natural disasters, climate change, and their impact on inclusive wealth in G20 countries. *Environmental Science and Pollution Research*, *26*(2), pp.1455-1463.

Feeney, J.M., Goldberg, R., Blumenthal, J.A. and Wallack, M.K., 2005. September 11, 2001, revisited: a review of the data. *Archives of Surgery*, *140*(11), pp.1068-1073.

First, M. B., Spitzer, R. L., Gibbon, M., & Williams, J. B. W., 1997. User's guide for the structured clinical interview for DSM-IV axis I disorders: SCID-1 clinician version. *American Psychiatric Publishing, Inc.*

Furr, J.M., Comer, J.S., Edmunds, J.M. and Kendall, P.C., 2010. Disasters and youth: a meta-analytic examination of posttraumatic stress. *Journal of Consulting and Clinical Psychology*, *78*(6), p.765.

Galea, S., Brewin, C. R., Gruber, M., Jones, R. T., King, D. W., King, L.. … Kessler, R.C., 2007. Exposure to hurricane-related stressors and mental illness after Hurricane Katrina. *Archives of General Psychiatry* 64, 1427–1434. doi:10.1001/archpsyc.64.12.1427

Garfin, D.R., Juth, V., Silver, R.C., Ugalde, F.J., Linn, H. and Inostroza, M., 2014. A national study of health care service utilization and substance use after the 2010 Chilean earthquake. *Psychiatric services*, *65*(11), pp.1392-1395.

Garfin, D.R., Silver, R.C., Gil-Rivas, V., Guzmán, J., Murphy, J.M., Cova, F., Rincón, P.P., Squicciarini, A.M., George, M. and Guzmán, M.P., 2014. Children's reactions to the 2010 Chilean earthquake: The role of trauma exposure, family context, and school-based mental health programming. *Psychological Trauma: Theory, Research, Practice, and Policy*, *6*(5), p.563.

Garfin, D.R., Silver, R.C., Ugalde, F.J., Linn, H. and Inostroza, M., 2014. Exposure to rapid succession disasters: a study of residents at the epicenter of the Chilean Bío Bío earthquake. *Journal of abnormal psychology*, *123*(3), p.545.

Garfin, D.R., Thompson, R.R. and Holman, E.A., 2018. Acute stress and subsequent health outcomes: A systematic review. *Journal of Psychosomatic Research*, *112*, pp.107-113.

Garfin, D.R., Thompson, R.R., Holman, E.A., Wong-Parodi, G. and Silver, R.C., 2022. Association between repeated exposure to hurricanes and mental health in a representative sample of Florida residents. *JAMA Network Open*, *5*(6), e2217251-e2217251.

Ginexi, E.M., Weihs, K., Simmens, S.J. and Hoyt, D.R., 2000. Natural disaster and depression: a prospective investigation of reactions to the 1993 Midwest floods. *American Journal of Community Psychology*, *28*(4), pp.495-518.

Goenjian, A., 1993. A mental health relief programme in Armenia after the 1988 earthquake: implementation and clinical observations. *The British Journal of Psychiatry*, *163*(2), pp.230-239.

Goenjian, A.K., Pynoos, R.S., Steinberg, A.M., Najarian, L.M., Asarnow, J.R., Karayan, I., Ghurabi, M. and Fairbanks, L.A., 1995. Psychiatric comorbidity in children after the 1988: earthquake in Armenia. *Journal of the American Academy of Child & Adolescent Psychiatry*, *34*(9), pp.1174-1184.

Goenjian, A.K., Steinberg, A.M., Najarian, L.M., Fairbanks, L.A., Tashjian, M. and Pynoos, R.S., 2000. Prospective study of posttraumatic stress, anxiety, and depressive reactions after earthquake and political violence. *American Journal of Psychiatry*, *157*(6), pp.911-916.

Golitaleb, M., Mazaheri, E., Bonyadi, M. and Sahebi, A., 2022. Prevalence of post-traumatic stress disorder after flood: a systematic review and meta-analysis. *Frontiers in Psychiatry*, p.1344.

Green, B.L., Grace, M.C., Vary, M.G., Kramer, T.L., Gleser, G.C. and Leonard, A.C., 1994. Children of disaster in the second decade: A 17-year follow-up of Buffalo Creek survivors. *Journal of the American Academy of Child & Adolescent Psychiatry*, *33*(1), pp.71-79.

Green, B.L., Korol, M., Grace, M.C., Vary, M.G., Leonard, A.C., Gleser, G.C. and Smitson-Cohen, S., 1991. Children and disaster: Age, gender, and parental effects on PTSD symptoms. *Journal of the American Academy of Child & Adolescent Psychiatry*, *30*(6), pp.945-951.

Groome, D. and Soureti, A., 2004. Post-traumatic stress disorder and anxiety symptoms in children exposed to the 1999 Greek earthquake. *British Journal of Psychology*, *95*(3), pp.387-397.

Guarnaccia, P.J., Canino, G., Rubio-Stipec, M. and Bravo, M., 1993. The prevalence of ataques de nervios in the Puerto Rico Disaster Study: The role of culture in psychiatric epidemiology. *Journal of Nervous and Mental Disease*.

Hall, B.J., Sou, K., Chen, W., Zhou, F., Chang, K. and Latkin, C., 2016. An evaluation of the buffering effects of types and sources of support on depressive symptoms among natural disaster–exposed Chinese adults. *Psychiatry*, *79*(4), pp.389-402.

Hobfoll, S.E., Watson, P., Bell, C.C., Bryant, R.A., Brymer, M.J., Friedman, M.J., Friedman, M., Gersons, B.P., De Jong, J.T., Layne, C.M. and Maguen, S., 2007. Five essential elements of immediate and mid–term mass trauma intervention: Empirical evidence. *Psychiatry*, *70*(4), pp.283-315.

Hollifield, M., Hewage, C., Gunawardena, C.N., Kodituwakku, P., Bopagoda, K., Weerarathnege, K. and International Post-Tsunami Study Group, 2008. Symptoms and coping in Sri Lanka 20–21 months after the 2004 tsunami. *The British Journal of Psychiatry*, *192*(1), pp.39-44.

Holman, E.A. and Silver, R.C., 1998. Getting" stuck" in the past: temporal orientation and coping with trauma. *Journal of Personality and Social Psychology*, *74*(5), p.1146.

Holman, E.A., Silver, R.C., Poulin, M., Andersen, J., Gil-Rivas, V. and McIntosh, D.N., 2008. Terrorism, acute stress, and cardiovascular health: A 3-year national study following the September 11th attacks. *Archives of General Psychiatry*, *65*(1), pp.73-80.

Horesh, D., Lowe, S.R., Galea, S., Aiello, A.E., Uddin, M. and Koenen, K.C., 2017. An in-depth look into PTSD-depression comorbidity: A longitudinal study of chronically-exposed Detroit residents. *Journal of Affective Disorders*, *208*, pp.653-661.

Hsu, C.C., Chong, M.Y., Yang, P. and Yen, C.F., 2002. Posttraumatic stress disorder among adolescent earthquake victims in Taiwan. *Journal of the American Academy of Child & Adolescent Psychiatry*, *41*(7), pp.875-881.

Hussain, A., Weisaeth, L. and Heir, T., 2011. Psychiatric disorders and functional impairment among disaster victims after exposure to a natural disaster: a population based study. *Journal of Affective Disorders*, *128*(1-2), pp.135-141.

Jia, Z., Shi, L., Duan, G., Liu, W., Pan, X., Chen, Y. and Tian, W., 2013. Traumatic experiences and mental health consequences among child survivors of the 2008 Sichuan earthquake: a community-based follow-up study. *BMC Public Health*, *13*(1), pp.1-9.

Kannis-Dymand, L., Carter, J.D., Lane, B.R. and Innes, P., 2019. The relationship of peritraumatic distress and dissociation with beliefs about memory following natural disasters. *Australian Psychologist*, *54*(4), pp.311-321.

Kar, N., Sharma, P.S.V.N., Murali, N. and Mehrotra, S., 2004. Mental health consequences of the trauma of super-cyclone 1999 in Orissa. *Indian Journal of Psychiatry*, *46*(3), p.228.

Keskinen-Rosenqvist, R., Michélsen, H., Schulman, A. and Wahlström, L., 2011. Physical symptoms 14 months after a natural disaster in individuals with or without injury are associated with different types of exposure. *Journal of Psychosomatic Research*, *71*(3), pp.180-187.

Kessler, R.C., McLaughlin, K.A., Koenen, K.C., Petukhova, M., Hill, E.D. and WHO World Mental Health Survey Consortium, 2012. The importance of secondary trauma exposure

for post-disaster mental disorder. *Epidemiology and Psychiatric Sciences*, *21*(1), pp.35-45.

Kiliç, C., Kiliç, E.Z. and Aydin, I.O., 2011. Effect of relocation and parental psychopathology on earthquake survivor-children's mental health. *The Journal of Nervous and Mental Disease*, *199*(5), pp.335-341.

Kiliç, C. and Ulusoy, M.A.H.I.R., 2003. Psychological effects of the November 1999 earthquake in Turkey: an epidemiological study. *Acta Psychiatrica Scandinavica*, *108*(3), pp.232-238.

Kilmer, R.P. and Gil-Rivas, V., 2010. Exploring posttraumatic growth in children impacted by Hurricane Katrina: Correlates of the phenomenon and developmental considerations. *Child Development*, *81*(4), pp.1211-1227.

King, S., Mancini-Marïe, A., Brunet, A., Walker, E., Meaney, M.J. and Laplante, D.P., 2009. Prenatal maternal stress from a natural disaster predicts dermatoglyphic asymmetry in humans. *Development and Psychopathology*, *21*(2), pp.343-353.

Knight, B.G., Gatz, M., Heller, K. and Bengtson, V.L., 2000. Age and emotional response to the Northridge earthquake: a longitudinal analysis. *Psychology and Aging*, *15*(4), p.627.

Kopak, A.M. and Van Brown, B., 2020. Substance use in the life cycle of a disaster: a research agenda and methodological considerations. *American Behavioral Scientist*, *64*(8), pp.1095-1110.

Kousky, C., 2016. Impacts of natural disasters on children. *The Future of Children*, *26*(1), pp.73-92.

Kulkarni, M. and Pole, N., 2008. Psychiatric distress among Asian and European American
survivors of the 1994 Northridge earthquake. *The Journal of Nervous and Mental
Disease*, *196*(8), pp.597-604.

LaGreca, A.M., Silverman, W.K., Vernberg, E.M. and Prinstein, M.J., 1996. Symptoms of
posttraumatic stress in children after Hurricane Andrew: a prospective study. *Journal of
Consulting and Clinical Psychology*, *64*(4), p.712.

Lai, T.J., Chang, C.M., Connor, K.M., Lee, L.C. and Davidson, J.R., 2004. Full and partial
PTSD among earthquake survivors in rural Taiwan. *Journal of psychiatric
research*, *38*(3), pp.313-322.

Laor, N., Wolmer, L., Kora, M., Yucel, D., Spirman, S. and Yazgan, Y., 2002. Posttraumatic,
dissociative and grief symptoms in Turkish children exposed to the 1999
earthquakes. *The Journal of Nervous and Mental Disease*, *190*(12), pp.824-832.

Lazaratou, H., Paparrigopoulos, T., Galanos, G., Psarros, C., Dikeos, D. and Soldatos, C., 2008.
The psychological impact of a catastrophic earthquake: a retrospective study 50 years
after the event. *The Journal of Nervous and Mental Disease*, *196*(4), pp.340-344.

Lifton, R.J. and Olson, E., 1976. The Human Meaning of Total Disaster. In *Coping with life
crises* (pp. 307-321). Springer, Boston, MA.

Lima, B.R., Chavez, H., Samaniego, N., Pompei, M.S., Pai, S., Santacruz, H. and Lozano, J.,
1989. Disaster severity and emotional disturbance: implications for primary mental health
care in developing countries. *Acta Psychiatrica Scandinavica*, *79*(1), pp.74-82.

Logue, J.N., Hansen, H. and Struening, E., 1981. Some indications of the long-term health
effects of a natural disaster. *Public Health Reports*, *96*(1), p.67.

Lonigan, C.J., Shannon, M.P., Finch Jr, A.J., Daugherty, T.K. and Taylor, C.M., 1991. Children's reactions to a natural disaster: Symptom severity and degree of exposure. *Advances in Behaviour Research and Therapy*, *13*(3), pp.135-154.

Lonigan, C.J., Shannon, M.P., Taylor, C.M., Finch Jr, A.J. and Sallee, F.R., 1994. Children exposed to disaster: II. Risk factors for the development of post-traumatic symptomatology. *Journal of the American Academy of Child & Adolescent Psychiatry*, *33*(1), pp.94-105.

Luszczynska, A., Benight, C.C. and Cieslak, R., 2009. Self-efficacy and health-related outcomes of collective trauma: a systematic review. *European Psychologist*, *14*(1), p.51.

Madianos, M.G. and Evi, K., 2010. Trauma and natural disaster: The case of earthquakes in Greece. *Journal of Loss and Trauma*, *15*(2), pp.138-150.

Makwana, N., 2019. Disaster and its impact on mental health: A narrative review. *Journal of family medicine and primary care*, *8*(10), p.3090.

Martínez-Levy, G.A., Bermúdez-Gómez, J., Merlín-García, I., Flores-Torres, R.P., Nani, A., Cruz-Fuentes, C.S., Briones-Velasco, M., Ortiz-León, S. and Mendoza-Velásquez, J., 2021. After a disaster: Validation of PTSD checklist for DSM-5 and the four-and eight-item abbreviated versions in mental health service users. *Psychiatry Research*, *305*, p.114197.

Marx, B.P. and Sloan, D.M., 2005. Peritraumatic dissociation and experiential avoidance as predictors of posttraumatic stress symptomatology. *Behaviour Research and Therapy*, *43*(5), pp.569-583.

Masten, A.S. and Osofsky, J.D., 2010. Disasters and their impact on child development: Introduction to the special section. *Child Development*, *81*(4), pp.1029-1039.

McFarlane, A.C., 1987. Posttraumatic phenomena in a longitudinal study of children following a natural disaster. *Journal of the American Academy of Child & Adolescent Psychiatry*, *26*(5), pp.764-769.

McFarlane, A.C., Policansky, S.K. and Irwin, C., 1987. A longitudinal study of the psychological morbidity in children due to a natural disaster. *Psychological Medicine*, *17*(3), pp.727-738.

McFarlane, A.C. and Raphael, B., 1984. Ash Wednesday: The effects of a fire. *Australian & New Zealand Journal of Psychiatry*, *18*(4), pp.341-351.

McFarlane, A.C. and Van Hooff, M., 2009. Impact of childhood exposure to a natural disaster on adult mental health: 20-year longitudinal follow-up study. *The British Journal of Psychiatry*, *195*(2), pp.142-148.

McKinley, C.E., Scarnato, J.M., Liddell, J., Knipp, H. and Billiot, S., 2019. Hurricanes and Indigenous Families: Understanding connections with discrimination, social support, and violence on PTSD. *Journal of Family Strengths*, *19*(1).

McMillen, J.C., North, C.S. and Smith, E.M., 2000. What parts of PTSD are normal: intrusion, avoidance, or arousal? Data from the Northridge, California, earthquake. *Journal of Traumatic Stress*, *13*(1), pp.57-75.

Miller, M., Paton, D. and Johnston, D., 1999. Community vulnerability to volcanic hazard consequences. *Disaster Prevention and Management: An International Journal*, *8*(4), pp.255-260.

Munich Re., 2022. Munich Re. *Hurricanes, cold waves, tornadoes: Weather disasters in USA dominate natural disaster losses in 2021*. Munich Re. Retrieved May 13, 2022, from

https://www.munichre.com/en/company/media-relations/media-information-and-corporate-news/media-information/2022/natural-disaster-losses-2021.html

Munich Re., 2012. Munich Re NatCatSERVICE: Natural catastrophes in 2011. https://www.munichre.com/touch/naturalhazards/en/publications/topics_geo/issue/2011.aspx. Accessed February 28, 2013.

Naeem, F., Ayub, M., Masood, K., Gul, H., Khalid, M., Farrukh, A., Shaheen, A., Waheed, W. and Chaudhry, H.R., 2011. Prevalence and psychosocial risk factors of PTSD: 18 months after Kashmir earthquake in Pakistan. *Journal of Affective Disorders*, *130*(1-2), pp.268-274.

Nakabayashi, M., 2022. Cumulative Adverse Mental Health Outcomes After Concurrent Disasters—Social, Scientific, and Policy-Making Implications. *JAMA Network Open*, *5*(6), pp.e2217260-e2217260.

National Oceanic and Atmospheric Administration., 2012. Summary of natural hazard statistics for 2011 in the United States. http://www.nws.noaa.gov/os/hazstats/sum11.pdf. Accessed February 28, 2013.

Neria, Y., Nandi, A. and Galea, S., 2008. Post-traumatic stress disorder following disasters: a systematic review. *Psychological medicine*, *38*(4), pp.467-480.

Norris, F.H., 2005. Range, magnitude, and duration of the effects of disasters on mental health: Review update 2005. *Research Education and Disaster Mental Health*, pp.1-23.

Norris, F.H., 2005. Disaster research methodology: Past progress and future directions. *Research Education Disaster Mental Health.*

Norris, F.H., Friedman, M.J., Watson, P.J., Byrne, C.M., Diaz, E. and Kaniasty, K., 2002. 60,000 disaster victims speak: Part I. An empirical review of the empirical literature, 1981—2001. *Psychiatry*, *65*(3), pp.207-239.

Norris, F.H. and Murrell, S.A., 1988. Prior experience as a moderator of disaster impact on anxiety symptoms in older adults. *American Journal of Community Psychology*, *16*(5), pp.665-683.

Norris, F.H., Perilla, J.L., Riad, J.K., Kaniasty, K. and Lavizzo, E.A., 1999. Stability and change in stress, resources, and psychological distress following natural disaster: Findings from Hurricane Andrew. *Anxiety, Stress & Coping*, *12*(4), pp.363-396.

Norris, F.H. and Uhl, G.A., 1993. Chronic stress as a mediator of acute stress: The case of Hurricane Hugo 1. *Journal of Applied Social Psychology*, *23*(16), pp.1263-1284.

North, C.S., Kawasaki, A., Spitznagel, E.L. and Hong, B.A., 2004. The course of PTSD, major depression, substance abuse, and somatization after a natural disaster. *The Journal of Nervous and Mental Disease*, *192*(12), pp.823-829.

Ozer, E.J., Best, S.R., Lipsey, T.L. and Weiss, D.S., 2003. Predictors of posttraumatic stress disorder and symptoms in adults: a meta-analysis. *Psychological bulletin*, *129*(1), p.52.

Palinkas, L., Downs, M., Petterson, J. and Russell, J., 1993. Social, cultural, and psychological impacts of the Exxon Valdez oil spill. *Human Organization*, *52*(1), pp.1-13.

Phifer, J.F., 1990. Psychological distress and somatic symptoms after natural disaster: differential vulnerability among older adults. *Psychology and Aging*, *5*(3), p.412.

Pooley, J.A., Cohen, L., O'Connor, M. and Taylor, M., 2013. Posttraumatic stress and posttraumatic growth and their relationship to coping and self-efficacy in Northwest

Australian cyclone communities. *Psychological Trauma: Theory, Research, Practice, and Policy*, *5*(4), p.392.

Psychology Beyond Borders, 2010. *Psychosocial strategies for managing the long-term impacts of Chile's 2010 earthquake and aftershocks*. Austin, TX.

Pynoos, R.S., Goenjian, A., Tashjian, M., Karakashian, M., Manjikian, R., Manoukian, G., Steinberg, A.M. and Fairbanks, L.A., 1993. Post-traumatic stress reactions in children after the 1988 Armenian earthquake. *The British Journal of Psychiatry*, *163*(2), pp.239-247.

Pynoos, R., Rodriguez, N., Steinberg, A., Stuber, M., & Frederick, C., 1998. *UCLA PTSD index for DSM-IV*. UCLA Trauma Psychiatry Service, Unpublished manual.

Robins, L.N. and Smith, E.M., 1983. The diagnostic interview schedule/disaster supplement. *St. Louis, MO: Washington University School of Medicine*.

Rose, S.C., Bisson, J., Churchill, R. and Wessely, S., 2002. Psychological debriefing for preventing post traumatic stress disorder (PTSD). *Cochrane database of systematic reviews*, (2).

Rosenthal, M.Z., Cheavens, J.S., Lynch, T.R. and Follette, V., 2006. Thought suppression mediates the relationship between negative mood and PTSD in sexually assaulted women. *Journal of Traumatic Stress: Official Publication of The International Society for Traumatic Stress Studies*, *19*(5), pp.741-745.

Roussos, A., Goenjian, A.K., Steinberg, A.M., Sotiropoulou, C., Kakaki, M., Kabakos, C., Karagianni, S. and Manouras, V., 2005. Posttraumatic stress and depressive reactions among children and adolescents after the 1999 earthquake in Ano Liosia, Greece. *American Journal of Psychiatry*, *162*(3), pp.530-537.

Rowe, C.L., La Greca, A.M. and Alexandersson, A., 2010. Family and individual factors associated with substance involvement and PTS symptoms among adolescents in greater New Orleans after Hurricane Katrina. *Journal of Consulting and Clinical Psychology*, *78*(6), p.806.

Rubens, S.L., Felix, E.D. and Hambrick, E.P., 2018. A meta-analysis of the impact of natural disasters on internalizing and externalizing problems in youth. *Journal of Traumatic Stress*, *31*(3), pp.332-341.

Şahin, N.H., Batıgün, A.D. and Yılmaz, B., 2007. Psychological symptoms of Turkish children and adolescents after the 1999 earthquake: Exposure, gender, location, and time duration. *Journal of Traumatic Stress*, *20*(3), pp.335-345.

Scaramutti, C., Salas-Wright, C.P., Vos, S.R. and Schwartz, S.J., 2019. The mental health impact of hurricane Maria on Puerto Ricans in Puerto Rico and Florida. *Disaster Medicine and Public Health Preparedness*, *13*(1), pp.24-27.

Schneider, S., Rasul, R., Liu, B., Corry, D., Lieberman-Cribbin, W., Watson, A., Kerath, S.M., Taioli, E. and Schwartz, R.M., 2019. Examining posttraumatic growth and mental health difficulties in the aftermath of Hurricane Sandy. *Psychological Trauma: Theory, Research, Practice, and Policy*, *11*(2), p.127.

Schofield, D.J., Shrestha, R.N., Percival, R., Passey, M.E., Callander, E.J. and Kelly, S.J., 2011. The personal and national costs of mental health conditions: impacts on income, taxes, government support payments due to lost labour force participation. *BMC Psychiatry*, *11*(1), pp.1-7.

Schwarzer, R., Jerusalem, M., Weinman, J., Wright, S. and Johnston, M., 1995. Measures in health psychology: A user's portfolio. *Causal and Control Beliefs*, *35*(7).

Scott, S.B., Poulin, M.J. and Silver, R.C., 2013. A lifespan perspective on terrorism: age differences in trajectories of response to 9/11. *Developmental Psychology*, *49*(5), p.986.

Shalev, A.Y., Ankri, Y., Israeli-Shalev, Y., Peleg, T., Adessky, R. and Freedman, S., 2012. Prevention of posttraumatic stress disorder by early treatment: results from the Jerusalem Trauma Outreach And Prevention study. *Archives of General Psychiatry*, *69*(2), pp.166-176.

Shannon, M.P., Lonigan, C.J., Finch Jr, A.J. and Taylor, C.M., 1994. Children exposed to disaster: I. Epidemiology of post-traumatic symptoms and symptom profiles. *Journal of the American Academy of Child & Adolescent Psychiatry*, *33*(1), pp.80-93.

Sharan, P., Chaudhary, G., Kavathekar, S.A. and Saxena, S., 1996. Preliminary report of psychiatric disorders in survivors of a severe earthquake. *The American Journal of Psychiatry*.

Shaw, J.A., Applegate, B., Tanner, S., Perez, D., Rothe, E., Campo-Bowen, A.E. and Lahey, B.L., 1995. Psychological effects of Hurricane Andrew on an elementary school population. *Journal of the American Academy of Child & Adolescent Psychiatry*, *34*(9), pp.1185-1192.

Sheehan, D.V., Lecrubier, Y., Sheehan, K.H., Amorim, P., Janavs, J., Weiller, E., Hergueta, T., Baker, R. and Dunbar, G.C., 1998. The Mini-International Neuropsychiatric Interview (MINI): the development and validation of a structured diagnostic psychiatric interview for DSM-IV and ICD-10. *Journal of Clinical Psychiatry*, *59*(20), pp.22-33.

Shimizu, S., Aso, K., Noda, T., Ryukei, S., Kochi, Y. and Yamamoto, N., 2000. Natural disasters and alcohol consumption in a cultural context: the Great Hanshin Earthquake in Japan. *Addiction*, *95*(4), pp.529-536.

Silva, R.R., Alpert, M., Munoz, D.M., Singh, S., Matzner, F. and Dummit, S., 2000. Stress and vulnerability to posttraumatic stress disorder in children and adolescents. *American Journal of Psychiatry*, *157*(8), pp.1229-1235.

Silveira, S., 2021. *Chronic Mental Health Sequelae of Climate Change Extremes: A Case Study of the Deadliest Californian Wildfire*. MDPI. https://www.mdpi.com/1660-4601/18/4/1487#cite

Silver, R.C., Holman, E.A., McIntosh, D.N., Poulin, M. and Gil-Rivas, V., 2002. Nationwide longitudinal study of psychological responses to September 11. *JAMA*, *288*(10), pp.1235-1244.

Sprang, G. and LaJoie, A.S., 2009. Exposure, avoidance, and PTSD among Hurricane Katrina evacuees. *Traumatology*, *15*(2), pp.10-19.

Tang, B., Liu, X., Liu, Y., Xue, C. and Zhang, L., 2014. A meta-analysis of risk factors for depression in adults and children after natural disasters. *BMC Public Health*, *14*(1), pp.1-12.

Tedeschi, R.G. and Calhoun, L.G., 1996. The Posttraumatic Growth Inventory: Measuring the positive legacy of trauma. *Journal of Traumatic Stress*, *9*(3), pp.455-471.

Terr, L.C., 1979. Children of Chowchilla: A study of psychic trauma. *The Psychoanalytic Study of the Child*, *34*(1), pp.547-623.

Terr, L.C., 1981. Psychic trauma in children. In *Coping with Life Crises* (pp. 337-351). Springer, Boston, MA.

Takahashi, S., Tanno, K., Yonekura, Y., Shimoda, H., Tanaka, F., Sakata, K., Ogawa, A., Kobayashi, S. and Kawachi, I., 2021. Relationship between housing damage and serum

cortisol among survivors of the 2011 tsunami disaster. *Journal of Environmental Psychology*, *76*, p.101654.

Theleritis, C., Psarros, C., Mantonakis, L., Roukas, D., Papaioannou, A., Paparrigopoulos, T. and Bergiannaki, J.D., 2020. Coping and its relation to PTSD in Greek firefighters. *The Journal of Nervous and Mental Disease*, *208*(3), pp.252-259.

Thompson, M.P., Norris, F.H. and Hanacek, B., 1993. Age differences in the psychological consequences of Hurricane Hugo. *Psychology and Aging*, *8*(4), p.606.

Ticehurst, S., Webster, R.A., Carr, V.J. and Lewin, T.J., 1996. The psychosocial impact of an earthquake on the elderly. *International Journal of Geriatric Psychiatry*, *11*(11), pp.943-951.

Titchener, J.L. and Kapp, F.T., 1976. Family and character change at Buffalo Creek. *The American Journal of Psychiatry*.

Torres-Mendoza, Y., Kerr, A., Schnall, A.H., Blackmore, C. and Hartley, S.D., 2021. Community Assessment for Mental and Physical Health Effects After Hurricane Irma— Florida Keys, May 2019. *Morbidity and Mortality Weekly Report*, *70*(26), p.937.

Van Griensven, F., Chakkraband, M.S., Thienkrua, W., Pengjuntr, W., Cardozo, B.L., Tantipiwatanaskul, P., Mock, P.A., Ekassawin, S., Varangrat, A., Gotway, C. and Sabin, M., 2006. Mental health problems among adults in tsunami-affected areas in southern Thailand. *JAMA*, *296*(5), pp.537-548.

Vergunst, F. and Berry, H.L., 2021. Climate change and children's mental health: a developmental perspective. *Clinical Psychological Science*, p.21677026211040787.

Vernberg, E.M., Steinberg, A.M., Jacobs, A.K., Brymer, M.J., Watson, P.J., Osofsky, J.D., Layne, C.M., Pynoos, R.S. and Ruzek, J.I., 2008. Innovations in disaster mental health: Psychological first aid. *Professional Psychology: Research and Practice*, *39*(4), p.381.

Vetter, S., Rossegger, A., Rossler, W., Bisson, J.I. and Endrass, J., 2008. Exposure to the tsunami disaster, PTSD symptoms and increased substance use–an Internet based survey of male and female residents of Switzerland. *BMC public health*, *8*(1), pp.1-6.

Wang, X., Gao, L., Shinfuku, N., Zhang, H., Zhao, C. and Shen, Y., 2000. Longitudinal study of earthquake-related PTSD in a randomly selected community sample in north China. *American Journal of Psychiatry*, *157*(8), pp.1260-1266.

Warheit, G.J., Zimmerman, R.S., Khoury, E.L., Vega, W.A. and Gil, A.G., 1996. Disaster related stresses, depressive signs and symptoms, and suicidal ideation among a multi-racial/ethnic sample of adolescents: a longitudinal analysis. *Journal of Child Psychology and Psychiatry*, *37*(4), pp.435-444.

Watson, P.J., Brymer, M.J. and Bonanno, G.A., 2011. Postdisaster psychological intervention since 9/11. *American Psychologist*, *66*(6), p.482.

Weems, C.F., Pina, A.A., Costa, N.M., Watts, S.E., Taylor, L.K. and Cannon, M.F., 2007. Predisaster trait anxiety and negative affect predict posttraumatic stress in youths after hurricane Katrina. *Journal of Consulting and Clinical Psychology*, *75*(1), p.154.

Widyatmoko, C., Tan, E.T., Conor Seyle, D., Haksi Mayawati, E. and Cohen Silver, R., 2011. Coping with natural disasters in Yogyakarta, Indonesia: The psychological state of elementary school children as assessed by their teachers. *School Psychology International*, *32*(5), pp.484-497.

Wortman, C.B. and Silver, R.C., 1989. The myths of coping with loss. *Journal of Consulting and Clinical Psychology*, *57*(3), p.349.

Wu, H.C., Chou, P., Huang-Chih Chou, F., Su, C.Y., Tsai, K.Y., Ou-Yang, W.C., Tung-Ping Su, T., Chao, S.S., Sun, W.J. and Chen, M.C., 2006. Survey of quality of life and related risk factors for a Taiwanese village population 3 years post-earthquake. *Australian & New Zealand Journal of Psychiatry*, *40*(4), pp.355-361.

Xu, J. and Wu, Z., 2011. One-year follow-up analysis of cognitive and psychological consequences among survivors of the Wenchuan earthquake. *International Journal of Psychology*, *46*(2), pp.144-152.

Zhang, Y., Kong, F., Wang, L., Chen, H., Gao, X., Tan, X., Chen, H., Lv, J. and Liu, Y., 2010. Mental health and coping styles of children and adolescent survivors one year after the 2008 Chinese earthquake. *Children and Youth Services Review*, *32*(10), pp.1403-1409.