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Improving Adjustment and Resilience in Children Following a Disaster: Addressing Research Challenges

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There is compelling evidence of the potential negative effects of disasters on children's adjustment and functioning. Although there is an increasing base of evidence supporting the effectiveness of some interventions for trauma following disaster, more research is needed, particularly on interventions that can be delivered in the early aftermath of disaster as well as those that can address a broader range of adjustment difficulties such as bereavement that may be experienced by children after a disaster. This article identifies gaps in the knowledge of how best to intervene with children following disasters. Key challenges in conducting research in disaster contexts, including obtaining consent, designing rigorous studies, and obtaining funding quickly enough to conduct the study, are discussed. Several strategies hold

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promise to address research challenges in disasters, including using alternative designs (e.g., propensity scores, matched control groups, group-level assignment), working with schools and communities, and studying implementation of nontraditional modes of intervention delivery.

Keywords: disasters, children, intervention, resilience

Research over the last few decades has documented the potential negative effects of disasters, whether man-made or natural, on individuals' adjustment. Children are especially vulnerable to disasters because of their limited coping skills and dependence on social supports (Dodgen et al., 2016; Masten & Osofsky, 2010). Children exposed to disasters are at risk for a range of adjustment difficulties, including transitory distress symptoms, bereavement, and symptoms of posttraumatic stress disorder (PTSD), as well of anxiety and depression (Furr, Comer, Edmunds, & Kendall, 2010; Schonfeld, Demaria, the Disaster Preparedness Advisory Council, & Committee on Psychosocial Aspects of Child and Family Health 2015; see Masten, Narayan, Silverman, & Osofsky, 2015, for review). Risk may differ as a function of exposure (e.g., Furr et al., 2010) or loss of a loved one, preexisting difficulties, trauma history, and family and peer support (La Greca, Silverman, Vernberg, & Prinstein, 1996; Paul et al., 2015; Thienkrua et al., 2006).

Although gains have been made in understanding the effects of disaster on children, less is known about the effectiveness and implementation of empirically supported treatments on children's behavioral health and coping after a disaster. And although an evidence base is emerging to support various interventions for children exposed to disaster, many questions remain unanswered, including the following: Which interventions are most effective in preventing or reducing later mental health problems and promoting adjustment and recovery? Where and when should interventions be delivered? How can the existing evidence base be built upon to identify effective practices that foster resilience before problems occur? And, of importance, how can high-quality, rigorous prospective research be effectively conducted in the chaotic and stressful postdisaster environment?

In July 2015, a virtual conference was convened to address research on interventions with children following disaster while the first author was an American Psychological Association Executive Branch Science Fellow at the National Institute of Child Health and Human Development. Planning began with an informal review of National Institutes of Health grants on children and disaster funded since 1991. The analysis identified 49 funded grants in this 14-year period focusing on (a) follow-up of children who experienced disaster ($N = 37$), (b) intervention–treatment (most frequently cognitive behavioral therapy [CBT]; $N = 4$), (c) training health workers ($N = 4$), (d) providing education to professionals–public ($N = 4$), and (e) developing assessment tools ($N = 2$). The review revealed that (a) most funding has gone to studies following and assessing children who have experienced disaster and (b) there is a paucity of funded research on interventions for children after disaster.

The virtual conference was grounded in the interagency National Commission on Children and Disaster's (2010) recommendation to convene experts to "identify gaps in knowledge and recommend a national research agenda" (p. 8). Given the importance of an interdisciplinary approach to complex problems, the presenters represented psychology, psychiatry, pediatrics, social work, and public health and worked in a variety of settings. Each participant had on-the-ground and research experience in disasters. The goal of this article was thus to share participants' knowledge about intervening with children following disaster as well as challenges and opportunities in conducting research supporting children affected by disasters. Our hope is to encourage research and provide useful information to researchers and funders.

Why Focus on Responses to Children Following Disaster?

Precise estimates of adverse outcomes for children exposed to disaster are not possible because of the range of severity of disasters and exposure to them and the complex roles of developmental issues and family and social contexts. Children do not necessarily suffer long-term impairment, especially if given adequate support, though up to 30% may experience chronic impairment (Bonanno Brewin, Kaniasty, & La Greca, 2010). When exposure is prolonged or complex, it can have lasting psychological effects (e.g., Osofsky, Osofsky, Kronenberg, Brennan, & Hansel, 2009). Disasters also result in secondary losses and stressors such as displacement from homes, loss of loved ones, and disrupted routines, all of which can exacerbate impact (Kessler, Galea, Jones, & Parker, 2006; Schonfeld et al., 2015). Exposure to multiple disasters also results in cumulative effects (Thienkrua et al., 2006; Weems & Graham, 2014). Effects can vary from transient stress to diagnosable disorders, poor academic performance (Weems et al., 2013), and substance use (Chemtob, Nomura, Josephson, Adams, & Sederer, 2009).

Despite the complexity of quantifying adverse effects of disaster, estimates exist. McLaughlin et al. (2009) described 9.3% of 4- to 17-year-old children as experiencing a

serious emotional disturbance 18–27 months after Hurricane Katrina. Examining a range of disasters, McDermott and Palmer (1999) estimated that 5%–15% of children experience significant mental health symptoms following exposure. Illustrating the chronicity of effects, 3 years after Katrina, 27.7% of children met criteria for a mental health referral (Kronenberg et al., 2010).

What Is Known About Disaster-Related Interventions for Children?

Although impact estimates vary, given the risks of significant sequelae, it is important to detect, address, and prevent adverse effects. In recent years, numerous child disaster mental health interventions have been developed and evaluated for use in the acute postdisaster phase and for up to several years postevent (Pfefferbaum, Sweeton, Newman, et al., 2014). These include preparedness interventions, early interventions (e.g., psychological first aid, debriefing), and later interventions, often including cognitive–behavioral components.

Preparedness Interventions

Disaster preparedness intervention studies have provided evidence that preevent education increases knowledge of disasters and risk and may increase practical skills (Codreanu, Celenza, & Jacobs, 2014). Unfortunately, it is unclear whether interventions enhance household preparedness or self-protective activities during an event, whether effects are sustained (Johnson, Ronan, Johnston, & Peace, 2014), or whether such interventions affect child mental health after a disaster.

Early Interventions

The empirical literature on interventions delivered in the early months postdisaster has been sparse. Two interventions created specifically for use during this period—psychological debriefing and psychological first aid—have not been well studied in children. A recent review revealed significant methodological weaknesses in most child debriefing studies, with little evidence to support its use in children (Pfefferbaum, Jacobs, Nitiéma, & Everly, 2015), and the American Academy of Child and Adolescent Psychiatry recommended it be used only with caution (Pfefferbaum, Shaw, & the American Academy of Child and Adolescent Psychiatry [AACAP] Committee on Quality Issues [CQI], 2013). As one element of a stepped care approach, psychological first aid involves a set of principles and strategies that offer practical and social support and encourage active coping. No randomized controlled trials (RCTs) have been conducted with psychological first aid, though a noncontrolled pilot study using the Listen, Protect, Connect model found a decrease in depressive and PTSD symptoms and an increase in social support in youth relocated after a flood 10 months earlier (Ramirez et al., 2013, 2014). Although initial findings are favorable, a more solid evidence base for psychological first aid is needed.

A number of studies have introduced therapeutic techniques in the early postdisaster phase, including two RCTs, each comparing two active interventions. Catani and colleagues (2009) found no difference between narrative exposure and meditation relaxation delivered to Sri Lankan children exposed to civil war and the 2004 Indian Ocean tsunami, and Ronan and Johnston (1999) found no difference between CBT and exposure interventions in Australian children in the vicinity of volcanic eruptions. Both interventions in each of these studies resulted in benefit, but it is not possible to know whether children might have recovered without treatment. Massage therapy (compared to a video attention control; Field, Seligman, Scafidi, & Schanberg, 1996) and spiritual hypnosis (compared to no treatment; Lesmana, Suryani, Jensen, & Tiliopoulos, 2009) were both supported in RCTs conducted in the early postevent phase following a hurricane and terrorist incident, respectively. Thus, introducing therapeutic techniques before chronic problems develop holds promise and merits further study.

Later Interventions

After disasters, children's long-term mental health responses are similar to those following other types of trauma (e.g., PTSD, depression). Thus, later stage interventions can capitalize on general trauma treatment. Additionally, in postdisaster screening, many children identify predisaster traumas as their "worst" trauma experiences (Langley et al., 2013). Late-stage interventions must thus be able to address traumas experienced before, during, and after disasters.

Studies have suggested that disaster-impacted children can benefit from existing evidence-based trauma treatments. Many of the evidence-based trauma interventions used postdisaster are multimodal, but for the most part, studies have not identified specific components responsible for benefit (Pfefferbaum, Sweeton, Nitiéma, et al., 2014). Research has supported the use of interventions, especially cognitive–behavioral interventions, over no intervention (Forman-Hoffman et al., 2013), but there have been too few studies to establish the comparative benefit of any one type over others (Forman-Hoffman et al., 2013; Pfefferbaum, Newman, et al., 2014).

The most tested trauma treatment is trauma-focused cognitive behavioral therapy (TF-CBT; Cohen, Mannarino, & Deblinger, 2016), a time-limited intervention provided to children and caregivers. This approach has been tested in 18 RCTs for children ages 3–18 exposed to diverse traumas (e.g., sexual abuse, domestic violence, war, multiple trau-

mas) in the United States, Europe, Australia, and Africa, with documented efficacy improving PTSD, depressive, and other symptoms. Using a matching algorithm based on initial PTSD symptom severity to assign children to TF-CBT in two forms: four sessions of skills only (less severe) or 12 sessions of the full intervention (more severe), the CATS Consortium (2010) demonstrated that matching level of intervention to symptom severity effectively conserved resources and improved PTSD symptoms to subclinical levels.

Cognitive behavioral intervention for trauma in schools (CBITS; Jaycox, 2003) is a group model for addressing trauma in school settings. Consisting of 10 group sessions for children, two–three individual breakout sessions, and two–three parent groups, CBITS tested in an RCT was superior to a wait-list condition for improving PTSD and depressive symptoms (Stein et al., 2003). A quasi-experimental study also demonstrated effectiveness of CBITS in a school mental health application for immigrant children (Kataoka et al., 2003). An adaptation called Bounce Back, developed for elementary-age students, was effective (Langley, Gonzalez, Sugar, Solis, & Jaycox, 2015), and pilot work has shown the promise of an adaptation implemented by trained educators (Jaycox et al., 2009). Fifteen months after Hurricane Katrina, a stepped-care model (Jaycox et al., 2010), in which children were screened and those in need of treatment randomized to group CBITS in schools or individual TF-CBT in community clinics, showed that both groups decreased in PTSD symptoms but that access was significantly greater for CBITS, reinforcing the importance of accessible placement of services.

Other treatments have also been effective. For example, Chemtob, Nakashima, and Hamada (2002) evaluated a treatment focused on mastering disaster challenges (e.g., restoring a sense of safety) in children 2 years after a major hurricane in Kauai. Children receiving the intervention, either in a group or individually, showed decreased PTSD symptomatology relative to a control group. One year later, children who met criteria for PTSD received eye movement desensitization and reprocessing (EMDR), which resulted in improvement in PTSD symptoms, anxiety, and depression (Chemtob, Nakashima, & Carlson, 2002). Salloum and Overstreet (2008) showed a decrease in symptomatology in children receiving group or individual intervention that combined cognitive–behavioral and narrative components delivered 4 months after Katrina. An RCT found no difference in effectiveness between EMDR and a cognitive–behavioral intervention in adolescents following a factory explosion, but EMDR required fewer sessions (de Roos et al., 2011). Although more research is needed, acute and long-term intervention can be successfully deployed following disasters.

Status of the Evidence for Postdisaster Interventions

In a meta-analysis of 11 studies, Fu and Underwood (2015) found reduced PTSD symptoms using school-based mental health and psychosocial interventions delivered by teachers or paraprofessionals following natural and man-made disasters. In their meta-analysis of 24 studies of child interventions for natural and man-made disasters, Newman and colleagues (2014) found significant improvement in PTSD or PTSD symptoms relative to control or wait-list groups. Evidence supported EMDR, exposure therapy, and CBT interventions for children and adolescents postdisaster, though findings are tentative due to the small number of studies of some interventions. Both individual and group interventions were effective, but children receiving individual interventions showed greater improvement. Although interventions delivered by all providers were effective, those delivered by mental health professionals yielded greater improvement relative to other provider types. Additional studies are needed to make recommendations about individual versus group intervention, provider expertise and training, and delivery setting (Newman et al., 2014). Parental involvement improved outcome, but the effects of interventions not involving parents were also effective, suggesting that parental engagement may be optimal but not necessary (Newman et al., 2014).

Summary and Recommendations

Early interventions such as psychological first aid are promising but require stronger experimental evidence, using controlled designs, to demonstrate that improvement derives from the interventions rather than passage of time and natural recovery. In later stage interventions, there is a strong evidence-base for some interventions, particularly those including cognitive–behavioral techniques aimed at ameliorating posttraumatic symptoms and disorders. Far less research has explored the broader range of adjustment difficulties such as bereavement that may be experienced by children after a disaster. There is also much to be learned about how to implement these interventions in a postdisaster context, including how to identify those in need of intervention and what level of care they require. Furthermore, the optimal timing of intervention delivery needs study, especially given that timing of interventions may depend not only on the child's needs but also on community capacity, recovery, preparedness of schools (e.g., policies, training), and accessibility of technology.

Further research is also needed on how interventions might prepare children and families for future traumatic events and disasters. For example, disaster education and preparedness interventions are needed that promote household preparedness, self-protective activities during disasters, and preparedness as adults (Johnson et al., 2014).

Exploration of how interventions could enhance not only the child's current mental health functioning but also individual and community resilience would be useful. Models for preparing therapists in effective trauma interventions in advance of disaster and rapid ramp-up of community capacity following disaster also need research.

Researching Interventions for Disaster: A Complex Problem

Research on interventions for children experiencing disaster involves a complex set of considerations, including the nature of the disaster, acute and long-term responses, and both assessment and intervention. First, the term *disaster* refers to a wide range of events that differ along multiple dimensions, including natural (e.g., earthquake, tornado, flood) and man-made (e.g., shooting situation) and intentional versus unintentional. A meta-analysis of 25 potential risk factors in children found that children experiencing intentional (vs. unintentional) trauma (disasters as well as other types of trauma including violence) were at greater risk for posttraumatic stress (Trickey, Siddaway, Meiser-Stedman, Serpell, & Field, 2012). Other characteristics of disasters likely have implications for the design of effective interventions and warrant further study.

It is important not to conceptualize disasters as simply one-time events and to appreciate that after a disaster there is a continuum of needed actions for children's mental health across acute and long-term recovery phases. First, prospective research that incorporates known risk factors is needed to determine who is at risk following a disaster over time. Triage at the time of the event, for example using the PsySTART Rapid Mental Health Triage System (Schreiber, Pfefferbaum, & Sayegh, 2012; Thienkrua et al., 2006), has been demonstrated to predict risk for PTSD and depression using information on exposure, associated physical injuries, illnesses, deaths, severe peritraumatic reactions, and ongoing adversities such as home loss and displacement Although this is a promising strategy, how to connect rapid triage risk data and timely intervention requires further research.

Children's reactions to disaster can come in the form of short-term distress, exacerbation of preexisting mental health symptoms, or development of new mental disorders. There is an evolving use of a stepped-care continuum of care approach (Marks, 2010), including initial assessment, watchful waiting, reassessment and referral for evidence-based care, or acute intervention to tailor responses to different levels of risk or need. However, to do this, information is needed on prospective trajectories of risk factors and incident outcomes and treatment response. Achieving this is complicated by diversity in children's response patterns, including many with transitory symptoms and others at risk but exhibiting no initial signs of distress or else displaying avoidance or difficulty discussing symptoms. Adding further to the complexity is the likely differential impact of various interventions when applied to children of different backgrounds (e.g., culture, race, ethnicity, religion, gender) and personal or event experience (e.g., death of family members, secondary losses such as forced relocation).

Disaster research often focuses on the treatment or prevention of mental illness, especially trauma disorders. There is a need to also broaden the focus to include not only distress and bereavement but the promotion of adjustment and coping. As noted in the final report of the Sandy Hook Advisory Commission (2015), promoting mental health involves more than identifying and treating mental illness; it also involves efforts to promote health. This requires the development of valid measures of these outcomes and demonstration of their usefulness to research funders and policymakers.

An additional consideration in studying interventions, particularly clinical trials, is to consider both the efficacy of the intervention as well as its population-level reach. Efficacy refers to the effect size or treatment effect, and reach is the participation rate of a specified population. The overall impact of the intervention, then, is the product of its efficacy and reach (Koepsell, Zatzick, & Rivara, 2011). This approach acknowledges that interventions occur in the real world, where there are barriers to participation and, for some interventions, exclusions relative to who can participate. If the program applies to or can benefit only a small subset of those at risk, its impact is decreased. This is illustrated by the Jaycox et al. (2010) study of children affected by Hurricane Katrina discussed earlier. The study compared the CBITS, a group and individual school-based intervention, to the TF-CBT, an individual or conjoint clinic-based intervention that includes parents and children. Although both interventions decreased symptoms, 57 out of 58 children engaged in the CBITS, whereas only 14 out of 60 of those randomized to TF-CBT were engaged, demonstrating greater population impact of the intervention provided in schools versus clinics (Zatzick, 2012). More research is needed on both effectiveness and reach of disaster interventions for children.

Challenges in Conducting Research in Disaster Contexts

Research on responses to children following disasters is challenging due to the unpredictable and chaotic nature of disaster contexts and the sometimes conflicting priorities of immediate response and research. The primary objective of the community postdisaster is to provide support to survivors rather than knowledge advancement. For the researcher, a number of issues emerge.

First, there are often multiple stakeholders involved in the response. These include response agencies (e.g., American Red Cross, Salvation Army), emergency managers, community officials, faith-based organizations, and others. Obtaining permission to conduct studies within these complex structures becomes extraordinarily difficult.

Second, it may be difficult to locate, access, and approach survivors. During or after a disaster, families may be in multiple locations, including shelters or others' homes, or may be displaced from the community entirely. It may be possible to utilize a shelter sample, but these individuals will not necessarily be representative of the affected population, limiting conclusions (Norris, 2006). Shelter residents are often the most vulnerable in the community, lacking the resources necessary to find other accommodations. Individuals may remain at shelters for variable amounts of time—minutes, days, or weeks—making follow-up difficult, which compromises the ability to conduct an intervention or longitudinal research. Finally, shelters are often chaotic, and it may be difficult to find private areas to administer assessments.

Third, obtaining consent to participate in research is a challenge. Following a disaster, survivors are under high levels of stress. Considering or consenting to research may not be possible, and the challenge of obtaining meaningful informed consent and assent, present in all contexts, is accentuated. Survivors' primary concerns are food, shelter, comfort, and getting back on their feet (North & Norris, 2006). Further, children may be separated from parents or legal guardians, and thus researchers may not be able to obtain consent. Researchers from outside the community may have particular difficulty building the trust necessary to conduct the research.

Fourth, there are challenges in implementing rigorous designs. Although RCTs are often optimal for causal inference, there may be practical issues that prevent random assignment to condition or including a control group. In the aftermath of disaster there is often a compelling need within impacted communities to provide interventions to children even if the evidence-base for available interventions is quite limited. In addition, rarely are there data on predisaster functioning, which makes it difficult to determine whether difficulties individuals report are a result of the disaster or occurred beforehand (Masten & Narayan, 2012).

Disaster mental health research requires rapid response capability, but time needed to plan the study, secure funding, obtain approval from institutional review boards (IRBs), and secure partnerships necessary for recruitment of the target population often precludes time-sensitive research. Most funding agencies do not have mechanisms that facilitate rapid funding decisions, and even when efforts have been made to achieve this (e.g., the Rapid Assessment Post Impact of Disaster grant mechanism at the National Institute of Mental Health [NIMH]), many months pass between the time researchers conceive of a critical research question and the time they launch their study. The process of defining the sampling frame and design, preparing a grant application, funding agency review, responding to reviews, and obtaining IRB approval, even with a facilitated process, rarely takes under 6 months. By that time the research team typically has missed a critical window of opportunity to learn about a population's needs during the acute and intermediate response phases or about the value of a brief intervention designed for the initial phase.

Although the challenges of doing disaster research are many, the importance of an evidence base to inform best practices to promote response and recovery in children experiencing disasters cannot be overestimated. To facilitate this, it is critical for researchers to forge relationships with agencies that provide disaster services prior to disasters (Wells, Tang, et al., 2013). This may help researchers, local or regional agencies, and communities to understand what is and is not known about best practices for disaster response and to have some agreement that including an evaluation component following a disaster can benefit the agencies and communities in the long run. Maintaining relationships with agencies and the community during the research process and providing ongoing feedback and sharing of results and toolkits for future use will be important to building community trust in research. Finally, creative solutions are needed to enable scientists and communities to launch studies with fewer barriers and delays. One approach is to expand the use of administrative supplements to existing grant awards. However, this solution may apply to only a small percentage of investigators who have active and synergistic grant awards in place. Another approach may be the creation of phased mechanisms for grant funding, where the preparatory work and approvals are completed in advance of a disaster (Phase 1) and then funding is discontinued until the occurrence of a qualifying disaster that activates funding for the research phase of the project (Phase 2). The NIMH has experimented with this approach, which is most applicable to research in which highly accessible interventions are being tested (e.g., technology-based) and/or where national partners (e.g., American Red Cross) serve important roles.

Promising Avenues for Research

Research in disaster contexts must consider the unique and dynamic nature of postdisaster contexts and create novel and flexible design strategies to adapt to the context. RCTs may not be possible in these contexts (Fleischman, Collogan, & Tuma, 2006; Masten & Narayan, 2012). Further, researchers may be newly entering communities with their own complex relationships and histories. The range of complexities in conducting mental health research in disaster settings is well described in the book by Norris, Galea,

Friedman, and Watson (2006), in which they noted ways to plan for measurement, sampling, follow-up, and design issues in disaster research. The next sections of this article follow those themes and consider some of the promising ways to manage and build on these challenges in the implementation and design of studies.

Implementation Science

Although a disaster can preclude an ability to implement an intervention for children and families, as well as a study of its effects, with the precision and control of an efficacy study, disasters can present an opportunity to study how interventions can be deployed in this unfortunate but real-world context. In the context of a disaster, intervention staff may not be able to be trained in routine ways, and staff may not be able to implement the intervention uniformly. Using an implementation science framework, with its focus on studying the uptake of evidence-based interventions in actual community conditions, a researcher can examine how variations in training or characteristics of the providers and their work settings can influence outcomes (La Greca, Silverman, & Lochman, 2009).

An implementation question might address, for example, what level of staff training is sufficient to produce a meaningful effect on children's adjustment. Thus, a researcher could examine the natural variation in staff members' training on a trauma-based intervention as a "natural experiment." Although not focused on a disaster, in a field trial of a cognitive–behavioral school-based intervention (Coping Power) for aggressive children, Lochman, Boxmeyer, and colleagues (2009) compared intensive to basic training provided to school counselors. Compared with children in the control condition and with children whose counselors had received only basic training, high-risk children treated by counselors who received intensive training had better outcomes. This study underscores the importance of understanding how variations in training affect the dissemination of interventions in the aftermath of disasters.

Alternative Research Designs

Given the importance of alternative research designs for studies of interventions for children and families postdisaster, this section reviews various design and measurement approaches that can be considered in this research.

Quasi-experimental designs. Implementing a rigorous controlled trial following a natural disaster can be challenging. Adherence may be difficult—for example, it may be hard to get parents and children to attend all intervention sessions, due to stress as well as disruptions in basic services. In this context, intention-to-treat analysis including all individuals who are assigned to a condition (intervention, control) can be a useful and rigorous test of the intervention, although it may underestimate the actual intervention effect because it is indicating the effects of only a partially received version of the program. As a result, it may be useful to use several quasi-experimental approaches to augment typical intention-to-treat analyses when intervention dosage has been curtailed and to create comparison groups when an RCT design is not possible. Two such quasi-experimental approaches used in intervention research with children and parents involve propensity score and complier average causal effect (CACE) models (Lochman, Boxmeyer, Powell, Roth, & Windle, 2006).

Propensity scores. This approach matches "compliant" intervention participants (e.g., parents or children who have attended intervention sessions at an adequate level) with similar individuals in the control group on multiple observed covariates (D'Agostino, 1998; Frangakis & Rubin, 2002), thus setting aside the less compliant participants. The procedure reduces a set of baseline (background) characteristics into a composite score that can be used to represent the probability of being a compliant participant, using statistical approaches such as logistic regression (Lochman et al., 2006) or discriminant analysis (D'Agostino, 1998). These probabilities, or propensity scores, for the compliant participants are then matched at a case level with propensity scores for individuals in the control condition using methods such as Mahalanobis metric matching (D'Agostino, 1998). This permits a comparison between compliers in the intervention condition and individuals in the control condition who, on the basis of similar baseline data, likely would have complied had the intervention been assigned to them. There are several approaches to matching propensity scores of compliers in the intervention and control conditions (Hill, Brooks-Gunn, & Waldfogel, 2003). A greedy matching technique balances the sometimes competing goals of maximizing the exactness of the matches and the number of cases that can be matched (Parsons, 2001). In this technique, an iterative matching algorithm is used to match as many cases as possible at the fifth decimal point of the propensity score, then to the fourth decimal, and so on down to the first decimal point. Inevitably some compliant intervention participants cannot be matched to a control at the first decimal place, and these cases are excluded from intervention versus control comparisons.

Complier average causal effect (CACE). CACE is another method to deal with problems introduced by noncompliance (Angrist, Imbens, & Rubin, 1996; Frangakis & Rubin, 2002); it has been used to estimate intervention and prevention effects, as in school-based preventive interventions (e.g., Ialongo, Poduska, Werthamer, & Kellam, 2001) and afterschool programs for students with attention-deficit/hyperactivity disorder (Schultz, Evans, Langberg, & Schoemann, 2017). CACE begins with an assumption that treatment has no effect among noncompliers and uses an instrumental variable approach or structural equation mod-

eling procedures to estimate the unobserved (latent) variable of compliance in the control group. CACE estimates this latent class variable on the basis of the observed outcomes of all participants. An assumption of the CACE model is that the noncompliers in the control group would have had the same outcome as the noncompliers in the intervention group, if the noncomplier latent class in the control group had been assigned to intervention. Estimates of the latent compliance variable among the controls may be more precise when baseline covariates are added to the model, but CACE models can also be run with no covariates.

An example of CACE and propensity score analyses. In a nondisaster example, parents of 120 aggressive children who were offered a cognitive–behavioral group intervention to assist with their children's aggressive behaviors attended only 30% of their sessions. Analyses showed a nonsignificant trend indicating that their children had reduced externalizing problems compared with 120 aggressive children in a randomized control group (Lochman et al., 2006). Subsequent propensity analyses using greedy matching and CACE analyses indicated that the effect was indeed statistically significant using a low threshold for parent compliance (attending at least one session). The two approaches that compared minimally compliant intervention participants to control participants who were estimated to be minimally compliant found that the intervention significantly reduced children's externalizing behavior and indicated the utility of using these methods as an adjunct to typical intention-to-treat analyses when dosage problems exist.

Matched control groups. Propensity scores can be used to create a matched comparison group from a broader population of children when randomization to a control group is not possible (D'Agostino, 1998). The absence of comparison or control data is a central problem in demonstrating causal effects of interventions after disasters (North & Norris, 2006; Steinberg, Brymer, Steinberg, & Pfefferbaum, 2006). Propensity scores using baseline data (collected on an entire population, such as all students in a school) to characterize the intervention group can be used to identify a similar group of children from a larger population of assessed children, and outcomes from the intervention and matched comparison group can be compared in a quasi-experimental way. As an alternative to propensity scores, matching can be made with existing predisaster behavioral screening scores available in school systems. For example, Goldman and colleagues (2015) studied the effects of school-based interventions for at-risk youth in a greater New Orleans school district 1 year following Hurricane Katrina. Students who had significant depressive and/or disruptive disorder symptoms received treatment using evidence-based interventions. At the same time, a district-wide mental health needs assessment of middle and high school students (N = 11,861) had screened for students' behavioral and emotional difficulties at the beginning and end of the school year. "High mental health need" groups were selected from the intervention sample and from the district-wide screening sample as a matched comparison group. Using mixed-effects regression models, Goldman and colleagues found that high-need intervention students demonstrated clinically significantly lower levels of emotional and behavioral problems in comparison to the matched control group following the intervention, supporting the potential effectiveness of the school-based intervention for youth after a natural disaster.

Group-level assignment. Because research on responses to disasters can be a fruitful opportunity to examine the dissemination process involved in community settings, it can be useful to consider designs that involve group rather than individual random assignment, that is, assigning providers, programs, schools, or whole communities to either an intervention or control or comparison condition. Group-level assignment can permit researchers to control for the effects of children being nested within the same classrooms and to examine how provider and setting characteristics can influence the delivery of the intervention (Lochman, Powell, et al., 2009). If randomization occurs at the community level, research can examine how characteristics of communities (e.g., presence of community coalitions, buy-in) affect implementation and outcome.

Leveraging Available Data

It may be possible to build on ongoing research to address some of the challenges of doing research in disaster contexts, such as not having predisaster data, a common challenge in interpreting findings in studies after disasters (North & Norris, 2006; Steinberg et al., 2006).

Partnering with local researchers. A first step in studying the effects of an intervention in the wake of a disaster is to catalog which local researchers are already working in local schools and other community settings. It is key to coordinate efforts across different groups of researchers following a disaster and to form close, integrated partnerships between university researchers and local schools (Steinberg et al., 2006). Such efforts can create webs of collaborating researchers for a project, increasing the likelihood of the project's acceptance and completion. Local researchers often know how to connect with local agencies and schools, and who the "key players" are.

Building on existing data collection. Another opportunity for disaster research is to build on data collected prior to the disaster, which can serve as a predisaster baseline for child functioning. This may be coupled with information about children's exposure to the disaster through child and parent report or geographic information system mapping. For children involved in ongoing research in their community, such data can be used to determine whether their

functioning before the disaster predicts their later adjustment. Martin, Felton, and Cole (2016) found that children's predisaster levels of depressive symptoms and degree of exposure predicted their subsequent posttraumatic stress symptoms. An important issue is whether predisaster data include the key constructs expected to be affected by the disaster, including children's behavioral, emotional, and psychophysiological functioning; peer relations; and parenting. A recent study (Lochman et al., 2017) provided a unique opportunity to examine how children's and parents' exposure to a major natural disaster, an EF-4 tornado that destroyed 12% of Tuscaloosa, Alabama, in April 2011, affected changes, from pretornado levels, in children's internalizing and aggressive behaviors. This study built upon an ongoing study (Lochman et al., 2015) of a CBT intervention for children exhibiting aggressive behavior, and thus there were data on pretornado functioning. The disaster study used growth models across three assessment points to examine changes over a 1-year period in these at-risk children's functioning following the tornado, using pretornado data as a baseline. The results indicated that a greater degree of exposure to the tornado predicted relatively poorer slopes for children's aggressive behavior and internalizing behaviors across time, with some child characteristics (e.g., baselines and tornado-related anxiety) moderating the effects of exposure (Lochman et al., 2017). The findings illustrate the usefulness of having predisaster data and building on ongoing research efforts.

Working With Communities

Disasters at scale inherently affect communities, and responses to disasters for children occur within a family and community context, as does research on interventions to address them. Many national bodies recommend community-based participatory research (CBPR; e.g., Institute of Medicine Promoting Health) for program implementation and research with vulnerable populations, such as underresourced communities with disparities in services availability and low-income or ethnic minority communities. Because many underresourced communities may have historical distrust in services and/or research (Gamble et al., 1997), it is key to engage communities in services and research following disasters.

Bringing community into design. Community-partnered participatory research (CPPR) is a manualized form of CBPR that has been applied to behavioral health programs and research, including for children and adolescents, pre- and postdisaster (Jones & Wells, 2007; Jones et al., 2009; Kataoka et al., 2009; Springgate et al., 2009; Wells, Jones, et al., 2013). Key principles include promotion of trust and respect, transparency, power sharing and coleadership, and two-way knowledge exchange, within a strength-based approach based on building on assets of communities. The structure of CPPR initiatives includes leadership by a council inclusive of community stakeholders having equal voice to health system and academic members, working groups that define and implement action plans, additional scientific or community experts to support effective programs and evaluation, and regular report back to and input from the broader community in all phases.

In a nondisaster example of a CPPR-based group-level randomized trial for improving depression services across health and social-community programs in underresourced communities, community coleaders helped formulate goals and refine intervention conditions and provided input into defining and measuring outcomes leading to "community-prioritized" secondary outcomes (Chung et al., 2010). To achieve this, substantial capacity building was required of stakeholders in research concepts and of researchers in community history, culture, and assets (Chung et al., 2010).

Many CPPR principles were utilized in the CBITS school-based trauma intervention work cited earlier (Kataoka et al., 2009; Stein et al., 2003), including implementing CBITS post-Katrina, where stakeholder input led to features such as self-care during training of local providers who themselves were traumatized. More generally, application of CPPR to child and adolescent adjustment in a postdisaster context requires broadening of the concept of community stakeholder to include families, peers, children, and programs and services supporting children and families. Achieving the breadth of stakeholders required may mean relying on infrastructures such as schools or faith-based organizations that already have programs for families and children and are trusted locally (Kataoka et al., 2006).

Working with schools. Delivering behavioral health services in schools has been an important method of reaching youth whose disaster-related problems may otherwise be unaddressed (Fu & Underwood, 2015; Jaycox, 2003; Jaycox et al., 2007, 2009, 2010; Kataoka et al., 2003; Langley et al., 2015; Stein et al., 2003). Schools provide access to the vast majority of the child population and have long been identified as an ideal entry point for improving access to mental health services with the potential for overcoming many key constraints such as financial and logistical barriers. Schools are a "natural," low-stigma environment well known to children and their families, who are often familiar and comfortable with school-based services and wellness centers (Schonfeld et al., 2015). Schools may be operational before other institutions are after disaster (Dean et al., 2008) and may be sites for the delivery of community disaster services (e.g., emergency sheltering) and Federal Emergency Management Agency (FEMA) Crisis Counseling services.

During times of relative calm, it is important to develop partnerships with schools to establish familiarity, trust, and working relationships among academic and/or child-serving agencies and K–12 education. Memoranda of understanding

or more structured agreements such as contracts take time to negotiate even under the best circumstances.

Having preexisting relationships can facilitate entry into schools postdisaster. In New York City, post-9/11, agencies with established relationships with schools prior to the attacks were able to provide services to schools more quickly than were other agencies.

Bridging the cultural divide between mental health and education aims and defining shared outcomes and objectives is at the heart of developing predisaster relationships. Assessment, screening, and intervention in schools may not align with research or service goals. Successful partnerships build on the understanding that school administrators and faculty are concerned with the rapid restoration of the educational environment. Their objectives are to measure the school's ability to resume normal schedules, the teacher's ability to resume teaching, and the student's ability to engage fully in learning.

One promising opportunity for collaboration is through the U.S. Department of Education Project SERV (School Emergency Response to Violence), which provides independent funding to school districts after crises or disasters. Patterned after the FEMA Crisis Counseling grants, Project SERV is an unsolicited grant for which schools or districts can apply to provide an array of services. Accountability for the grant requires a plan for measuring outcomes. Schools actively seek the assistance of researchers to craft the evaluation design and select the assessment measures.

For research, schools collect individual-level data that can be utilized as a baseline to trace the trajectory of students who remain in the community postdisaster. School data, while not "clinical," include important functional indicators such as attendance; grades; referrals for disruptive behavior; suspensions; and other behavioral, academic, and health-related changes.

Research in hospital settings. There is much to learn about disaster response from research conducted in nondisaster contexts and vice versa. This is the case for research conducted in hospital settings after injury. Such studies are quite germane, because there is a strong association between traumatic injury and PTSD, with one in six children showing posttraumatic stress symptoms (PTSS) after injury (Kassam-Adams, Marsac, Hildenbrand, & Winston, 2013). The hospital setting, with rapid movement through emergency and other health service delivery settings, mimics the instability in the aftermath of a disaster and can represent tests of intervention under real-life conditions. Interventions post–medical trauma have shown some success in decreasing PTSS and preventing new PTSS over time. Kassam-Adams et al. (2016) evaluated a web-based cognitive–behavioral intervention for children soon after they experienced medical events. The intervention showed reduced PTSS relative to a wait-list control group at 6 and 12 months. Two studies, one using a stepped-care approach (Kassam-Adams et al., 2011) and the other a web-based intervention for parents (Marsac et al., 2013), showed the feasibility of intervening soon after medical events, but neither showed lower PTSS or depression relative to usual care. Overall, early intervention and prevention efforts in medical settings are promising (Kramer & Landolt, 2011) and may be useful contexts to study interventions following disasters.

Studying Nontraditional Intervention Delivery

The high prevalence, unpredictability, and stressfulness of disasters create a compelling need for effective interventions that can be implemented rapidly and widely. Interventions deployed to smartphones and other web-accessible devices represent a new frontier for delivering mental health treatment. About 77% of Americans own a smartphone, roughly 67% have a broadband Internet subscription via computer, 95% own cell phones, and over 50% own tablets (Pew Research Center, 2015), suggesting clear potential for use in disaster recovery initiatives.

Most children and adults with mental health disorders do not seek or receive mental health services, and disaster survivors are no exception (Demyttenaere et al., 2004; Fairbrother, Stuber, Galea, Pfefferbaum, & Fleischman, 2004). Stigma, transportation, time commitments, scheduling problems, and cost are common barriers (Kim, Britt, Klocko, Riviere, & Adler, 2011). Technology-based resources hold potential to overcome many of these barriers. For example, *m*Health (e.g., smartphone, tablet, web) interventions can be accessed instantly (barrier: scheduling, time commitment), freely (barrier: cost), privately (barrier: stigma), and almost anywhere (barriers: time commitment and transportation). Moreover, evidence has indicated that the desire to handle the problem on one's own is the most common attitudinal barrier to seeking treatment—73% in the United States and 64% globally (Andrade et al., 2014)—among individuals with perceived need for mental health treatment (Mojtabai et al., 2011). Self-help and other technology-based solutions that assist in the delivery of evidence-based resources to children—or to promote self-management among older youth—therefore may be ideally suited to address this key barrier. The sheer quantity of resources available on the Internet and app stores is tremendous, but most have not been evaluated, and the evidence base supporting them is highly variable (e.g., Scott, Gome, Richards, & Caldwell, 2015). Directing families toward *evidence-based* solutions is a major public health priority. To this end, national organizations such as the American Psychological Association, National Child Traumatic Stress Network, International Society on Traumatic Stress Studies, American Academy of Child and Adolescent Psychiatry, and National Center for PTSD offer online fact sheets and digital solutions. However, the proportion of families in need of mental

health assistance who are aware of and use these resources after a disaster is uncertain.

Developing an evidence base around highly accessible, scalable disaster mental health resources is a major public health priority. Technology-based interventions are of particular value because they can achieve high penetration at low cost. A British Red Cross first aid smartphone app hit its target of 30,000 downloads within 9 days of launch in 2011; downloads exceeded 4 million by 2014 (International Federation of Red Cross and Red Crescent Societies, 2013). U.S. data also support the potential to achieve high penetration. Nearly half (44%) of parents surveyed by the Pew Research Center reported searching within the past year for health information relating to the needs of their children or other loved ones (Fox & Duggan, 2013). Racial–ethnic minorities are more likely to seek health-related information online than are nonminorities (Rainie, 2010), and rural and nonrural residents are equally likely to seek health-related information online after adjusting for Internet access (Ruggiero, Gros, McCauley, de Arellano, & Danielson, 2011). These data are encouraging because early tests of efficacy for *m*Health and web-based interventions have suggested potential for meaningful impact among children and adults (Amstadter, Broman-Fulks, Zinzow, Ruggiero, & Cercone, 2009; Ruggiero et al., 2015). These approaches may have particular value in mental health because health information-seeking online is more likely among individuals with stigmatized (e.g., anxiety, depression) than nonstigmatized (e.g., cancer, heart problems) conditions (Berger, Wagner, & Baker, 2005).

Research examining the impact of technology-based interventions with disaster-affected populations has been limited, in part due to the challenges inherent in conducting time-sensitive research, as discussed earlier. Technology-based interventions are particularly well suited to the acute and intermediate disaster recovery phases, where they may have greatest relevance to families with unmet mental health needs. Although many disaster-affected families may not have ready access to technology in the days and weeks following a disaster, most technology-based mental health interventions are unlikely to have significant value until 2–4 weeks postdisaster, after families have had an opportunity to address their most urgent needs.

Ruggiero et al. (2015) conducted the first wide-scale study of a web-based intervention for adolescents following a disaster. The study was an RCT evaluating Bounce-Back Now (BBN), a set of web-based modules focusing on potential sequelae of disasters including depression, PTSD symptomatology, and substance use. The researchers used address sampling to target 2,000 families with adolescents affected by the devastating tornadoes in Joplin, Missouri, and Alabama in 2011. Following a phone interview, families were provided a website and unique password that randomized them into the BBN, BBN plus parent module, or assessment only. It is important to note that almost half of the adolescents accessed the website. Further, relative to the assessment-only group, those receiving BBN showed lower depressive and PTSD symptoms 1 year later. Although more research is needed, this study demonstrates the tremendous potential of a system that can be rapidly adopted after disasters, especially given that Internet access via mobile devices will continue to grow.

Conclusions

Developing evidence-based interventions for children experiencing disaster is a national priority, given the pervasiveness of disasters and their potential sequelae. Such research should be broadened beyond studying the prevalence of trauma and other mental health symptoms and the impact of trauma approaches to include the full spectrum of outcomes (such as new-incidence disorders, bereavement, nonclinical distress, adjustment, coping, and resilience) and potential interventions. Conducting research within the often hectic and chaotic disaster setting presents a set of challenges—including identifying participants, obtaining consent, following participants longitudinally, and obtaining funding and support to develop and deploy interventions rapidly—that are not part of typical intervention research. We hope that our identification of these challenges, as well as promising strategies for meeting them, will inspire researchers to develop creative solutions, including considering a range of alternative designs, proactively forging ongoing relationships with schools and communities, and studying nontraditional means of delivery.

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