

# Sampling and design challenges in studying the mental health consequences of disasters

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## Abstract

*Disasters are unpredictable and frequently lead to chaotic post-disaster situations, creating numerous methodologic challenges for the study of the mental health consequences of disasters. In this commentary, we expand on some of the issues addressed by Kessler and colleagues, largely focusing on the particular challenges of (a) defining, finding, and sampling populations of interest after disasters and (b) designing studies in ways that maximize the potential for valid inference. We discuss these challenges – drawing on specific examples – and suggest potential approaches to each that may be helpful as a guide for future work. We further suggest research directions that may be most helpful in moving the field forward. Copyright © 2008 John Wiley & Sons, Ltd.*

**Key words:** trauma, research design, epidemiology, population health

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## Introduction

Researchers face numerous challenges when designing, implementing, and analyzing studies aimed at understanding the mental health consequences of natural disasters. In this paper, we expand upon two of the issues addressed by Kessler and colleagues (Kessler, Keane, Ursano, Mokdad, and Zaslavsky, this issue) that have often threatened the external and internal validity of disaster research. First, we discuss the problems that pertain to defining, finding, and sampling populations of interest after disasters. Second, we consider the challenges inherent in designing post-disaster research studies. Lastly, we expand upon the prior discussion and suggest emerging areas of research in the field. Although we focus on natural disasters to complement other papers in this special issue, the points raised here apply equally well to other disaster types. Our goal in highlighting these challenges is to better inform inference

from the extant body of post-disaster research and to help illuminate approaches that may be fruitfully applied in the future to strengthen work in the field.

## Sampling challenges

### *Defining populations*

Defining the population of interest may be a relatively easy question in most non-disaster research but is substantially harder in the unpredictable, and frequently chaotic, post-disaster circumstance, as mentioned by Kessler and colleagues (this issue). Perhaps this is best illustrated by example. Let us take a situation where a town is hit by a hurricane. Researchers may be interested in assessing all those who were affected by this event. But who are those persons? Are all persons in the town through which the hurricane passed 'affected'? Or would the affected be only persons who saw the

hurricane? Or those who had property damage as a result of the hurricane? If the latter is the desired group, how much property damage is sufficient for a person to be considered to be part of the sampling frame? A further complication in defining the relevant sampling frame of interest pertains to mobile populations. For example, in southern Mississippi before Hurricane Katrina hit the area in 2005, a substantial (and still unknown) proportion of the population was composed of migrant workers, frequently undocumented, who worked in the southern Mississippi casinos. These persons almost certainly left the area after Hurricane Katrina, literally leaving very little trace that they had been there. It is almost indisputable that extant studies that aimed to characterize the overall mental health of persons in the gulf coast area after Hurricane Katrina undercounted these persons (Galea et al., 2007). Such challenges in sampling frame definition have long bedeviled disaster research, making comparisons between studies challenging (Galea et al., 2005). Central to handling this issue, a clear definition of the sampling frame of interest – with clear consideration of the range of persons who should be in the sampling frame (by specifying, for example, the exact nature of ‘exposure’ that is an eligibility criterion for a particular study), and, if at all possible, an enumeration of the size of this population – is needed for each specific study.

The challenge of defining the relevant population pertains both to general population studies and to studies of particular populations, such as persons injured in a disaster or rescue workers. While at first glance it may seem easy to define persons injured after a disaster, this is simply not the case. Extending our hurricane example, let us suppose that a particular research project was interested in documenting whether persons who were injured after a hurricane had long-term substance use problems. Researchers would then be interested in studying all those injured. However, who would be considered injured? Persons who were hospitalized? Perhaps. Yet hospitalization is a function both of injury severity and hospital access. Factors such as socio-economic status and race/ethnicity influence the likelihood of hospitalization; these factors may well confound the potential relations of interest, hence making hospitalization – when used as an eligibility criterion – a potential source of selection bias. What if all persons who had at least some physical injury were considered eligible? After some events, minor injuries, such as corneal abrasions or smoke inhalation, are the

most typical injury (Feeney et al., 2005). Would all these persons then be eligible? If such minor injuries are considered as part of the eligibility criteria, how might we find such persons since those with relatively minor injuries are likely never to present to care? These difficulties in defining a population can be extended to studies that are concerned with the mental health of rescue workers after disasters. While the notion of ‘rescue workers’ might suggest fire fighters or police officers, in fact, after many disasters, it is construction workers or maintenance and sanitation workers who spend an inordinate amount of time in disaster areas cleaning up after these events and being exposed to the realities and horrors of them (Perrin et al., 2007). Clearly, omitting these persons from sampling frames that are concerned with rescue workers would substantially undermine the ability of these sampling frames to represent the population of interest.

#### *Finding persons*

Inextricably linked to this issue of defining the population of interest is the logistical challenge of finding persons within the sampling frame of interest. There are several reasons why reaching participants may be challenging after disasters. As described by Kessler and colleagues (this issue), large disasters may scatter potential participants not only throughout the affected area but potentially throughout the state or country, which was the case after Hurricane Katrina (Galea et al., 2007; Kessler et al., 2006). Also, breakdown of typical communication mechanisms, including telephone or internet service, may make typical means of assessing participants available only in a limited way. Persons affected by disasters may also be busy handling its aftermath. Procuring services, re-establishing homes and employment, and in large disasters, searching for loved ones become pressing needs, leaving little time for or interest in research participation. Nonetheless, available reports suggest that the vast majority of persons who do participate in such research find their participation rewarding (Newman and Kaloupek, 2004).

Ultimately, once the population of interest is defined, research studies must overcome these hurdles to appropriately sample, find, and collect information from research participants. Unfortunately the challenges inherent in doing so have resulted in a preponderance of disaster-related research that has used convenience samples (Norris et al., 2002; Norris, 2006). Convenience samples may well be necessary in some

circumstances and may, particularly in highly unusual events where no other means of accessing participants is possible, yield invaluable information (Goenjian et al., 2005; Neuner et al., 2006; Sattler et al., 2002). However, in general, convenience samples have substantial limitations. Centrally, these samples embed potential selection biases – the persons who volunteer to participate may well be different, frequently in unknown ways, from those who do not – that limit their usefulness to describe the underlying population of interest. As a consequence, comparison across convenience samples both within the same disaster and across disasters is difficult, making these samples of limited use for scientific generalization and inference.

Several methods have been used to identify persons of interest after disasters and to facilitate sampling that better represents the underlying populations of interest. Each of these methods has its own strengths and weaknesses. Perhaps the most traditional method of finding research participants involves door-to-door sampling and in-person interviews (Bromet and Havenaar, 2006). Door-to-door sampling has the advantage of ensuring that all extant dwellings can be included in a sampling frame, which can be extended to include temporary dwellings such as mobile homes if necessary. It does not depend on functioning technology such as telephones and can facilitate complicated research designs such as assessments of multiple family members or mixed methods designs that include qualitative and quantitative interviews. However, door-to-door sampling is expensive, slow, and dependent on the timely hiring and training of research personnel at the disaster site. It requires in-person access to areas that are frequently inaccessible to all but local residents; in addition, it is not an effective means of reaching persons in areas that have been devastated by disaster and from where local residents have essentially fled.

More recently, disaster studies have used methods such as telephone interviewing and web-based interviewing to reach persons of interest after disasters. These methods are substantially cheaper than in-person methods, and researchers may implement them from a distance. These methods, however, have marked weaknesses. Both depend on functioning technology, which is in no way a certainty after disasters. While both telephone and web-based survey methods were used effectively after the September 11, 2001 terrorist attacks in New York City (Galea et al., 2002; Galea et al., 2003; Schlenger et al., 2002; Silver et al., 2002), telephone

and web-service were very quickly restored in New York City after these attacks. Therefore, researchers could operate with some confidence that access to these modes of communication was not hindered. Nonetheless, even if service is restored to normal levels, both these methods remain limited to persons who actually make use of these modes of communication and as such have their own limitations. While nearly all Americans have phones, Americans are increasingly using only cell phones which are much harder to access than traditional land lines (see Blumberg et al., 2006; Galea et al., 2006). In regard to web-access, a substantial proportion of Americans still does not have it, although this number is decreasing. Those who lack web access differ from the general population on important characteristics such as age, race/ethnicity, and socioeconomic position (less access among older persons, minorities, and poorer persons). Hence, while both these methods may have utility, their effectiveness is very much dependent upon the particular post-disaster circumstance, and they must be deployed judiciously with the earlier limitations carefully considered. Kessler and colleagues provide a useful and illustrative summary of how telephone sampling was successfully deployed after Hurricane Katrina (this issue).

#### *Describing populations: capturing elements of disaster exposure*

Although an in-depth discussion of measurement issues is beyond the scope of this paper, defining the population of interest cannot be accomplished without simultaneously defining, and subsequently measuring, disaster exposure. Assessing 'exposure' to a disaster is not as simple as it may first seem. Disasters are heterogeneous, and the population exposure within any given disaster may be heterogeneous. For example, the nature of the exposure to a hurricane may be quite different than that of a terrorist attack wherein a building is bombed. In the former, loss of a home and prolonged displacement from home and community may be key exposures; in the latter, key exposures may be the loss of friends or family and disability. Hence, key elements of exposure must be considered on a disaster-by-disaster basis. Assuming that the nature of exposure is dependent on broad categories of disaster-types may even be problematic, as the exposure to one 'natural disaster' may be quite different from another.

It may be more fruitful to instead consider exposures to disaster events as being characterized by specific

disaster dimensions such as intensity and duration. Thus, disasters that unfold slowly over time (e.g. Havenaar et al., 1997) may be characterized by prolonged exposure, in stark contrast to point events (e.g. Bodvarsdottir and Elklit, 2004) wherein the exposure may be highly transient. The challenge then is to adequately assess the nature of the exposure that was relevant to the participant in a particular event and to define the specific characteristics of this event. Ancillary to this challenge is the issue of drawing generalizable inference across several studies in the peer-reviewed literature. Given that both the types of exposure and the characteristics of disasters measured may vary amongst studies, comparison across studies must be done carefully with consideration of these limitations.

Complicating the issue of measuring exposure is the emerging, and potentially important, issue of indirect exposure. Kessler and colleagues (this issue) note that indirect trauma after the September 11, 2001 terrorist attacks was widespread in the US population; several studies have similarly shown that after large disasters persons who were not directly affected by the disaster may still exhibit symptoms of psychopathology and changes in behavior (Salib, 2003; Schlenger et al., 2002). This raises important nosologic and conceptual challenges regarding the nature of exposure (Galea and Resnick, 2005). It has been suggested that phenomena such as widespread television watching (Ahern et al., 2002; Ahern et al., 2004) or perceived threat and relative risk appraisal (Marshall et al., 2007) may mediate the relation between indirect exposure to a disaster event and the consequences that have been typically associated with directly exposed persons only. Future post-disaster work that rigorously assesses the potential mechanisms that may mediate the relation between indirect disaster exposure and mental health would greatly strengthen the field. The validity of these studies would rest on careful definitions of direct and indirect exposure and sampling strategies that represent populations that have been directly, indirectly, and not exposed.

### Study design

#### *The problem of post-only studies*

Disasters are unpredictable and, barring a few exceptions, the research field concerned with the consequences of disasters must contend with studies that are launched only after an event. As noted by Kessler and

colleagues (this issue), this is perhaps one of the central study design challenges in the field. Having to rely on post-only designs means that researchers have limited ability to determine the extent to which disasters caused the mental health consequences being documented after these events. Modern epidemiologic thinking rests primarily on a counterfactual heuristic. Namely, we consider what might have happened if populations were, or were not, exposed to a full set of experiences present or absent of a putative cause. In many respects then disasters provide an ideal natural experiment for determining causation: they are population-based, relatively random events that incur changes likely brought on by the events themselves. However absent an assessment of what the population of interest was like before the event, we are limited in our inference as to whether what we see after an event is truly a change or simply a reflection of the pre-disaster circumstances. Hence, post-disaster only designs are limited in their assessments to prevalent cases of disease – which include ongoing psychopathology, regardless of the date of manifestation – rather than incident or ‘new’ cases of disease.

Studies have adopted four central approaches to address this problem. One approach is to obtain a detailed history of the time course of symptoms to determine their onset relative to the disaster event (Bravo et al., 1990). A second approach is to obtain explicit assessment of pre- and post-disaster behavior and function (Vlahov et al., 2002). A third approach is to compare post-disaster prevalences of disorder with pre-established prevalences (Kessler et al., 2006) using resources such as the National Health Interview Survey, as described by Kessler and colleagues (this issue). A fourth approach is to enroll non-affected communities as comparison groups (Basoglu et al., 2004). These methods all have limitations. Retrospective historic assessment is limited to recall bias. Participants inevitably anchor their responses to the disaster event and may provide socially desirable responses, limiting inquiry into pre/post functioning. Comparisons to pre-existing baseline estimates assume that these estimates are drawn from similar populations to the post-disaster samples. Similarly, comparisons to control communities are confounded by unmeasured differences between the case and control community that make inference from these studies challenging.

There is no easy solution to the challenge of the post-only study designs that are endemic in the field.

Disaster research needs to be implemented with consideration of this challenge, and inference from its observations must be formulated carefully and judiciously, limited to that which can be drawn with confidence from such work.

#### *Optimizing study design*

In a review of the disaster literature, Norris showed that nearly three-quarters of studies make use of cross-sectional study design (Norris, 2006). Researchers and practitioners alike frequently seek the information provided by cross-sectional designs, as a snapshot of population mental health (e.g. Verger et al., 2004). However, as has been noted elsewhere, the disaster mental health field is sufficiently mature that there is little need for more burden-of-disease studies (Galea et al., 2005). In addition, cross-sectional designs have one central limitation: their inability to definitively establish temporal sequence between the variables being studied. Thus, for example, a cross-sectional study implemented six months after a disaster that assesses both depression symptoms and experience of traumatic events may be limited in its inference as to whether depression preceded these experiences or vice versa. Most cross-sectional studies attempt to overcome this limitation by carefully obtaining temporal histories of key experiences and the psychological symptoms assessed. Conclusions, however, remain limited by the issues of recall bias noted earlier.

Longitudinal study designs overcome some of the problems of cross-sectional designs by allowing for the assessment of the course of psychopathology, an area of growing interest in the field. These studies are increasingly highlighting the complexity of psychopathology trajectories after disasters, hence suggesting new areas of both research and intervention (Beard et al., 2008; Carr et al., 1997; North et al., 1997). Longitudinal designs do little to overcome the post-only challenge that was previously noted – determining causality. However, by broadening the time course of data collection and potentially assessing the explicit relationship between post-disaster experiences and psychological symptoms, they allow for greater inference to be drawn from research. For specific methods of temporal sampling, see the discussion by Kessler and colleagues (this issue).

Logistically, longitudinal studies can be very challenging. These studies are expensive and frequently bear costs that far exceed the resources available. Other

logistical challenges include the difficulty of tracking and following persons who may be transient. Newer analytic methods that take into account follow-up loss may provide the means to deal with some of these limitations (Galea et al., 2008).

Two study designs – case-control and experimental – are seldom used in disaster research but may hold particular promise. Case-control study designs are conceptually equivalent to cohort studies but start with case identification; controls that are demographically matched to the cases are then selected. A full discussion of case-control methods is beyond our scope, but one advantage to these methods is the capacity to assess exposures historically since they are nested within the underlying cohort. This overcomes one of the limitations of cross-sectional studies noted earlier – recall bias. However, case and control identification requires clear specification of the base population, raising all the challenges inherent in defining a sampling frame of interest as noted earlier.

We note, in conclusion, that experimental designs are also underused in the post-disaster situation. We do not discuss this in more detail here in the interest of parsimony, but clearly the role of experimental designs in determining interventions that can minimize psychopathology after disasters merits further and separate discussion.

#### **Future directions and conclusions**

We have elaborated on some of the points raised by Kessler and colleagues (this issue) here, highlighting the substantial methodological challenges that are inherent in the study of the mental health consequences of natural disasters. These challenges arise primarily out of the difficulties in the establishment of research after disasters and out of the nature of disasters themselves. For example, the unexpectedness of disasters largely leads to post-only designs being the only feasible research approach. Identifying, and sampling, the populations of interest after these events is frequently problematic, as is designing studies that assist in this sampling. Careful attention to defining and measuring levels of exposure and the use of case control studies both have the potential to contribute to further development of the field.

In many respects, despite the substantial sampling and design challenges inherent in studying the consequences of natural disasters, we have made tremendous progress as a field. As we have noted in previous work,

'the available information is sufficient to suggest plausible ranges of PTSD [post-traumatic stress disorder] prevalence that can be expected in the first year after disasters, among exposure groups' and 'there is little scientific rationale for carrying out additional studies specifically aiming to document the burden of PTSD after disasters' (Galea et al., 2005). This is progress indeed and challenges us to consider how we may move the field forward.

We conclude by drawing on our own experience and of reading of the literature to suggest potential directions for future work aimed at studying the consequences of disasters. We suggest that the most productive research designs in the future will be composed of the following: (a) a population-representative sample, (b) assessments of multiple potential levels of influence, (c) a longitudinal component, and (d) use of mixed methods that allow for information from both qualitative and quantitative assessments. Importantly, such designs can contribute to three particularly promising areas in the study of the psychological consequences of natural disasters.

First is the study of the trajectories and pathways of psychopathology after these events. For example, there has been renewed interest recently in the notion of 'resilience' (Bonanno, 2004; Norris et al., 2008); we have suggested elsewhere that 'resilience' may be considered to be one of several trajectories of psychological well-being after disasters (Norris et al., submitted for publication). Future work that considers the different trajectories of psychopathology after natural disasters together with biologic work that helps us understand the mechanisms of recovery after these events can substantially move the field forward.

Second, although traditional work in the field – as with most of the work in psychological and psychiatric research – has focused on the individual experiences and characteristics that shape individual risk of psychopathology after disasters, emerging work has provided examples of how community features (Ahern and Galea, 2006) and genetic factors (Kilpatrick et al., 2007) both contribute to the determination of post-disaster psychopathology. These examples illuminate the multi-factorial causation of health and disease in these circumstances, which encourages work that can incorporate multiple levels of influence in understanding the consequences of natural disasters. In this respect, the incorporation of methods from areas such as qualitative and quantitative work (for mixed method

analyses) and from newer analytic tools, such as complex system dynamic models (Galea et al., in press), may be helpful.

Third, epidemiologic research is increasingly considering the role of various factors in shaping individual mental health during different developmental stages. Early evidence suggests the importance of considering traumatic event experiences (Koenen et al., 2007), likely including the experience of disasters, across the lifecourse when studying mental health trajectories. Future epidemiologic work that expressly adopts a lifecourse perspective can greatly aid the integration of developmental psychological insights with extant post-disaster research.

We recognize, of course, that this prescription for research directions in many ways 'raises the bar'. However, despite substantial challenges, the field of post-disaster mental health research has made tremendous progress in the past few decades. Innovative work that builds on this history can stand to make substantial scientific contributions and help identify how psychopathology can be mitigated in the aftermath of natural disasters.

### Declaration of Interests

The authors declare no conflict of interest.

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