International Journal of Mental Health & Psychiatry

Mental Health Symptoms in Post-earthquake Miami Haitians: Cumulative Effect of Disaster-related Stressful Events

Antoine Messiah[1*], Guillaume Vaiva[1,2], Erick Gokalsing[1,3], Raymond Tempier[1,4], Naomie Jean[5] and Juan M Acuna[5]

Abstract

Purpose: This study evaluated correlates of mental health symptoms among Haitians living in Miami-Dade County, 2-3 years following the 2010 Haiti earthquake, using 3 types of exposure variables: (1) basic exposure status (direct/indirect/no), (2) total of earthquake-related stressful events, (3) a combination of the two former variables. The novelty of the design was that it allowed studying disaster-related accumulated stress among people indirectly exposed to a disaster, which had not been done previously to the investigators' knowledge.

Methods: A random-sample household survey was conducted from October 2011 through December 2012, in Miami-Dade County, Florida. Haitian participants (N=421) were assessed for their earthquake exposure and related stressful events, and for symptoms of posttraumatic stress disorder (PTSD), of generalized anxiety, and of major depression, using standardized screening scales and thresholds.

Results: We found a dose-response association for each type of exposure variable with 5 outcomes: percentage of respondents exceeding threshold for PTSD (PCL-C ≥ 44), for anxiety (BAI ≥ 26), and for depression (CES-D ≥ 16); at least one scale exceeds its threshold; and number of scales exceeding their respective threshold. Stepwise logistic or linear regressions produced stronger associations for the combined exposure variable with all outcomes, except for anxiety which was more strongly associated with basic exposure status.

Conclusions: The number of disaster-related stressful events is an important correlate of mental health symptoms, including among people indirectly exposed to the disaster. Those indirectly exposed represent a population much larger than those directly exposed, deserving equal mental mental-health attention. Evaluation of accumulated stress and emergence of psychopathology among persons indirectly exposed to disaster should be the focus of further research and of public health interventions.

Keywords

Cumulative stress; Mental health; Disasters; Earthquakes; Probability sample; Haitians

*Corresponding author: Antoine Messiah, MD, PhD, DrSc, Paul Brousse Hospital, 16 Avenue Paul VaillantCouturier, F- 94807 Villejuif Cedex, France, Tel: 33145595361; Fax: 33145595331; E-mail: antoine.messiah@inserm.fr

Introduction

Disasters are traumatic events experienced by many people, and may produce a wide range of mental health consequences; the literature addressing this issue is now abundant, and has led to several reviews [1-8]. In brief, the most frequently studied mental-health disorder following a disaster is the post-traumatic stress disorder (PTSD), with prevalence around 30-40% among those directly exposed, versus 5-10% in the general population. Other mental disorders can also appear in the wake of a disaster, like major depressive disorder (MDD), with related symptoms such as suicidality, or anxiety disorders such as general anxiety or panic disorder, but they are studied much less frequently. In some cases, disasters can cause symptoms of non-specific distress, including sleep disturbances, aggravation or relapse of alcohol consumption, and somatic complaints. For children or teenagers, behavioural changes can appear, such as dependence on adults, separation anxiety, inability to sleep alone, incontinence, hyperactivity or aggressive behaviour; all of these exacerbated by parental stress.

Based on numerous studies [1-8], some features may be predictive of post-disaster adverse mental health outcomes. Disasters in developing countries seem to lead to more adverse outcomes than in developed countries, probably because of delayed recovery in a context of lower resources, alongside delayed care and late return to safety. The impact of mass violence is more negative than that of technological disasters; the same is true for man-made disaster compared with natural disaster. Indeed, the more intentional a disaster, the more traumatic for persons experiencing it. Gender differences exist: women seem more prone to develop PTSD, while men seem to react more by increasing their alcohol consumption. Young adults seem to be more at risk of developing PTSD compared with older adults or elderly, suggesting that resilience improves with age, although this has been shown only when there is no pre-existing mental disorder (PTSD or MDD). While a lot of studies on post-disaster mental health have been cross-sectional, a few are longitudinal and showed that the prevalence of mental-health disorders peaks during the first year after the event, and then decreases progressively.

A large majority of studies found that severity of exposure to traumatic events is associated with poor mental-health outcomes. Behind the consistent (but non-systematic) [9] association, however, lies a great deal of variability, since exposure severity is measured by quite different constructs, even within one given type of disaster. Indeed, there is no consensus on how exposure should be operationalized [10]. In the case of natural disasters, for example, severity can be assessed by the amount of destruction experienced by the individual [9,11-14], or by an indicator thereof, such as the distance to epicentre in the case of earthquakes [15,16]. Many studies have assessed a set of disaster-related stressors, and analyzed their correlation with poor mental-health outcome using various methods. In the most commonly used method, each stressor is analyzed as a separate variable, regardless of any a-priori hierarchy [9,11,12,14,15,17-27]. In another set of studies, severity is operationalized through exposure to the stressor(s) considered as the most disruptive [28-31]. Finally, other studies enumerate stressors, yielding a score of accumulated stress [20,32-39]. This is the case,

in particular, of longitudinal studies on the course of mental-health outcomes over time, where mid- and long-term effects of exposure are under scrutiny [34,35,37,38]. In these studies, disasters were natural (hurricane) or industrial (fireworks factory explosion), and the population comprised directly exposed persons. Mental health outcomes consistently addressed PTSD; one or several other mental health problems, such as depression, anxiety, sleeping problems, distress, and/or specific phobias, were under scope as well, but in a less consistent manner. A consistent result of these studies is the association between the index of disaster-related accumulated stress and most, if not all, mental-health outcomes and their persistence over time (up to 4 years). Since the analytical methods and strategy varies between these studies, as well as their time span, the elicited association pathways are not identical. In some studies, the accumulated stress is associated with symptoms at all points in time; in others, accumulated stress is associated with short and mid-term symptoms, which are in turn associated with mid- and long-term symptoms, respectively. But in all cases, accumulated stress is a key factor for poor mental-health outcomes.

Neurobiological studies of allostatic load (AL) support the role of traumatic stress accumulation on health deterioration. Allostatic load (AL) is the term used to describe cumulative physiological wear and tear that results from repeated efforts to adapt to stressors overtime [40-43]. AL is typically operationalized as a composite index of biological risk factors (e.g., blood pressure, cholesterol, glycosylated hemoglobin, cortisol, norepinephrine, and epinephrine). Such AL composites have been shown to increase with age, predict long-term morbidity and mortality among the elderly and be associated with putative "high stress" or posttraumatic stress disorder (PTSD) [44]. AL is correlated with cumulative stress [45] and with one's ability to recover from acute emotional distress [41]. In the case of a natural disaster, several traumatic events occur during a short period of time, resulting in a rapidly growing AL. We can therefore hypothesize that both direct and indirect victims of an earthquake, as far as they experience similar levels of cumulative stress and its corresponding AL, can have similar likelihood of poor mental health outcomes.

To the best of our knowledge, however, association between accumulated stress and mental-health has never been studied among individuals indirectly exposed to a disaster. Indeed, the role of indirect exposure has been subject to debate [46,47]. Several studies found that indirect exposure was associated with poor mental health outcome [26,32,46,48-53], but they differed substantially in their exposure measurement. Therefore, studying stress accumulation and mental health among people indirectly exposed can be an important contribution, especially under a public health perspective since this group is much larger than the group directly exposed.

The study described here aims to provide such a contribution. It derives from the "Little Haiti Benchmark Survey and Post-Earthquake Needs Assessment" project that was conducted as part of a series of community-oriented health initiatives launched by the Florida International University College of Medicine [54]. It examined the mental health status of Haitians living in Miami-Dade County 21 to 35 months after the earthquake, using a census-base sampling frame and a random selection of households, and found that more than two thirds of participants were exposed to the earthquake, directly or indirectly [48]; symptoms of PTSD, generalized anxiety, and depression, were more frequent among those exposed directly than among those exposed indirectly, but the analysis did not take into account the number of earthquake-related stressful events. In

addition, those exposed indirectly were 7.6 times more numerous than those exposed directly, indicating the public-health importance of a disaster in this group, which has been rarely studied.

This article analyzes several mental health outcomes among Haitians exposed directly and indirectly to the 2010 Haiti earthquake, using 3 types of exposure variables: (1) basic exposure status (direct/indirect/no), (2) number of accumulated earthquake-related stressful events, and (3) a combination of the two former variables. The aim of this study is to determine whether accumulated disaster-related stress is an important correlate of symptoms of PTSD, anxiety, and depression, especially among subjects indirectly exposed to the disaster.

Material and Methods

Study sample

A random-sample household survey was conducted from October 2011 through December 2012, in Miami-Dade County, Florida, in the 20 census tracts with a minimum of 30% Haitian households (based on year 2010 census data). From the 1,769 households randomly selected for the survey, 634 (35.8%) declined to participate and 184 (10.4%) could not be reached and interviewed within 11 contact attempts, resulting in 951 completed surveys. Ethnicity of household could be ascertained only once the interview had started. Among the 951 completed surveys, 421 were conducted in Haitian households; they comprise the sample analyzed in this article. Details of the survey procedure can be found elsewhere [48].

Data collection

Data were collected via face-to-face interviews that lasted 90 minutes on average, with one self-designated household member. Participants were interviewed in Creole, French, or English, depending upon their usual or preferred language; they gave an informed consent prior to interview. Interviews included a battery of demographic questions including household composition, age, gender, ethnicity, financial and housing situation, and number of years of residence in the home where the interview was conducted.

Earthquake experience: Haitian households were asked questions related to the January 2010 Haiti earthquake. Respondents were asked whether they were in Haiti during the earthquake, how close they were to the epicentre, and whether direct and indirect family members or close friends had been killed or injured. Respondents were asked about earthquake-related losses of job, assets, or economic resources, and whether they had hosted earthquake survivors who were displaced from Haiti in their Miami home.

Assessment of symptoms of common mental disorders: Validated screening measures were used to assess participant, at time of interview, for symptoms of posttraumatic stress disorder (PTSD), generalized anxiety (GA), and depression. The Post-traumatic Check List – Civilian (PCL-C) was used to assess symptoms of PTSD [55-57]. Symptoms of GA were assessed using the Beck Anxiety Inventory (BAI) [58–60]. Symptoms of depression were measured using the Centre for Epidemiologic Studies – Depression scale (CES-D) [58-62]. We used standard thresholds to designate elevated symptoms levels, as follows: PCL-C ≥ 44, BAI ≥ 26, and CES-D ≥ 16.

Data analysis

Earthquake experience was used to build 3 types of exposure variables:

Basic exposure status (direct/indirect/no, later referred to as BES);

Total of 7 earthquake-related stressful events, later referred to as TERSE;

A combination of the two former exposure variables (combination of exposures, later referred to as COE).

For BES, exposure status was "direct" for interviewees who were in Haiti during the earthquake, "indirect" for interviewees not in Haiti but having experienced at least one earthquake-related event, and "no" otherwise. For TERSE, earthquake-related stressful events under investigation were:

Being in Haiti at the time of the earthquake;

Being within 20 km of the earthquake epicentre;

Having had direct family members victim of the earthquake (killed or injured);

Having had other family members victim of the earthquake;

Having had close friends victim of the earthquake;

Hosting or having hosted family members or friends displaced from Haiti;

Earthquake-related reduction in ability to maintain livelihoods (loss of job, assets, or economic resources).

Each of these were assigned a value of 1, and added up to obtain the number (0-7) of events that participants had experienced. This number was merged into 4 categories: 0, 1-2, 3-4, and 5+, for analysis of accumulated earthquake-related stressful events.

Five outcomes were studied: being above symptoms thresholds, that is

PCL-C ≥ 44;

BAI ≥ 26;

CES-D ≥ 16;

Having at least one measure above threshold;

Number of the three measures above threshold (from 0 to 3).

Forward stepwise logistic (qualitative outcomes) or linear regressions (quantitative outcome) were used to assess which exposure variable had the strongest association with each outcome: basic exposure status (BES), total of earthquake-related stressful events (TERSE), and interaction between these two variables. Linear and logistic regressions were further used to adjust for the possible confounding effect demographic variables. Analyses were performed using SPSS (Statistical Package for the Social Sciences) version 19.0 [63].

Results

Respondent demographics

The mean age was 46 years and the majority of participants (61%) were women (Table 1). About half (55%) of respondents were married or living with a partner and less than half (43%) had education beyond high school. Sixty percent were employed full or part time (45% and 15%, respectively); however 64% had household incomes below 30,000 USD per year. Half (53%) had been living in their current home for at least 10 years.

Earthquake exposure and symptoms of mental disorders

Information was available to determine BES and TERSE for 418 of 421 participants (Table 2). Most of them had been directly (8%) or indirectly (61%) exposed. Almost half (46%) had experienced 1 or 2 stressful events, and 22% had experienced 3 to 7 stressful events. As expected, exposure status and the number of accumulated stressful events were highly correlated (chi-square for trend=297, 1 d.f., p<0.0001); indeed, most participants with indirect exposure had experienced 1 to 4 stressful events, while most of those directly exposed had experienced 3 to 7 stressful events.

Forward stepwise logistic or linear regressions revealed that the exposure variable which had the strongest association with each outcome was the BES-TERSE interaction, except for elevated symptoms of anxiety (BAI ≥ 26), with which the BES had the strongest association.

Table 3 shows odds ratios (logistic regressions) and slope coefficient (linear regression) for each outcome by TERSE, analyzed separately by BES (indirect vs. no and direct vs. no). It allows to see the effect size of each of the two primary exposure variables (BES and TERSE) when the other one is held constant. Odds ratios and regression coefficients show dose-effect relationships for BES within each level of TERSE (vertical reading) and for TERSE within each level of BES (horizontal reading), therefore confirming the importance of the two exposures combined.

We therefore constructed a composite variable, referred to as COE (combination of exposures) based on the joint distribution of BES

Table 1: Sample demographic characteristics: column percents except for age.

Variable	col. % (N=421)
Age (Mean)	46
Gender	
Male	39
Female	61
Marital Status	
Married, Living with Someone	55
Single	25
Separated, Divorced, Widowed	20
Educational Attainment	
Less than High School	25
High School or Equivalent	32
Above High School	43
Household income	
Less than $30,000	64
$30,000 - $49,999	26
$50,000 and over	10
Employment	
Full time	46
Part time	14
Not Employed	25
Retired	15
Duration of living in USA	
Less than 10 years	46
10 – 19 years	33
20 years and over	21
Language elected for the survey	
Creole	78
English	20
French	2

Table 2: Exposure characteristics: Total earthquake-related stressful events (TERSE) by basic exposure status (BES); frequencies and total percents.

			TERSE				Total
			0	1-2	3-4	5-7	
BES	No	N	134	0	0	0	134
		%	32	0	0	0	32
	Indirect	N	0	189	57	7	253
		%	0	45	14	2	61
	Direct	N	0	4	15	12	31
		%	0	1	4	3	8
Total		N	134	193	72	19	418
		%	32	46	17	5	100

with TERSE, as follows: no exposure (0 events)/ indirect exposure, 1-2 events/ indirect exposure, 3-7 events/ direct exposure 1-3 events/ direct exposure, 4-7 events. COE was significantly associated with the number of years in current US home (p=0.001), and with marital status (p=0.027); association with marital status was no longer significant when number of years in current US home were adjusted for. We then analyzed the association of COE with all outcomes under scope, adjusting for number of years in current US home, and found dose-effect relationships for all outcomes (Table 4). Among these outcomes, depression (CESD≥16) had the highest odds-ratios, while anxiety (BAD ≥ 16) had the lowest.

Discussion

Significance of findings

The study findings demonstrate the importance of assessing the number of stressful events, in addition to basic exposure classification, suggesting that the accumulation of these events plays a role in mental health deterioration. Accumulation, nevertheless, did not fully account for poor mental health outcomes in our study, since basic exposure status, combined with accumulation, resulted in the strongest association with most of these outcomes. Indeed, anxiety (BAI ≥ 16) had a stronger association with BES alone than with BES combined with TERSE. The study examined the relationship between a two dimensional exposure variable and the presence and number of several psychological outcomes, providing documentation for a dose-response relationship. This dose-effect relationship aligns well with the consistent finding across a broad spectrum of disasters that the likelihood of adverse mental-health effects increases with exposure severity [9,12,21,36-39,48,63-69]. In our study, severity was operationalized by considering the joint distribution of two distinct and complementary exposure variables.

Indirect exposure, combined with important accumulation of stressful events (3 or more), was associated with elevated symptom levels with odds-ratios between 1.9 and 4.0 (point estimates). This supports previous publications suggesting that indirect exposure is an important contributor to post-disaster mental-health disorders [3,7,46,47,50,67]. As shown by our previous work [48], the group of persons indirectly exposed to the earthquake is much larger than the group of persons directly exposed (×7.6 in our case). Under a public-health perspective, the importance of low-level effects among a large number of persons equals or exceeds that of a stronger effect among a small population subset.

Identification of persons at risk of psychological problems in the wake of a disaster is important to target intervention or treatment and allocate resources towards them. This study suggests that indirectly

exposed people should be included in this process. Assessment of accumulated disaster-related stressful events among them may provide a way to easily screen those who are the most at risk and deserve further attention.

Study strengths

This study enriches and complements earlier operationalizations of exposure to natural disasters, and demonstrates the importance of accumulated stress, especially among those indirectly exposed, a subgroup rarely studied. Previous studies have documented psychological effects of the earthquake among Miami Haitians [48,49,52,53,70], representing the largest Haitian Diaspora. Nevertheless, none of them addressed the psychological effect of the accumulation of earthquake-related stressful events. Examination of the mental health status of Haitians living in Miami-Dade County 21 to 35 months after the earthquake allowed studying mental health symptoms that have persisted or have appeared over time, therefore contributing to a longer time perspective to the understanding of poor mental-health outcomes. The sampling frame for this study was defined by objective, census-based data, with random selection of households; most studies on disaster, by contrast, used convenience samples. It was developed before, and independent of, the earthquake. Questionnaires were available in multiple languages in order to obviate bias due to language barrier. Surveys were conducted in Creole, French, and English, allowing respondents to participate in the language of their choice. Importantly, the study includes both directly and indirectly exposed participants. Furthermore, we addressed symptoms of three mental health outcomes (symptoms above threshold for PTSD, generalized anxiety, and depression), and two derived outcomes: at least one measure above threshold, and number of measures above threshold.

Study limitations

As part of a series of community-oriented health surveys, an important limitation was the restricted number of exposure items that could be included in the questionnaire. Indeed, the survey was designed before the 2010 earthquake and was aimed at general health issues. The earthquake-specific questions used in the current analysis were added to the original questionnaire after the disaster. Therefore, it was not feasible to extend the disaster-related questions as much as it would be for an entirely disaster-specific survey, including history of previous disasters and previous exposure to trauma. Furthermore, information on exposure was collected a few years after the earthquake, leaving room for memory bias and possible influence of mental condition on the recollection process. The limitation for the direct exposure group was limited in size (N=31), therefore constraining us to divide this group according to its distribution when we constructed the COE. The limitation for the indirect exposure category was the joining of several distinct and disparate experiences into a single category; however, almost all of them (97%) met the DSM-5 criterion A for PTSD [71] - all members of the direct exposure group met criterion A.

Because Haitians have ways of living through and expressing mental pain that are culture-specific [72-84], we must consider whether the western instruments we used were appropriate. These instruments have not been validated in any Creole-speaking community, although PCL-C and CES-D have already been used in adult Haitians [85-87]. This limitation may have been partially offset by the selection of interviewers of Haitian origin, and by the duration of US residence of the participants (more than half had been

Table 3: Outcomes analyzed by total earthquake-related stressful events (TERSE) and basic exposure status (BES): Odds ratio and their 95% CI (qualitative outcomes, logistic regressions); beta coefficient for the slope (quantitative outcome, linear regression).

Outcome	Upper values: BES Indirect vs. No Lower values: BES Direct vs. No			
	TERSE			
	0 (ref.)	1-2 OR [95% CI]	3-4 OR [95% CI]	5-7 OR [95% CI]
PCLC ≥ 44	1	1.2 [0.8 – 2.1] 1.9 [1.2 – 3.1]	1.6 [0.6 – 4.2] 3.8 [1.5 – 9.5]	2.0 [0.4 – 8.7] 7.3 [1.8 – 29.1]
BAI ≥ 26	1	1.3 [0.9 – 1.8] 1.8 [1.2 – 2.6]	1.7 [0.9 – 3.4] 3.3 [1.6 – 6.8]	2.2 [0.8 – 6.3] 5.9 [1.9 – 17.8]
CESD ≥ 16	1	1.8 [1.3 – 2.6] 2.3 [1.6 – 3.4	3.4 [1.7 – 6.8] 5.3 [2.5 – 11.4]	6.2 [2.2 – 17.8] 12.2 [3.9 – 38.3]
At least one above condition	1	1.6 [1.2 – 2.2] 2.2 [1.5 – 3.2]	2.7 [1.4 – 5.0] 4.9 [2.4 – 10.3]	4.4 [1.7 – 11.2] 11.0 [3.6 – 32.9]
Number (0-3) of above conditions (linear regression)	Slope coefficient [95% CI]		0.16 [0.04 – 0.28] 0.33 [0.20 – 0.46]	

Table 4: Regression analysis of health status by combination of exposures (COE), adjusted for number of years in current US home: Odds Ratios (OR) and 95% Confidence Intervals (CI).

Basic exposure status	No	Indirect		Direct		
Total earthquake-related stressful events	0 N=125	1-2 N=193	3-7 N=64	1-3 N=19	4-7 N=12	P value
	OR (logistic regressions) or slope coefficient (linear regression) [95% CI]					
PCLC ≥ 44 (logistic regression)	1 (ref.)	1.5 [1.1 – 2.0]	2.2 [1.2 – 4.2]	3.3 [1.3 – 8.6]	4.9 [1.4 – 17.6]	0.015
BAI ≥ 26 (logistic regression)	1 (ref.)	1.4 [1.1 – 1.8]	1.9 [1.2 – 3.1]	2.7 [1.3 – 5.5]	3.7 [1.4 – 9.7]	0.007
CESD ≥ 16 (logistic regression)	1 (ref.)	2.0 [1.5 – 2.7]	4.0 [2.2 – 7.1]	7.9 [3.3 – 18.9]	15.7 [4.9 – 50.4]	0.000
At least one condition (logistic regression)	1 (ref.)	1.9 [1.4 – 2.4]	3.5 [2.0 – 5.9]	6.4 [2.9 – 14.4]	11.9 [4.1 – 35.0]	0.000
Number (0-3) of Conditions (linear regression)	0.310 [0.16 – 0.46]					0.000

living in their current US home for at least 10 years). Language of administration was neither a confounder nor an effect modifier in our multivariate regressions.

Another study limitation was the non-random selection of respondents within each household. Since this survey was part of a series of household surveys, it was not possible to alter the methodology, in order to maintain survey comparability and keep costs at expected levels. However, because the present analysis focused on classification by disaster exposure, which is likely to be shared by all members of a given household – the within-household selection bias is likely minimal. Moreover, the survey was introduced to participants as a general health survey, with no mention of earthquake-related or mental health questions. We cannot exclude selection bias due to non-responding households: 36% declined to participate and 10% were unreachable. Since ethnicity of households was assessed once the interview had started, we could not determine these rates among Haitians only. Nevertheless, non-response rate was in the low end of the range of health surveys [88-92], and non-response rate is a poor predictor of non-response bias [88,93-99].

Conclusions

While the dose-effect relationship between accumulated stress and poor mental health had been previously established among people directly exposed to a disaster, the current study shows that a similar dose-effect relationship can be found among those indirectly exposed. This group should therefore be evaluated for number of

stressful events when a disaster strikes, followed by mental-health surveillance, and possible service, when this number exceeds a threshold - e.g. 3 as suggested by this study. Further exploration of traumatic events accumulation in the production of psychopathology is needed in this group.

Ethical Standards

The study was approved by Florida International University (FIU) Internal Review Board. All participants gave an informed consent prior to their inclusion in the study.

References

1. Galea S, Nandi A, Vlahov D (2005) The epidemiology of post-traumatic stress disorder after disasters. Epidemiol Rev 27: 78-91.

2. Goldmann E, Galea S (2014) Mental health consequences of disasters. Annu Rev Public Health 35: 169-183.

3. Neria Y, Nandi A, Galea S (2008) Post-traumatic stress disorder following disasters: a systematic review. Psychol Med 38: 467-480.

4. Norris FH, Friedman MJ, Watson PJ, Byrne CM, Diaz E, et al. (2002) 60,000 disaster victims speak: Part I. An empirical review of the empirical literature, 1981-2001. Psychiatry 65: 207-239.

5. Norris FH, Friedman MJ, Watson PJ (2002) 60,000 disaster victims speak: Part II. Summary and implications of the disaster mental health research. Psychiatry Interpers Biol Process 65: 240-260.

6. North CS, Pfefferbaum B (2013) Mental health response to community disasters: A systematic review. JAMA 310: 507-518.

7. Ozer EJ, Best SR, Lipsey TL, Weiss DS (2003) Predictors of posttraumatic stress disorder and symptoms in adults: A meta-analysis. Psychol Bull 129: 52-73.

8. Warsini S, West C, Mills J, Usher K (2014) The psychosocial impact of natural disasters among adult survivors: An integrative review. Issues Ment Health Nurs 35: 420-436.

9. 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. J Trauma Stress 24: 44-53.

10. Chan CS, Rhodes JE (2014) Measuring exposure in Hurricane Katrina: a meta-analysis and an integrative data analysis. PloS One 9: e92899.

11. Jia Z, Tian W, Liu W, Cao Y, Yan J, et al. (2010) Are the elderly more vulnerable to psychological impact of natural disaster? A population-based survey of adult survivors of the 2008 Sichuan earthquake. BMC Public Health 10: 172.

12. Kun P, Tong X, Liu Y, Pei X, Luo H (2013) What are the determinants of post-traumatic stress disorder: age, gender, ethnicity or other? Evidence from 2008 Wenchuan earthquake. Public Health 127: 644-652.

13. Liu A, Tan H, Zhou J, Li S, Yang T, et al. (2006) An epidemiologic study of posttraumatic stress disorder in flood victims in Hunan China. Can J Psychiatry 51: 350-354.

14. Qu Z, Wang C-W, Zhang X, Ho AHY, Wang X, et al. (2014) Prevalence and determinants of depression among survivors 8 months after the Wenchuan earthquake. J Nerv Ment Dis 202: 275-279.

15. Gigantesco A, Mirante N, Granchelli C, Diodati G, Cofini V, et al. (2013) Psychopathological chronic sequelae of the 2009 earthquake in L'Aquila, Italy. J Affect Disord 148: 265-271.

16. Groome D, Soureti A (2004) Post-traumatic stress disorder and anxiety symptoms in children exposed to the 1999 Greek earthquake. Br J Psychol 95: 387-397.

17. Cairo JB, Dutta S, Nawaz H, Hashmi S, Kasl S, et al. (2010) The prevalence of posttraumatic stress disorder among adult earthquake survivors in Peru. Disaster Med Public Health Prep 4: 39-46.

18. Cerda M, Bordelois PM, Galea S, Norris F, Tracy M, et al. (2013) The course of posttraumatic stress symptoms and functional impairment following a disaster: what is the lasting influence of acute versus ongoing traumatic events and stressors? Soc Psychiatry Psychiatr Epidemiol 48: 385-395.

19. Frankenberg E, Friedman J, Gillespie T, Ingwersen N, Pynoos R, et al. (2008) Mental health in Sumatra after the tsunami. Am J Public Health 98: 1671-1677.

20. Galea S, Brewin CR, Gruber M, Jones RT, King DW, et al. (2007) Exposure to hurricane-related stressors and mental illness after Hurricane Katrina. Arch Gen Psychiatry 64: 1427-1434.

21. Hirth JM, Leyser-Whalen O, Berenson AB (2013) Effects of a major U.S. Hurricane on mental health disorder symptoms among adolescent and young adult females. J Adolesc Health 52: 765-772.

22. Hussain A, Weisæth L, Heir T (2013) Posttraumatic stress and symptom improvement in Norwegian tourists exposed to the 2004 tsunami--a longitudinal study. BMC Psychiatry 13: 232.

23. Kessler RC, Galea S, Gruber MJ, Sampson NA, Ursano RJ, et al. (2008) Trends in mental illness and suicidality after Hurricane Katrina. Mol Psychiatry 13: 374-384.

24. Osofsky HJ, Osofsky JD, Kronenberg M, Brennan A, Hansel TC (2009) Posttraumatic stress symptoms in children after Hurricane Katrina: Predicting the need for mental health services. Am J Orthopsychiatry 79: 212-220.

25. Shigemura J, Tanigawa T, Nishi D, Matsuoka Y, Nomura S, et al. (2014) Associations between disaster exposures, peritraumatic distress, and posttraumatic stress responses in Fukushima nuclear plant workers following the 2011 nuclear accident: the Fukushima NEWS Project study. PloS One 9: e87516.

26. Stige SH, Sveaass N (2010) Living in exile when disaster strikes at home. Torture 20: 76-91.

27. Yang P, Yen CF, Tang TC, Chen CS, Yang RC, et al. (2011) Posttraumatic stress disorder in adolescents after Typhoon Morakot-associated mudslides. J Anxiety Disord 25: 362-368.

28. John PB, Russell S, Russell PS (2007) The prevalence of posttraumatic stress disorder among children and adolescents affected by tsunami disaster in Tamil Nadu. Disaster Manag Response 5: 3-7.

29. Kun P, Chen X, Han S, Gong X, Chen M, et al. (2009) Prevalence of post-traumatic stress disorder in Sichuan Province, China after the 2008 Wenchuan earthquake. Public Health 123: 703-707.

30. Montazeri A, Baradaran H, Omidvari S, Azin SA, Ebadi M, et al. (2005) Psychological distress among Bam earthquake survivors in Iran: a population-based study. BMC Public Health 5: 4.

31. Wang L, Zhang Y, Wang W, Shi Z, Shen J, et al. (2009) Symptoms of posttraumatic stress disorder among adult survivors three months after the Sichuan earthquake in China. J Trauma Stress 22: 444-450.

32. Giannopoulou I, Strouthos M, Smith P, Dikaiakou A, Galanopoulou V, et al. (2006) Post-traumatic stress reactions of children and adolescents exposed to the Athens 1999 earthquake. Eur Psychiatry 21: 160-166.

33. Lai TJ, Chang CM, Connor KM, Lee LC, Davidson JR (2004) Full and partial PTSD among earthquake survivors in rural Taiwan. J Psychiatr Res 38: 313-322.

34. Lowe SR, Tracy M, Cerdá M, Norris FH, Galea S (2013) Immediate and longer-term stressors and the mental health of Hurricane Ike survivors. J Trauma Stress 26: 753-761.

35. Meewisse ML, Olff M, Kleber R, Kitchiner NJ, Gersons BP (2011) The course of mental health disorders after a disaster: predictors and comorbidity. J Trauma Stress 24: 405-413.

36. Smid GE, van der Velden PG, Lensvelt-Mulders GJ, Knipscheer JW, Gersons BP, et al. (2012) Stress sensitization following a disaster: a prospective study. Psychol Med 42: 1675-1686.

37. van den Berg B, Wong A, van der Velden PG, Boshuizen HC, Grievink L (2012) Disaster exposure as a risk factor for mental health problems, eighteen months, four and ten years post-disaster-a longitudinal study. BMC Psychiatry 12: 147.

38. van der Velden PG, Wong A, Boshuizen HC, Grievink L (2013) Persistent mental health disturbances during the 10 years after a disaster: Four wave longitudinal comparative study. Psychiatry Clin Neurosci 67: 110-118.

39. Zhang Y, Ho SM (2011) Risk factors of posttraumatic stress disorder among survivors after the 512 Wenchuan earthquake in China. PLoS One 6: e22371.

40. Karatsoreos IN, Karatoreos IN, McEwen BS (2013) Annual Research Review: The neurobiology and physiology of resilience and adaptation across the life course. J Child Psychol Psychiatry 54: 337-347.

41. Karatsoreos IN, McEwen BS (2011) Psychobiological allostasis: resistance, resilience and vulnerability. Trends Cogn Sci 15: 576-584.

42. Karatsoreos IN, McEwen BS (2013) Resilience and vulnerability: a neurobiological perspective. F1000prime Rep 5: 13.

43. McEwen BS, Seeman T (1999) Protective and damaging effects of mediators of stress. Elaborating and testing the concepts of allostasis and allostatic load. Ann N Y Acad Sci 896: 30-47.

44. Glover DA, Stuber M, Poland RE (2006) Allostatic load in women with and without PTSD symptoms. Psychiatry 69: 191-203.

45. Glover DA, Garcia-Aracena EF, Mohlman J (2008) Peripheral biomarker composite associated with smaller hippocampal volume. Neuroreport 19: 1313-1316.

46. Neria Y, DiGrande L, Adams BG (2011) Posttraumatic stress disorder following the September 11, 2001, terrorist attacks: A review of the literature among highly exposed populations. Am Psychol 66: 429-446.

47. Neria Y, Sullivan GM (2011) Understanding the Mental Health Effects of Indirect Exposure to Mass Trauma Through the Media. JAMA 306: 1374.

48. Messiah A, Acuna JM, Castro G, Rodríguez de la Vega P, Vaiva G, Shultz J, et al. (2014) Mental health impact of the 2010 Haiti earthquake on the Miami Haitian population: A random-sample survey. Disaster Health 2: 1-8.

49. Allen A, Marcelin LH, Schmitz S, Hausmann V, Shultz JM (2012) Earthquake Impact on Miami Haitian Americans: The Role of Family/Social Connectedness. J Loss Trauma 17: 337-349.

50. Marshall RD, Bryant RA, Amsel L, Suh EJ, Cook JM, et al. (2007) The psychology of ongoing threat: Relative risk appraisal, the September 11 attacks, and terrorism-related fears. Am Psychol 62: 304-316.

51. Neria Y, Wickramaratne P, Olfson M, Gameroff MJ, Pilowsky DJ, et al. (2013) Mental and physical health consequences of the September 11, 2001 (9/11) attacks in primary care: a longitudinal study. J Trauma Stress 26: 45-55.

52. Shultz JM, Besser A, Kelly F, Allen A, Schmitz S, et al. (2012) Psychological consequences of indirect exposure to disaster due to the Haiti earthquake. Prehosp Disaster Med 27: 359-368.

53. Smith LE, Bernal DR, Schwartz BS, Whitt CL, Christman ST, et al. (2014) Coping With Vicarious Trauma in the Aftermath of a Natural Disaster. J Multicult Couns Dev 42: 2-12.

54. FIU Herbert Wertheim College of Medicine (2012) Community Research Initiatives.

55. Blanchard EB, Jones-Alexander J, Buckley TC, Forneris CA (1996) Psychometric properties of the PTSD Checklist (PCL). Behav Res Ther 34: 669-673.

56. Freedy JR, Steenkamp MM, Magruder KM, Yeager DE, Zoller JS, et al. (2010) Post-traumatic stress disorder screening test performance in civilian primary care. Fam Pract 27: 615-624.

57. McDonald SD, Calhoun PS (2010) The diagnostic accuracy of the PTSD checklist: a critical review. Clin Psychol Rev 30: 976-987.

58. Beck AT, Epstein N, Brown G, Steer RA (1988) An inventory for measuring clinical anxiety: psychometric properties. J Consult Clin Psychol 56: 893-897.

59. Beck AT, Steer RA, Ball R, Ciervo CA, Kabat M (1997) Use of the Beck Anxiety and Depression Inventories for primary care with medical outpatients. Assessment 4: 211-219.

60. Steer RA, Beck AT (1997) Beck Anxiety Inventory. In: Zalaquett CP, Wood RJ (eds). Evaluating stress: A book of resources. Lanham, MD, US: Scarecrow Education 23-40.

61. Radloff LS (1977) The CES-D Scale A Self-Report Depression Scale for Research in the General Population. Appl Psychol Meas 1: 385-401.

62. Roberts RE (1980) Reliability of the CES-D Scale in different ethnic contexts. Psychiatry Res 2: 125-134.

63. IBM (2013) IBM SPSS Statistics.

64. Brewin CR, Andrews B, Valentine JD (2000) Meta-analysis of risk factors for posttraumatic stress disorder in trauma-exposed adults. J Consult Clin Psychol 68: 748-766.

65. Davidson TM, Price M, McCauley JL, Ruggiero KJ (2013) Disaster impact across cultural groups: comparison of Whites, African Americans, and Latinos. Am J Community Psychol 52: 97-105.

66. Kessler RC, McLaughlin KA, Koenen KC, Petukhova M, Hill ED (2012) The importance of secondary trauma exposure for post-disaster mental disorder. Epidemiol Psychiatr Sci 21: 35-45.

67. Neria Y, Olfson M, Gameroff MJ, Wickramaratne P, Gross R, et al. (2008) The mental health consequences of disaster-related loss: Findings from primary care one year after the 9/11 terrorist attacks. Psychiatry Interpers Biol Process 71: 339-348.

68. Neria Y, Shultz JM (2012) Mental health effects of Hurricane Sandy: characteristics, potential aftermath, and response. JAMA 308: 2571-2572.

69. Xu J, Zhang Y, Chan J, Li N, Yang Y, et al. (2011) A comparison of the acute stress reactions between the Han and Tibetan ethnic groups in responding to devastating earthquakes. Int J Psychiatry Med 42: 167-180.

70. Kobetz E, Menard J, Kish J, Bishop I, Hazan G, et al. (2013) Impacts of the 2010 Haitian earthquake in the diaspora: findings from Little Haiti, Miami, FL. J Immigr Minor Health 15: 442-447.

71. Staggs S (2013) Symptoms & Diagnosis of PTSD - Psych Central. Psych Central.com.

72. Desir C (2011) Diasporic Lakou: A Haitian Academic Explores Her Path to Haiti Pre- and Post-Earthquake. Harv Educ Rev 81: 278-296.

73. Desrosiers A, St. Fleurose S (2002) Treating Haitian patients: Key cultural aspects. Am J Psychother 56: 508-521.

74. Diaz J, Schneider R (2012) Globalization as retraumatization: Rebuilding Haiti from the spirit Up. J Soc Issues 68: 493-513.

75. James LE, Noel JR, Favorite TK, Jean JS (2012) Challenges of postdisaster intervention in cultural context: The implementation of a lay mental health worker project in postearthquake Haiti. Int Perspect Psychol Res Pract Consult 1: 110-126.

76. Keys HM, Kaiser BN, Kohrt BA, Khoury NM, Brewster AR (2012) Idioms of distress, ethnopsychology, and the clinical encounter in Haiti's central plateau. Soc Sci Med 75: 555-564.

77. McShane KM (2011) Mental health in Haiti: A resident's perspective. Acad Psychiatry 35: 8-10.

78. Nemeroff CB, Goldschmidt-Clermont PJ (2011) In the aftermath of tragedy: Medical and psychiatric consequences. Acad Psychiatry 35: 4-7.

79. Nicolas G, DeSilva AM, Grey KS, Gonzalez-Eastep D (2006) Using a multicultural lens to understand illnesses among Haitians living in America. Prof Psychol Res Pract 37: 702-707.

80. Nicolas G, Jean-Jacques R, Wheatley A (2012) Mental health counseling in Haiti: Historical overview, current status, and plans for the future. J Black Psychol 38: 509-519.

81. Onyango GR, Paratharayil M, van den Berg S, Reiffers R, Snider L, et al. (2011) Spirituality and psychosocial work in emergencies: Four commentaries and a response. Interv Int J Ment Health Psychosoc Work Couns Areas Armed Confl 9: 61-62.

82. Raviola G, Eustache E, Oswald C, Belkin GS (2012) Mental health response in Haiti in the aftermath of the 2010 earthquake: A case study for building long-term solutions. Harv Rev Psychiatry 20: 68-77.

83. Safran MA, Chorba T, Schreiber M, Archer WR, Cookson ST (2011) Evaluating mental health after the 2010 Haitian earthquake. Disaster Med Public Health Prep 5: 154-157.

84. Schafer A (2010) Spirituality and mental health in humanitarian contexts: An exploration based on World Vision Haiti earthquake response. Interv Int J Ment Health Psychosoc Work Couns Areas Armed Confl 8: 121-130.

85. Cerda M, Paczkowski M, Galea S, Nemethy K, Péan C, et al. (2013) Psychopathology in the aftermath of the Haiti earthquake: a population-based study of posttraumatic stress disorder and major depression. Depress Anxiety 30: 413-424.

86. Dévieux JG, Malow RM, Attonito JM, Jean-Gilles M, Rosenberg R, et al. (2013) Post-traumatic stress disorder symptomatology and alcohol use among HIV-seropositive adults in Haiti. AIDS Care 25: 1210-1218.

87. Martsolf DS (2004) Childhood Maltreatment and Mental and Physical Health in Haitian Adults. J Nurs Scholarsh 36: 293-299.

88. Davern M (2013) Nonresponse Rates are a Problematic Indicator of Nonresponse Bias in Survey Research. Health Serv Res 48: 905-912.

89. Mannetje A, Eng A, Douwes J, Ellison-Loschmann L, McLean D, et al. (2011) Determinants of non-response in an occupational exposure and health survey in New Zealand. Aust N Z J Public Health 35: 256-263.

90. Mindell J, Aresu M, Becares L, Tolonen H (2012) Representativeness of participants in a cross-sectional health survey by time of day and day of week of data collection. Eur J Public Health 22: 364-369.

91. Van der Heyden J, Demarest S, Van Herck K, De Bacquer D, Tafforeau J, et al. (2014) Association between variables used in the field substitution and post-stratification adjustment in the Belgian health interview survey and non-response. Int J Public Health 59: 197-206.

92. Van Loon AJM, Tijhuis M, Picavet HSJ, Surtees PG, Ormel J (2003) Survey non-response in the Netherlands: effects on prevalence estimates and associations. Ann Epidemiol 13: 105-110.

93. Davern M, McAlpine D, Beebe TJ, Ziegenfuss J, Rockwood T, et al. (2010) Are lower response rates hazardous to your health survey? An analysis of three state telephone health surveys. Health Serv Res 45: 1324-1344.

94. Groves RM (2006) Nonresponse rates and nonresponse bias in household surveys. Public Opin Q 70: 646-675.

95. Groves RM, Peytcheva E (2008) The Impact of Nonresponse Rates on Nonresponse Bias: A Meta-Analysis. Public Opin Q 72: 167-189.

96. Messiah A, Castro G, Rodríguez de la Vega P, Acuna JM (2014) Random sample community-based health surveys: does the effort to reach participants matter? BMJ Open 4: e005791.

97. Shlomo N, Skinner C, Schouten B (2012) Estimation of an indicator of the representativeness of survey response. J Stat Plan Inference 142: 201-211.

98. Stang A, Jockel KH (2004) Studies with low response proportions may be less biased than studies with high response proportions. Am J Epidemiol 159: 204-210.

99. Voigt LF, Boudreau DM, Weiss NS, Malone KE, Li CI, et al. (2005) Studies with low response proportions may be less biased than studies with high response proportions. Am J Epidemiol 161: 401-402.

Author Affiliations

[1]INSERM research unit U-1178 "Mental Health and Public Health", Research team IPSOM "Psycho trauma and Suicide in Overseas Territories", Villejuif, France

[2]PSYCHIC team CNRS, Lille University Hospital and the Universities of Lille, Lille, France

[3]Medico-Psychological Emergency Cell - Indian Ocean, Public Establishment of Mental Health of Reunion, Saint-Paul, Reunion Island, France

[4]Department of Psychiatry, University of Ottawa, Ottawa, Canada

[5]Department of Medical and Health Sciences Research, Herbert Wertheim College of Medicine, Florida International University, Miami, FL, USA