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

Antoine Messiah1*, Guillaume Vaiva1,2, Erick Gokalsing1,2, Raymond Tempier1,4, Naomie Jean1 and Juan M Acuna5

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 results for PTSD and depression, and showed that the prevalence of mental-health disorders peaks during the first year after the event, and then decreases progressively.

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-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

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:
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

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 |

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

<table>
<thead>
<tr>
<th>BES</th>
<th>TERSE</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0</td>
<td>1-2</td>
</tr>
<tr>
<td>No</td>
<td>134</td>
<td>0</td>
</tr>
<tr>
<td>%</td>
<td>32</td>
<td>0</td>
</tr>
<tr>
<td>Indirect</td>
<td>0</td>
<td>189</td>
</tr>
<tr>
<td>%</td>
<td>0</td>
<td>45</td>
</tr>
<tr>
<td>Direct</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>%</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Total</td>
<td>134</td>
<td>193</td>
</tr>
<tr>
<td>%</td>
<td>32</td>
<td>46</td>
</tr>
</tbody>
</table>

with TERSE, as follows: no exposure (0 events)/ indirect exposure, 1-2 events/ indirect exposure, 3-7 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 [3,46,47,50,67]. 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 (x≥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 [48,49,52,53,71], 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).

<table>
<thead>
<tr>
<th>Outcome</th>
<th>BES Direct vs. No BES</th>
<th>Number of stressful events</th>
<th>OR (logistic regressions) or slope coefficient (linear regression) [95% CI]</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0 (ref.)</td>
<td>1-2</td>
<td>3-4</td>
</tr>
<tr>
<td>PCLC ≥ 44</td>
<td>1</td>
<td>1.2 [0.8 – 2.1]</td>
<td>1.6 [0.6 – 4.2]</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1.9 [1.2 – 3.1]</td>
<td>3.8 [1.5 – 9.5]</td>
</tr>
<tr>
<td>BAI ≥ 26</td>
<td>1</td>
<td>1.3 [0.9 – 1.8]</td>
<td>1.7 [0.9 – 3.4]</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1.8 [1.2 – 2.6]</td>
<td>3.3 [1.6 – 6.6]</td>
</tr>
<tr>
<td>CESD ≥ 16</td>
<td>1</td>
<td>1.8 [1.3 – 2.6]</td>
<td>3.4 [1.7 – 6.8]</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2.3 [1.6 – 3.4]</td>
<td>5.3 [2.5 – 11.4]</td>
</tr>
<tr>
<td>At least one above condition</td>
<td>1</td>
<td>1.6 [1.2 – 2.2]</td>
<td>2.7 [1.4 – 5.0]</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2.2 [1.5 – 3.2]</td>
<td>4.9 [2.4 – 10.3]</td>
</tr>
<tr>
<td>(linear regression)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number (0-3) of above</td>
<td>Slope coefficient [95% CI]</td>
<td>0.16 [0.04 – 0.28]</td>
<td>0.33 [0.20 – 0.46]</td>
</tr>
<tr>
<td>conditions</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(linear regression)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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).

<table>
<thead>
<tr>
<th>Basic exposure status</th>
<th>No</th>
<th>Indirect</th>
<th>Direct</th>
<th>P value Total earthquake-related stressful events</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0</td>
<td>1-2</td>
<td>3-7</td>
<td>1-3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>N=125</td>
<td>N=193</td>
<td>N=64</td>
</tr>
<tr>
<td></td>
<td></td>
<td>N=19</td>
<td>N=19</td>
<td>N=12</td>
</tr>
<tr>
<td>PCLC ≥ 44 (logistic regression)</td>
<td>1 (ref.)</td>
<td>1.5 [1.1 – 2.0]</td>
<td>2.2 [1.2 – 4.2]</td>
<td>3.3 [1.3 – 8.6]</td>
</tr>
<tr>
<td>BAI ≥ 26 (logistic regression)</td>
<td>1 (ref.)</td>
<td>1.4 [1.1 – 1.8]</td>
<td>1.9 [1.2 – 3.1]</td>
<td>2.7 [1.3 – 5.5]</td>
</tr>
<tr>
<td>CESD ≥ 16 (logistic regression)</td>
<td>1 (ref.)</td>
<td>2.0 [1.5 – 2.7]</td>
<td>4.0 [2.2 – 7.1]</td>
<td>7.9 [3.3 – 18.9]</td>
</tr>
<tr>
<td>At least one condition</td>
<td>1 (ref.)</td>
<td>1.9 [1.4 – 2.4]</td>
<td>3.5 [2.0 – 5.9]</td>
<td>6.4 [2.9 – 14.4]</td>
</tr>
<tr>
<td>(logistic regression)</td>
<td></td>
<td>Number (0-3) of Conditions (linear regression)</td>
<td>0.310 [0.16 – 0.46]</td>
<td>0.000</td>
</tr>
</tbody>
</table>

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.

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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.

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