



Post-traumatic stress symptomatology and displacement among Hurricane Harvey survivors

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ABSTRACT

Exposure to natural disasters predisposes individuals to significant physical and mental health consequences. Research identifies a number of stressors important to determining what might exacerbate this exposure risk, as well as what types of social/psychological resources might help mitigate these negative outcomes. Using a targeted quota sample of adults ($n = 316$) interviewed two months after Hurricane Harvey made landfall on the Gulf Coast of Texas in August 2017, the present study examines the intersection of vulnerabilities, stressors, and resources and their relationship with post-traumatic stress symptomatology. Stress is high among this sampled group with over one-quarter of respondents reporting high enough symptoms to meet the clinical caseness criteria for PTSD. Results show significant variation across categorical groupings of post-traumatic stress symptoms; younger persons, nonwhites, and those displaced from their home during the storm were more likely to be found in the highest symptom count category. Regression results confirm the bivariate results and as hypothesized, stressors were associated with higher symptom reporting among respondents, and social and psychological resources were associated with lower symptom reporting. With one of the only studies to report these relationships between vulnerability, stressors, and resources in the post-disaster Harvey setting, our work underscores the importance of identifying who is at risk, what factors can potentially mitigate that risk, and just how severe the consequences can be for survivors requiring mental health services after a disaster. Clearly, more work is needed, particularly on the identification of resources acting as protection against the overwhelming circumstances of exposure to devastation and destruction caused by natural disasters.

1. Introduction

Hurricane Harvey made landfall in Rockport, Texas on August 25, 2017 and by the time it finally dissipated, more than 60 inches of rain had fallen with widespread flooding and destruction reported. Hurricane Harvey was certainly not a typical hurricane, but neither was 2017 a typical hurricane season. Harvey, Irma, and Maria would become household names and forever reshape the way scientists think about hurricanes, climate change, disaster, resilience, and recovery. The destruction brought about by Hurricane Harvey on the Texas Gulf Coast would make the record books—causing billions of dollars in damage, killing more than 100 people, and displacing hundreds of thousands of survivors who had to seek shelter from their homes (Blake and Zelinksky 2018; Fitzpatrick and Spialek 2020). Now, here it is more than three years after Harvey made landfall, and some survivors still have not rebuilt their homes or returned to their neighborhoods (Lozano 2020). The physical and economic damage caused by natural disasters is clear; however, the impact that exposure to these disasters has on survivor's

immediate mental health is a much harder toll to identify.

Natural disasters can create significant socio-emotional imbalance and upheaval among survivors. As such, this imbalance often requires our attention in order to advance not only a general understanding of how disasters impact well-being, but also the importance of developing programming to address disaster response and recovery to meet survivor's immediate and even long-term mental health needs. Although disaster exposure often is associated with multiple psychosocial consequences (e.g., depression, anxiety), post-traumatic stress is typically one of the most prevalent post-disaster, negative mental health outcomes (Dar et al., 2018; DeSalvo et al., 2007; Goldmann and Galea 2014; Norris et al. 2002a, 2002b; Pietrzak et al., 2012). Post-traumatic stress is also of particular interest to mental health disaster researchers because post-traumatic stress is the only disorder whose diagnosis is grounded in the experience of a specific, identifiable traumatic event (Bevilacqua et al., 2020; Goldmann and Galea 2014). While natural disasters typically do not differentiate who their victims will be, certain groups tend to be more vulnerable and experience disaster at varying levels of

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suffering (e.g. Galea et al., 2007; Kessler et al. 2006; Wyczalkowski et al., 2019).

Considerable research has documented the ill effects of natural disasters on survivor's physical and mental health (Bevilacqua et al., 2020; Bourque et al., 2006; Karaye et al., 2019; Cribbin-Lieberman et al., 2017; Neria and Schultz 2012; Paul et al., 2014; Pietrzak et al., 2012; Schwartz et al., 2018a, b). Both acute and chronic health consequences among survivors are part of the narrative in many coastal areas throughout the United States (e.g. Lowe et al., 2013; Norris et al. 2010; Schwartz et al., 2018a, b). Personal injury, loss of property, loss of employment, and loss of family and friends are also an important part of the survivor's story. The stress caused by these and other conditions place coastal residents at particularly high risk for exposure to circumstances like those caused by Hurricane Harvey, and as a result, directly impact their mental/physical health and overall well-being (e.g. Bevilacqua et al., 2020; Karaye et al., 2019). While the historical record is voluminous when it comes to documenting the mental health impact of natural disasters on survivors, very little research has emerged from the Harvey disaster setting and, to our knowledge, even fewer studies have documented the mental health fall-out among survivors, particularly as it pertains to post-traumatic stress symptomatology.

With an interest in documenting the health and well-being of Hurricane Harvey survivors, our specific goal is to help fill in this existing research gap by examining post-traumatic stress symptoms (PTSS) among a targeted quota sample of adult survivors (n = 316) that were interviewed less than two months after Hurricane Harvey hit the Texas Gulf Coast. Natural disasters create a level of stress that impact felt emotion, increase fear, and can upset the well-being balance among the exposed and vulnerable (Dodgen et al., 2016; Neria et al. 2008). The current study examines some of the stressors that can exacerbate the already negative circumstances people are experiencing during a natural disaster recovery. Additionally, we examine several social and psychological resources that may mitigate risk, and lessen the negative effects of risk on mental health consequences, specifically, post-traumatic stress.

2. Framing disaster consequences

We propose to build upon previous research regarding negative mental health outcomes like post-traumatic stress following a natural disaster, and extend the discussion by analyzing displacement pathways as a critical, but sometimes overlooked circumstantial risk factor impacting mental health. The current study utilizes a framework to examine both stressors and resources while underscoring the importance of the relationships among stressors that negatively impact health, and resources that often mitigate those negative health risks (Fitzpatrick and LaGory 2011). Using this strategy, our goal here is to first identify what, if any, social vulnerabilities place residents at heightened risk to experience mental health consequences because of who they are or where they live.

2.1. Social Vulnerabilities

While there are a few studies examining the intersection of these factors (Clay et al., 2018; Clay and Ross 2020; MacNabb and Fletcher 2019), the current study looks to expand our general understanding of the intersection of vulnerability, stressors, and resources and their impact on the mental health of survivors in a post-disaster setting. Research suggests that the more risks present in an individual's environment, the more likely they will report negative health outcomes (Fitzpatrick and LaGory 2011). A meta-analysis done by Norris et al. (2002a, 2002b) identified specific circumstances under which disasters are more likely to lead to negative mental health impacts, e.g., what risks are more likely to increase negative mental health outcomes. While research findings show considerable variation in vulnerability in the context of natural disasters, for adults, being female, younger, and a

member of a racial/ethnic minority group are often associated with negative mental health outcomes (e.g. Galea et al., 2007; Kessler et al., 2006; Norris et al., 1999; Norris et al. 2002a, 2002b). Given the findings from this body of literature, we expect to find some differences in reported post-traumatic stress symptomatology between certain socio-demographic groups. Racial and ethnic minorities, women, and younger residents often experience the aftermath of natural disasters differently than their counterparts—in part because of the already difficult circumstances that many of them are living in and the limited access to or stability in acquired resources because of the neighborhoods they live in. As such, we hypothesize that these socially and sometimes resource-challenged groups (young, Nonwhite, Hispanic, female) will have higher levels of reported post-traumatic stress symptoms compared to their white, non-Hispanic, male, and older counterparts.

2.2. Circumstantial Risk

Natural disasters create additional stressors often associated with negative mental health outcomes, either directly or indirectly. In the disaster literature, displacement has been noted as one of those stressors impacting the mental health of survivors. Displacement disrupts social networks, sources of medical care, and access to social services (Clay et al., 2018; Fullilove 1996; Karaye 2019; Schwartz et al., 2018a, b; Uscher-Pines 2009). DeSalvo et al. (2007) found that following Hurricane Katrina, there was a strong relationship between displacement and post-traumatic stress. Survivors of Katrina that were experiencing greater levels of post-traumatic stress had been displaced longer, had not returned to their pre-storm residence, and/or were currently living in temporary housing (i.e., trailer) (DeSalvo et al., 2007). Other researchers examining the impact of Hurricane Katrina found that displacement, which had the effect of scattering formal and informal social networks, was positively associated with post-traumatic stress (Morris and Deterding 2016; Schwartz et al., 2018a, b). After a natural disaster, displacement can be both an immediate as well as a long-term stressor. Some studies have shown that displacement, for as little as a week or more, was an immediate stressor that significantly correlated with post-traumatic stress (e.g. Lowe et al., 2013; Lowe et al., 2015; Tracy et al. 2011; Schwartz et al., 2018a, b). Building on this displacement literature, we hypothesize those persons leaving their residence prior to or during a disaster will report higher levels of post-traumatic stress symptoms than persons who stay behind in their residence.

2.3. Individual stressors

Researchers have argued that based on the type of disaster, severity, and level of exposure, individual-level mental health outcomes can vary (Norris et al. 2002a, 2002b; Tracy et al. 2011). Others researchers argue that the impact of disaster is less differentiated by the type of disaster and more as a function of the pre-disaster characteristics of the individual and community parameters (Bourque et al., 2006). Norris et al. (2002a, 2002b) found that when natural disasters were associated with widespread damage to property, ongoing financial problems, and high prevalence of trauma in the form of injury, threat to life, and/or loss of life, severe and chronic impairment were likely. This is further supported by research, which found that immediate stressors experienced by Hurricane Ike survivors contributed to longer-term post disaster psychological symptomatology (Lowe et al., 2013). We know that Hurricane Harvey caused widespread damage to property (Blake and Zelinsky 2018) and survivors were still experiencing financial struggles a year or more after the storm (Kaiser Family Foundation 2018.).

Previous disaster exposure has been shown to play a significant role in determining the current mental health symptomatology among disaster survivors. Research by Pietrzak et al. (2012) found that persons experiencing traumatic events prior to Hurricane Ike was an important predictor in determining post-traumatic stress assessed after Hurricane Ike. Studies find that previous disaster-focused life events were highly

correlated with current post-traumatic stress in the form of higher avoidance, intrusion, and arousal (Norris et al., 1999; Paul et al., 2014; Schwartz et al., 2018a, b). Given this earlier work, *we expect survivors with previous disaster exposure will report higher levels of post-traumatic stress symptomatology compared to those with limited or no previous disaster exposure.*

Natural disasters often cause widespread destruction, leaving the physical environment of a community damaged and its individuals vulnerable to social and economic-related trauma (Wyczalkowski et al., 2019). Using data collected following Hurricane Ike, researchers found that the most common hurricane experience reported by survivors was loss of or damage to personal property, which encompassed 86 percent of their sample (Tracy et al. 2011). Research shows that the immediate damage caused by the disaster is both significantly associated with immediate post-traumatic stress as well as long-term post-traumatic stress caused in part by the continuous financial struggle that many survivors experience (Lowe et al. 2013, 2015; Paul et al., 2014; Tracy et al. 2011). Following Hurricane Andrew, researchers found that the post-traumatic stress symptoms (intrusion and arousal) were more strongly influenced by disaster-related stressors like property damage (Norris et al., 1999). Others have found considerable support for the relationship between post-traumatic stress and levels of damage to individual's residence in a variety of disaster settings (David et al., 1996; Fussell and Lowe 2014; Lowe et al., 2015; Norris and Kaniasty 1996). Given these earlier findings, *we expect that survivors reporting greater levels of current damage to their residence will report more post-traumatic stress symptomatology compared to those survivors reporting little or no damage to their residence.*

A final stressor that may be linked to post-disaster mental illness is pre-disaster mental health problems. Because history of mental health may predict future mental health problems, it is conceivable that individuals with mental health problems, regardless of their severity, prior to a disaster are at greater risk of having psychological symptoms after the disaster, compared with other disaster survivors (Goldmann and Galea 2014; Norris et al. 2002a, 2002b). Morris and Deterding (2016) examined how poor mental health before Hurricane Katrina increased susceptibility to post-traumatic stress, in which they found baseline psychological distress significantly predicted the likelihood of post-traumatic stress. Studies that assessed the pre- and post-disaster psychological distress of Hurricane Katrina survivors, found that pre-Katrina mental health was a significant component in determining psychological distress (e.g. Fussell and Lowe 2014; Sullivan et al., 2013). Given these findings from earlier disaster research, *we hypothesize that survivors with previous mental health problems will report more post-traumatic stress symptomatology compared to those reporting few or no prior mental health problems.*

2.4. Social and psychological resources

Research strongly supports the idea that individuals can be protected, or shielded, from certain negative outcomes when accessing a variety of social and psychological resources. Social resources are based on the individual's social networks, while psychological resources are based more on the individual and their internal/felt characteristics and their ability to cope and manage unusually high levels of stress. Research clearly highlights the finding that when higher social support is reported, whether actual or perceived, lower negative health consequences (mental health) are the result (Acierno et al., 2006; Lin et al. 1986; Nillni et al., 2013; Pearlin et al., 1981; Thoits 1995). Even some disaster studies have found that perceived social support/social ties was negatively associated with mental health consequences (e.g. Acierno et al., 2006; Dar et al., 2018; Zhen et al. 2018). While these studies operationalize social support differently than we do here, they nevertheless demonstrate the potential role that social support/ties may play in mitigating the negative risks on post-traumatic stress. As such, *we hypothesize that survivors with higher perceived social support (ties) will report fewer post-traumatic stress symptoms compared to persons reporting a*

lower perception of support/social ties.

One psychological resource that might help mitigate the negative effects of trauma exposure on post-traumatic stress is mastery of fate. The mastery of fate scale, as determined by Pearlin and Schooler (1978), assesses how strongly a respondent believes they are in control of their own life course. An individual's perception of how much control they have over the things in their lives can act as a mediator against negative mental health outcomes because it potentially augments an individual's ability to cope with stressful demands (Thoits, 2010). Research also suggests that mastery supports individual level resilience and is linked to declines in negative mental health outcomes like post-traumatic stress (Pietrzak et al., 2012). Furthermore, the belief that one can exert control over stressful life events can act as an effective coping mechanism for stress (Taylor and Aspinwall 1996). In the context of this earlier work, *we hypothesize survivors with higher levels of mastery of fate will report fewer posttraumatic stress symptoms compared to their counterparts with lower mastery of fate.*

A final psychological resource with health-relevant implications and linked to resisting stress, is optimism (Taylor and Aspinwall 1996). Research has shown that optimism influences the maintenance of positive mood among people that are managing severe stressors (Scheier and Carver 1985). Additionally, optimism has been shown to indicate active and complex coping strategies, alongside seeking social support (Scheier and Carver 1985). Optimism influences psychological well-being, for example, people who were optimistic about their health were interested in obtaining more information regarding health risk (Aspinwall and Brunhart 1996). Optimism has also shown to predict depressive symptoms and coping (Taylor and Aspinwall 1996), which may also be related to predicting post-traumatic stress. While optimism has not been used to our knowledge in disaster literature examining post-traumatic stress, it has been used in other disaster research that reports a significant relationships between optimism, hope and health-related quality of life among disaster survivors (e.g. Cherry et al., 2017; Suls 2013; Van der Velden 2007). Because of the findings reported in previous literature, *we hypothesize that survivors with higher levels of optimism will report fewer posttraumatic stress symptoms compared to their counterparts.*

3. Data and methods

3.1. Participants

This study is based on data collected in Fall 2017. The analysis is of a sample of 316 interviews with Hurricane Harvey survivors, selected from locations along the coast, that were part of FEMA's damage estimates targeting those counties with the most reported damage (Brazoria, Galveston, Harris, Jefferson, and Nueces). To obtain a sample that would mirror these counties and their population characteristics, each county's total population estimates were determined and the largest cities within these counties were selected for targeted sampling. A percentage of participants to be selected from each city was determined by comparing the overall percentage of persons directly or indirectly impacted by Hurricane Harvey according to FEMA. Of those interviews, the goal was to obtain an even gender distribution, as well as a distribution that reflected racial and ethnic compositions of the counties. Based on these targets, we estimate that the demographic breakdown of the sample was largely representative.

To help to clarify our sampling strategy, we provide an example of how decisions were made about interview locations and potential respondents for interview selection. For example, Brazoria County, with its total city populations of approximately 167,000, represented about 5 percent of the total number of persons based on the 3.5-million-person FEMA estimate of persons that had been directly or indirectly impacted by the storm. Representing 5 percent of the total interviews, we estimated at least 14 interviews would need to be secured from this county if we were keeping with our proposed target of 300–350 total interviews. Alvin, Lake Jackson, and Pearland were specific city targets

within Brazoria County, though interviews came from persons living elsewhere in the county and outside of those city limits. In addition, we added other requirements with regards to which 14 persons could be selected for interviews. First, we had to ensure a reasonable gender distribution (preferably 50/50), as well as a distribution that reflected the racial and ethnic composition of the counties that we were focusing on. To simplify matters, we focused on obtaining white vs. nonwhite interviews, and then once we determined the concentration of Hispanics in each one of the targeted cities, we included that into our final computations of how many nonwhite interviews we would need to target. Again, in the Brazoria County example, where 88 percent of the county was white, the targets would be 9 white respondents, leaving the remaining 5 interviews to be nonwhite and since 30 percent of Brazoria County was Hispanic that would mean of the 5 nonwhite target interviews, (2) interviews would need to be Hispanic. We targeted 7 males and 7 females.

Here is how things actually worked when it came to interviewee selection. The data that was collected for Brazoria County included 25 total interviews (our original target was a minimum of 14). The percentage of women was 60 percent (the original target was 50 percent). The racial and ethnic targets were pretty precise; 88 percent of interviews were white which was the current percentage of white residents in Brazoria County. We needed at least a third of nonwhite respondents to be Hispanic and we managed to get 21 percent of Hispanic interviews. Finally, interviews were divided into groups where: those not having to move from their residence (58 percent), and the remaining respondents who were displaced (42 percent), divided across the other displacement options. Keep in mind that these represented targeted estimates, and in some cases, we were successful in reaching the targets, in other cases, we were not. A similar strategy was used for the collection of the online survey responses. We invoked strict parameters for participation and if persons fit in the pre-determined quotas they were allowed to participate in the survey. [Appendix A](#) provides an overview of county demographic estimates and actual completed targeted surveys.

Once the targeted sampling was established, several outreach methods were used to structure the interviewing process. The first approach was to survey respondents using face-to-face interviewing. Researchers interfaced with local shelters, hotels/motels receiving vouchers from FEMA, service providers and obtained access that led to approximately one hundred face-to-face interviews being completed. The second approach was to collect surveys using Qualtrics, Inc. Qualtrics, a national survey research firm, used an identical survey and built a series of selection protocol questions requiring potential survey respondents to meet specific criteria in order to participate. First, surveys were sent out to households only in the targeted zip codes that were part of FEMA's county estimates receiving the highest levels of damage. Then, potential respondents were asked a series of sociodemographic questions to help ensure a representative sample; two hundred and twenty interviews were secured using this online platform.

3.2. Measurement

Post-Traumatic Stress Symptomatology. We measure post-traumatic stress symptomology (PTSS) using the Impact of Event Scale-Revised (IES-R), a twenty-two-item self-report measurement that assesses subjective levels of stress from traumatic events ([Weiss and Marmar 1996](#)). The IES-R ranks responses to a series of questions on a five-point scale coded from 0 = not at all to 4 = extremely, targeting how respondents felt in the last few weeks. Summing the twenty-two item responses into a composite/index creates the scale that we use in the analysis. The literature categorizes the scale from zero to eighty-eight with scores of 24 or greater as "concerning" and scores 33 or higher as representing the best cutoff for a probable diagnosis of PTSD ([Asukai et al., 2002](#); [Creamer et al., 2002](#)). The PTSS scale was normally distributed with a skewness value < 1 and two normality significance tests

(Kolmogorov-Smirnov and Shapiro-Wilk) both confirming a normal distribution for this variable ([Yap and Sim 2011](#)). The PTSS scale was reliable with Cronbach's $\alpha = 0.97$.

Social Vulnerabilities. A number of social vulnerabilities have been documented in previous research when examining the relationship between post-traumatic stress and disasters ([DeSalvo et al., 2007](#); [Fussell and Lowe 2014](#); [Galea et al., 2007](#); [Lowe et al. 2013, 2015, 2016](#); [Morris and Deterding 2016](#); [Norris et al., 1999](#); [Pietrzak et al., 2012](#); [Tracy et al. 2011](#)). For the purposes of the present analysis, we include gender (male = 1); white/nonwhite race dichotomy (White = 1); Hispanic status (yes = 1) and age coded in years. Other potential control variables (confounders) were considered but none of those variables were particularly relevant to the current examination of post-traumatic stress. Nevertheless, we did examine some of those in a preliminary analysis (education, employment status, marital status and income) where none of these potential confounders were significant and none of them were central to the overarching framework of interest.

Circumstantial Risk. While previous research does not define displacement as a circumstantial risk, multiple studies have utilized displacement as a variable of interest ([Acierno et al., 2006](#); [DeSalvo et al., 2007](#); [Lowe et al. 2013, 2015, 2016](#); [Tracy et al. 2011](#); [Schwartz et al., 2015](#)). In the current data on Harvey survivors, the largest portion of the sample stayed home (55%), followed by staying in a shelter or currently homeless (24%), staying with a friend or relative (15%), or staying in a hotel/motel (5%). Preliminary ANOVA and multiple comparison tests (not shown here) revealed only significant differences between survivors that stayed in their residence compared to those that left. There were no significant differences in PTSS between survivors that had left and followed different pathways. Thus, we recoded and constructed a dichotomous variable—stayed at home = 0 and persons who left = 1.

3.3. Individual risk variables

Disaster Exposure. A considerable literature has demonstrated a positive relationship between levels of previous disaster exposure individuals experience and levels of post-traumatic stress symptomology following another disaster ([Acierno et al., 2006](#); [Goldmann and Galea 2014](#); [Lowe et al., 2015](#); [Norris et al., 1999](#); [Schwartz et al., 2018a, b](#)). This measure of disaster exposure was measured using a four-item scale where responses to a series of questions were coded as 0 = no; 1 = yes; and 2 = more than once. Participants were asked if they had experienced any of the following as a result of a natural disaster that they experienced prior to Hurricane Harvey: 1) perceived threat to life, 2) household property damage, 3) loss of things having personal significance or sentimental value, and 4) heard of someone in your community who had been injured or killed during a disaster. The responses to the four items were summed to create a previous disaster exposure scale, where scores ranged from 0 to 8 and the scale was reliable with a Cronbach's $\alpha = 0.70$.

Current Property Condition. Property damage is so widespread during a disaster and supported throughout the literature as a stressor related to post-traumatic stress ([Lowe et al. 2015, 2016](#); [Norris et al., 1999](#); [Tracy et al. 2011](#); [Wyczalkowski et al., 2019](#)). This measure assesses current condition of the participant's residence as a result of the storm damage. Participants ranked the level of damage their residence received on a 5-item Likert scale including: 1 = no damage; 2 = mild damage; 3 = moderate damage; 4 = severe damage; or 5 = totally destroyed.

Prior Mental Health Status. Since prior mental health has been shown to increase risk for post-traumatic stress for disaster survivors, we assess the variable prior mental health as a risk variable ([Fussell and Lowe 2014](#); [Goldmann and Galea 2014](#); [Lowe et al., 2013](#); [Morris and Deterding 2016](#); [Norris et al. 2002a, 2020b](#)). To measure pre-disaster mental health, respondents were asked, "if they ever had problems with mental illness or nerves" and the variable was coded as 1 = yes.

3.4. Social and psychological resource variables

Social Ties. As measure of social resources, the strength of social ties can act as a resource, potential mitigator, from the stress caused by living through a disaster and the potential risk(s) that survivors are exposed to. Survivors were asked how often they had felt bothered by three problems: 1) having no close companion, 2) not having enough friendships, and 3) not seeing enough people that you feel close to. To measure strength of social ties, we used these three-items to create a scale using the following responses to those three questions: 1 = most or all of the time, 2 = occasionally or a moderate amount of time; 3 = some or a little of the time; 4 = rarely; and 5 = never, with higher scores indicating that respondents have no problems with their social relationships. The three items were averaged to create the strength of social ties scale, where scores ranged from 3 to 15, with the average respondent reporting they had felt bothered by these problems at least “some or a little of the time” (Lin et al. 1986). This scale has been validated in a variety of work examining the mitigating role of social ties and their impact on mental health outcomes (e.g. Fitzpatrick 2016; Thoits, 2006). The variable was reliable with a Cronbach’s $\alpha = 0.85$.

Mastery. The mastery of fate scale was used to measure how confident respondents feel in their ability to determine their own life course (Pearlin and Schooler 1978). Individual’s perceptions of one’s own destiny can act as strong resource to mitigate the negative effects of risks. To measure mastery of fate, we used a seven-item scale coded using 1 = strongly agree to 4 = strongly disagree, with higher scores indicating they have a high psychological sense of being in control of their own life. The participants were asked: 1) you have little control over things that happen to you, 2) there is really no way that you can solve some of the problems that you have, 3) there is little you can do to change many of the important things in your life, 4) you often feel helpless in dealing with problems in life, 5) you can do just about anything you set your mind to, 6) sometimes you feel you are being pushed around, and 7) what happens in the future depends mainly on you. The seven item responses were averaged to create the scale; scores ranged from 7 to 27. The variable was moderately reliable with a Cronbach’s $\alpha = 0.63$.

Optimism. Because optimism has shown to mitigate the effects of stress (e.g. Scheier and Carver 1985; Taylor and Aspinwall 1996), we measured optimism using the Life Orientation Test-Revised (LOT-R) ten-item scale (Scheier et al. 1994). This scale has been examined extensively both in clinical and non-clinical settings (Carver et al. 2010), but has not been examined, to our knowledge, in a post-disaster analysis of survivor’s PTSS. The responses were coded as 1 = strongly agree to 4 = strongly disagree with higher scores indicating higher levels of optimism. The participants were asked: 1) in uncertain times, I usually expect the best, 2) it’s easy for me to relax, 3) if something can go wrong for me it will, 4) I’m always optimistic about my future, 5) I enjoy my friends a lot, 6) it’s important for me to keep busy, 7) I hardly ever expect things to go my way, 8) I don’t get upset too easily, 9) I rarely count on good things happening to me, and 10) I expect more good things to happen to me than bad things. The ten items were averaged to create the optimism scale, where scores ranged from 14 to 50. The scale was reliable with a Cronbach’s $\alpha = 0.78$.

3.5. Analytical strategy

The analysis begins with an examination of the sample descriptives. Additionally, in order to better understand the variation of PTSS across socially vulnerable groups, stressors and resources, we examine a series of bivariate relationships between categories of PTSS scores and categorical variables (e.g. gender, race, prior mental health status etc.), and between categories of PTSS scores and continuous level variables (e.g. previous disaster exposure, social ties, optimism etc.). For the categorical variables, we provide percentages of survivors found in each of the PTSS groups and these cross tabular differences are tested using a

standard χ^2 . In the case of continuous variables, we provide the mean scores for survivors in each category of PTSS and these mean differences are tested in a one-way ANOVA using a standard *F*-test. The goal of this part of the analysis is to provide some descriptive and bivariate overview of the variables and their relationship, particularly to the PTSS outcome variable. The final part of the analysis is a multiple linear regression used to examine four models comprising all of the hypothesized independent variables, including social vulnerability variables, circumstantial risk, individual stressor variables, and resource variables. Both unstandardized (*b*) and standardized (*B*) are included in the table along with a 95% confidence interval that provides evidence of statistical significance. The goal for the regression segment of the analysis is to examine both the group and individual variable effects and their specific relationship to PTSS among Hurricane Harvey survivors.

4. Results

4.1. Descriptive statistics

As shown in Table 1, the average level of post-traumatic stress symptomatology among surveyed respondents was 21.2 on a scale ranging from 0 to 88. Our circumstantial risk variable, which examined survivors being displaced compared to those that stayed home, found 42 percent of the sample elected or were forced to leave their residence before or during the storm.

The sample was approximately 47 percent male, 71 percent White, and 29 percent Hispanic, which is generally representative of the racial and ethnic composition of the high-disaster counties that were sampled (see Appendix A). The average age of respondents was slightly older (42 years) than the general population. Some residents experienced no damage (28.8 percent) or mild levels of damage (28.2 percent), while a near equal percentage of survivors reported experiencing moderate (17.1 percent) to severe damage (18.7 percent), and a smaller percent having their property totally destroyed (6.0 percent). The dichotomous mental health problems variable indicated that slightly more than half of those sampled reported having previous problems with mental illness or nerves.

Turning to Table 2, we examine the bivariate relationships with the model variables and the three designated categories of PTSS. The first

Table 1
Descriptive statistics for model variables (n = 316).

Dependent Variable	%	Mean	S.D.
Post-Traumatic Stress (0–88)	–	21.2	20.2
Social Vulnerabilities			
Gender (1 = Male)	47.2%	–	–
Age	–	41.9	14.7
Race (1 = White)	71.5%	–	–
Hispanic (1 = Yes)	29.0%	–	–
Circumstantial Risk			
Displacement (1 = Left)	42.0%	–	–
Individual Risks			
Previous Disaster Exposure Scale (0–8)	–	1.5	1.6
Current Property Condition (1–5)			
- No Damage	29.2%	–	–
- Mild Damage	28.5%	–	–
- Moderate Damage	17.3%	–	–
- Severe Damage	18.9%	–	–
- Totally Destroyed	6.1%	–	–
Prior Mental Health Problems (1 = Yes)	52.3%	–	–
Social and Psychological Resources			
Strength of Social Ties (3–15)	–	10.5	3.7
Mastery of Fate (7–27)	–	17.5	3.2
Optimism (14–50)	–	34.1	6.1

Table 2
Mean PTSD scores and bivariate associations between PTSD categories and model variables (n = 316).

PTSD Range	(Number of Cases)				<i>p</i> ^a
	Mean PTSD	<24	24–32	33+	
	21.2	(192)	(40)	(84)	
Social Vulnerabilities					
Gender					
Male	21.1	48%	40%	50%	.562
Female	21.3	52%	60%	50%	
Age					
–	–	43.4	41.9	38.4	.039
Race					
White	18.9	79.1%	55.0%	23.7%	.002
Nonwhite	27.0	20.9%	45.0%	76.3%	
Hispanic Origin					
Hispanic	24.1	26.5%	17.5%	38.7%	.033
Non-Hispanic	20.2	73.5%	82.5%	61.3%	
Circumstantial Risk					
Displacement Left					
Stayed	28.9	32.9%	48.7%	62.3%	.000
	16.0	67.1%	51.3%	37.7%	
Individual Stressors					
Previous Disaster Exposure					
–	–	1.4	1.3	2.0	.067
Current Property Condition					
–	–	2.2	2.9	2.9	.000
Prior Mental Health Problems					
Yes	25.7	65.4%	55.0%	51.5%	.166
No	18.8	34.6%	45.0%	48.5%	
Social and Psychological Resources					
Strength of Social Ties					
–	–	11.2	10.2	9.1	.001
Mastery of Fate					
–	–	18.2	17.5	15.4	.000
Optimism					
–	–	34.7	34.9	32.3	.005

^a χ^2 analysis was used to test for differences between categorical variables and PTSD groupings, and one-way ANOVA (*F-test*) was used to test for differences between continuous variables and PTSD groupings.

PTSS category represents the majority of persons who scored less than 24 on the IES-R and were considered to be of non-clinical interest. The second category, persons scoring between 24 and 32 on the IES-R, were of clinical concern and had scores high enough that would require a closer examination for further diagnosis. The final category, persons scoring 33 and above, represented persons in a category that is often used as a cutoff for probable diagnosis of PTSD. The percentage of persons in each of the categorical variables are presented with a test of categorical differences (χ^2), or in the case of continuous variables and the differences in means that are presented, a one-way ANOVA (*F-test*), examines differences across PTSS categories for the continuous vulnerability, stressor, and resource variables.

Among the vulnerability variables, younger persons were more likely to be found in the higher diagnostic category, as were Nonwhites, and persons who were displaced from their homes ($p < 0.05$). There were no significant differences in distributions across PTSS categories between males and females, or persons with or without prior mental health problems. The circumstantial risk variable showed a significant difference between those persons staying and those persons that were forced to leave in the highest PTSD symptom category—almost twice as many reported symptoms in excess of 33 that were forced to or decided to leave their home (62.3%), compared to those that stayed behind (37.7%). Persons reporting previous disaster exposure and current property damage were more likely to be in the higher PTSS category (33+) compared to those with no previous disaster exposure or limited property damage. There were no significant differences between survivors' with/without prior mental health problems and post-traumatic stress symptoms. In the case of the social and psychological resources, there were on average lower scores in the higher symptom categories than in the lower symptom categories. All of these differences across groups were significant at the $p < 0.05$ level and in all three cases, lower numbers of resources were found in categories with higher symptom

reporting.

The regression results are found in Table 3 where four models are introduced that assess a set of social vulnerability, circumstantial risk, individual stressor, and social/psychological resource variables and their relationship with PTSS. In model 1, we examine the relationship between social vulnerabilities and PTSS. Younger respondents ($B = -.16$) and Nonwhites ($B = -0.17$) reported lower PTSS symptoms compared to older and White respondents. Neither gender nor Hispanic status was significant in the first model. Model 2 adds the circumstantial risk variable and as hypothesized, there is a positive relationship between displacement ($B = 0.26$) and PTSS with persons who left their residence before or during the storm, reported higher PTSS than those persons who stayed in their place. Model 3 adds the individual stressors and except for prior mental health problems, individual stressors are positive and significantly related to PTSS; persons reporting more damage to their property ($B = 0.20$) and those persons reporting previous disaster exposure ($B = 0.13$) had higher PTSS levels than their counterparts. Finally, in Model 4, we added the social and psychological resource variables and as earlier hypothesized, persons reporting higher perceived social ties ($B = -0.14$), and greater mastery of fate ($B = -0.26$) reported fewer PTSD symptoms. Optimism was not significantly related to PTSS. All of the models at each successive stage were statistically significant (*F-test*; $p < 0.000$) and in each successive model, a significant change in R^2 was noted with a final $R^2 = 0.26$ found in Model 4. The largest individual effects (as noted by the size of the standardized regression coefficients) for the final model were age, property condition and mastery of fate. While some of the size of the standardized regression coefficients was somewhat smaller in the final model, no variable switched signs, lost statistical significance, or changed in size that much once additional factors were added.

5. Discussion

The current analysis highlights significant relationships among social vulnerability, circumstantial risk (displacement), individual stressors, social/psychological resources, and PTSS for our sample of Hurricane Harvey survivors. Even after introducing displacement, stressors, and resource variables, younger, nonwhite survivors reported higher levels of PTSS than their older, White counterparts. These findings are similar to what others report regarding the vulnerability of particular population subgroups to the negative circumstances of natural disasters across the country over the last thirty years (e.g. Schwartz et al., 2015, Schwartz et al., 2018a, b). As we argued earlier, natural disasters do not impact population groups equally. Disasters often hit the socially vulnerable hardest—those living in flood prone neighborhoods, with limited social and psychological resources, along with prior exposure and experience with disasters is a lethal combination for many residents, our survivors were no different.

As hypothesized, stressors were related to higher self-reporting of PTSS and resources were related to lower self-reporting of PTSS. While much of our work aligns with the findings from earlier mental health disaster research, despite the fact that a large number of survivors responded affirmatively to having prior mental health problems, the absence of a significant effect regarding this particular variable is an anomalous finding. Previous research highlights the importance of pre-disaster mental health complications as a consistent and strong predictor of post-disaster symptomatology (Paul et al., 2014; Schwartz et al., 2018a, b). We can only assume that the single-item question about whether or not individuals had experienced problems related to their nerves or mental illness prior to Hurricane Harvey was not nearly as robust or adequate to capture the nuance of this relationship.

We also find that, as hypothesized, resources were related to persons reporting lower PTSS. While a large number of studies typically focus only on risk and vulnerability as it relates to disaster, our work aligns with those studies that have tried to explore the protective mechanisms at work during a disaster (e.g. Dar et al., 2018; Pietrzak et al., 2012)

Table 3
Post-traumatic stress symptomatology multiple regressions (n = 316).

Model Variables	Model 1		Model 2		Model 3		Model 4	
	b	(β)	b	(β)	b	(β)	b	(β)
Social Vulnerabilities								
Gender (1 = Male)	-1.1	(-.03)***	-.17	(-.01)***	-.87	(-.02)***	-.45	(-.01)
Age	-.22	(-.16)**	-.19	(-.14)**	-.24	(-.18)**	-.19	(-.14)**
Race (1 = White)	-7.7	(-.17)**	-4.9	(-.11)*	-3.1	(-.07)	-4.0	(-.09)*
Hispanic Status (1 = Non-Hispanic)	-1.0	(-.02)***	-1.4	(-.03)	-2.0	(-.07)	-2.8	(.05)
Circumstantial Risk								
Displacement (1 = Left)			10.7 (.26)**		8.3 (.20)**		5.4 (.13)**	
Individual Stressors								
Previous Disaster Exposure					1.6 (.13)*		1.3 (.10)*	
Current Property Condition					3.3 (.20)**		3.9 (.25)**	
Prior Mental Health Problems (1 = Yes)					.67 (.03)		.35 (.01)	
Social and Psychological Resources								
Strength of Social Ties							-.78 (-.14)**	
Mastery of Fate							-1.7 (-.26)**	
Optimism							.01 (.01)	
Constant	37.49		28.30		20.12		55.17	
Adjusted R ²	.06		.10***		.16***		.26***	

One-tailed t-tests $p < 0.05^*$; $p < 0.01^{**}$; R^2 Change $p < 0.001^{***}$ b = unstandardized coefficient; β = standardized coefficient.

Specifically, what factors, if any, might help to lower some of the negative mental health consequences or even mitigate negative risks? Their independent effects, the relationship between social ties and PTSS and mastery of fate and PTSS, were both significant and negative. Social and psychological resources matter and future research on natural disasters should consider more comprehensive analyses that would help to uncover precisely what protects survivors from exposure to the negative risks in a post-disaster setting.

5.1. Study limitations

While our work provides important insights into the post-disaster mental health complexities faced by Hurricane Harvey survivors, there are some limitations to this work. One, this is a cross-sectional study. Much of the work on the mental health sequelae of survivors in natural disaster settings requires longitudinal work. While prohibitive in the case of the current study, we nevertheless acknowledge how important this research strategy can be and how our data limits any effort to directly attach causality to the findings linking external stressors to mental health consequences. Two, while every effort was made to construct a representative sample of disaster survivors, there are a number of shortcomings that impacted the composition of the final sample. Survivors are mostly about surviving and often are not ready to sit down in the midst of recovery to answer a lengthy questionnaire, thus finding compliant survivors and a diverse pool of survivors is not always easy to do in a disaster zone. We relied heavily on a variety of service providers to help us gain access to a diverse pool of survivors that were staying in shelters, hotels, or accessing their services. While targeting particular groups to acquire representative quotas, we were able to secure some of those quota targets, yet in other cases were unable to obtain an adequate number of participants from certain groups. Our sample was slightly under representative of people living in more rural areas, lower incomes, and some racial groups like Asian-Americans and Native Americans. Nevertheless, we have a reasonably diverse group of respondents that adequately represent gender, white/nonwhite differences, Hispanic origin, and geographic locale of survivors in the sampled counties across the Texas Gulf Coast. Finally, the limitations of our survey strategy and working in a disaster zone, meant that a number of important indicators were overlooked, full batteries of questions were not asked, and by design, a limited number of stressor and resources

variables could be examined. Our results are certainly noteworthy and add to a voluminous literature on the mental health consequences of natural disasters. They are, however, findings unique to a particular part of the United States (Texas Gulf Coast), and a particular group of disaster survivors. Thus, generalizing our findings should be done with the caution and care that we typically do when integrating unique findings from a single study into a larger body of research.

6. Conclusion

Despite these and other limitations, our research provides some of the first comprehensive analyses related to the intersection of vulnerabilities, stressors, resources and PTSS in the post-disaster Harvey setting. With adequate representation of survivors across the coastal cities, this work provides much needed data on who is vulnerable, why they are vulnerable, and at what level they experience vulnerability, particularly in the context of PTSS. Work that provides some insight into these and other manifestations of risk are important to both mental health professionals and service providers who have boots on the ground. Future research should examine what protects survivors from the debilitating circumstances of disasters, while evaluating the effectiveness of any preventive or intervention programming that addresses the specific needs of an exposed and vulnerable populations, particularly the potential beneficial role social ties can play in lessening the post-disaster mental health burden of survivors. Perhaps as part of a community-wide effort, strategies can be developed and implemented that can both broaden and deepen social ties, expand access to resources, and underscore the importance of community as part of disaster preparedness, particularly among the most vulnerable.

Credit author

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Declaration of competing interest

None.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.socscimed.2020.113634>.

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