

# Research Article

## DIFFERENCES IN THE DETERMINANTS OF POSTTRAUMATIC STRESS DISORDER AND DEPRESSION AFTER A MASS TRAUMATIC EVENT

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**Background:** Hurricane Ike struck the Galveston Bay area of Texas on September 13, 2008, leaving substantial destruction and a number of deaths in its wake. We assessed differences in the determinants of posttraumatic stress disorder (PTSD) and depression after this event, including the particular hurricane experiences, including postevent nontraumatic stressors, that were associated with these pathologies. **Methods:** 658 adults who had been living in Galveston and Chambers counties, TX in the month before Hurricane Ike were interviewed 2–5 months after the hurricane. We collected information on experiences during and after Hurricane Ike, PTSD and depressive symptoms in the month before the interview, and socio-demographic characteristics. **Results:** The prevalence of past month hurricane-related PTSD and depression was 6.1 and 4.9%, respectively. Hurricane experiences, but not socio-demographic characteristics, were associated with Ike-related PTSD. By contrast, lower education and household income, and more lifetime stressors were associated with depression, as were hurricane exposures and hurricane-related stressors. When looking at specific hurricane-related stressors, loss or damage of sentimental possessions was associated with both PTSD and depression; however, health problems related to Ike were associated only with PTSD, whereas financial loss as a result of the hurricane was associated only with depression. **Conclusions:** PTSD is indeed a disorder of event exposure, whereas risk of depression is more clearly driven by personal vulnerability and exposure to stressors. The role of nontraumatic stressors in shaping risk of both pathologies suggests that alleviating stressors after disasters has clear potential to mitigate the psychological sequelae of these events. *Depression and Anxiety* 28:666–675, 2011. © 2011 Wiley-Liss, Inc.

**Key words:** posttraumatic stress disorders; depression; disasters; stressful events; trauma; life stress

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## INTRODUCTION

The psychopathological consequences of collectively experienced traumatic events have been well documented, with posttraumatic stress disorder (PTSD) and depression most frequently studied after disasters.<sup>[1,2]</sup> Most studies document an elevated prevalence, compared to what might be expected at baseline, of both disorders after disasters among persons who directly experience traumatic events related to the disaster (e.g., injury or loss of a loved one) as well as those in the general population who were living in the area when the disaster occurred.<sup>[1,3–6]</sup> Although only a minority of studies have assessed both PTSD and depression jointly and have therefore allowed comparison of the determinants of both disorders, those that have done so generally show that while the experience of disaster-related traumatic events is the central determinant of increased risk of PTSD, the determinants of depression may be more heterogeneous, with characteristics reflecting individual vulnerability potentially serving as equally important determinants of depression after disasters.<sup>[5,7]</sup> These differences suggest that the processes by which mass traumatic events lead to psychopathology may be quite different for PTSD and depression, potentially providing clues about pathogenesis.

Several studies in the past few years have demonstrated that nontraumatic stressors, including, for example, concern about employment, home reconstruction, or children's schooling, are common in the aftermath of disasters and may be key drivers of psychopathology in these contexts.<sup>[8,9]</sup> This observation is not surprising given long-established stress-diathesis models of the etiology of psychopathology,<sup>[10,11]</sup> but is of particular import for at least two reasons. First, the emerging central role of nontraumatic stressors as determinants of PTSD specifically raises important questions about our understanding of traumatic event experience nosology and has contributed to calls for revisions in our conception of traumatic events.<sup>[12]</sup> Second, stressors may well be modifiable in the aftermath of disasters, providing a potential opportunity for intervention to mitigate the consequences of these events. In both these respects, clarifying the nature of the stressors that are associated with increased risk of PTSD and depression can make an important contribution.

In this report we use data from a study of residents of Galveston and Chambers counties in Texas affected by Hurricane Ike in September 2008 to assess differences in the determinants of PTSD and depression, and to understand the particular event experiences, including postevent nontraumatic stressors, that are associated with both pathologies. Hurricane Ike was the third costliest hurricane ever to hit the United States, after Hurricane Katrina in 2005 and Hurricane Andrew in 1992. Nearly 200 deaths have been attributed to Hurricane Ike, with more than half of these deaths in the US. Galveston Bay, where the hurricane made

landfall, was the hardest hit area, although the hurricane caused damage across a large swath of the US southern coastline, from Louisiana to Texas.

## METHODS

### STUDY PARTICIPANTS

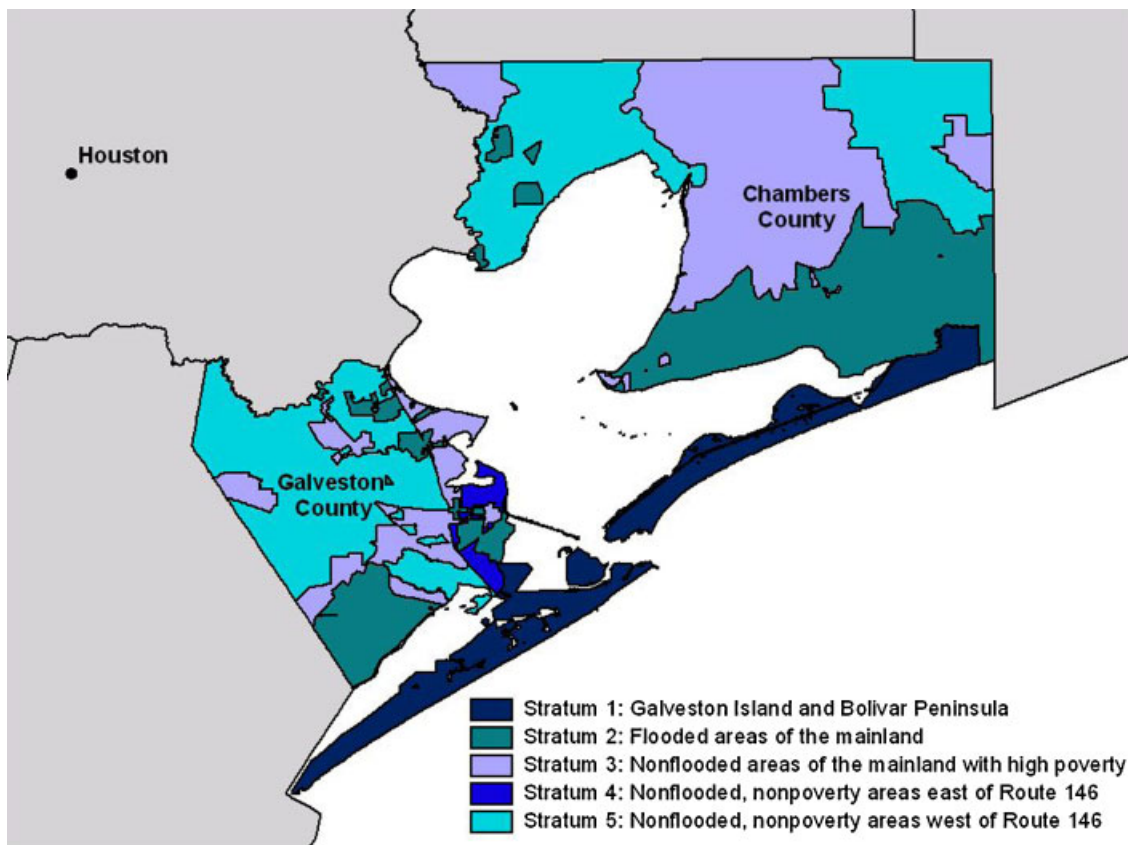
Eligible study participants were aged 18 years or older, and had been living in Galveston County or Chambers County, Texas for at least one month before September 13, 2008, when Hurricane Ike hit. The two counties were divided into five strata (pictured in Fig. 1), with differential sampling employed to ensure inclusion of residents of the most affected areas and those most likely to have experienced hurricane-related traumatic events. Eighty segments composed of Census blocks were selected from the five strata. Two thousand two hundred sixty-three households identified through field listing procedures as well as from a list of addresses obtained from the Experian credit reporting agency were sampled across the eighty segments. Six hundred fifty-eight individuals completed interviews (239 from Stratum 1, 68 from Stratum 2, 123 from Stratum 3, 33 from Stratum 4, and 195 from Stratum 5), resulting in a screening/locating rate of .52, a cooperation rate of .83, an eligibility rate of .81, and a response rate (AAPOR RR4) of .40.<sup>[13]</sup>

Interviews were conducted using a computer-assisted interview system, with 88% conducted via telephone and 12% conducted in person. A complete enumeration of adult household members was obtained and the respondent was randomly selected from all eligible household members. Interviews took place between November 7, 2008 and March 24, 2009, approximately 2–5 months after Hurricane Ike, and lasted 70 min on average. After the study was described, oral informed consent was obtained from participants. The study was approved by the Institutional Review Boards of the University of Michigan, Dartmouth College, and Yale University.

### MEASURES

We collected information on socio-demographic characteristics from study participants, including gender, age, race/ethnicity, educational attainment, household income, and current marital status. We also assessed participant experiences during and after Hurricane Ike. This included exposure to life-threatening circumstances to self or others during the hurricane (e.g., being physically present during hurricane force winds or major flooding), hereafter referred to as "hurricane exposures." Potentially traumatic events during the hurricane were also assessed (e.g., being physically injured; having a family member or close friend killed as a result of the hurricane), as were hurricane-related stressors (e.g., being displaced from home for more than 1 week; any loss of or damage to property or sentimental possessions; experiencing financial loss as a result of the hurricane). These items were modified from scales used after previous natural disasters, including Hurricanes Andrew and Katrina.<sup>[9,14]</sup> For each of these three categories of Hurricane Ike experiences, we summed the number of experiences reported by respondents, and created dichotomous variables split at the median.

<sup>1</sup>Participation rates were calculated as follows, where I is complete interviews, R-E is refusals among eligible respondents, NI-E is noninterviews among eligible respondents, R-UE is refusals among respondents of unknown eligibility, NI-UE is noninterviews among respondents of unknown eligibility, E is eligible respondents, and IE is ineligible respondents. Screening/locating rate = (I+R-E+NI-E)/(I+R-E+NI-E+R-UE+NI-UE). Cooperation rate = (I)/(I+R-E). Eligibility rate (e) = (E)/(E+IE). AAPOR RR4 = (I) / (I+R-E+NI-E + e\*(R-UE+NI-UE)). There were no partially completed interviews.



**Figure 1.** Map of sampling frame. High poverty areas were those areas with 15% or more households living at or below the poverty level, according to data from the 2000 U.S. Census.<sup>[28]</sup>

Information about 10 potentially traumatic events and 12 stressors experienced by participants before and after Hurricane Ike was obtained using a subset of DSM-IV Criterion A traumatic events (e.g., combat exposure, robbery or mugging, unwanted sexual contact)<sup>[15]</sup> and a modified list of stressful life events (e.g., experiencing a divorce or break-up with a partner, serious financial problems).<sup>[16,17]</sup> The numbers of traumatic events and stressors reported to have occurred before Hurricane Ike were categorized into tertiles for the sample, allowing more nuanced consideration of the relations between prior lifetime adversity and current psychopathology than would be possible using dichotomous measures.

We used the PTSD Checklist–Civilian Version (PCL-C) to measure criteria B (re-experiencing), C (avoidance/numbing), and D (arousal) symptoms related to Hurricane Ike.<sup>[18–21]</sup> Respondents reported how much they were bothered by each of the 17 symptoms with reference to Hurricane Ike, ranging from not at all to extremely; symptoms were counted if the respondent reported being at least “moderately” bothered.<sup>[18,21]</sup> Additional questions assessed feelings of terror or helplessness during Hurricane Ike (criterion A2), when symptoms began and ended (allowing calculation of duration for criterion E), and the degree to which symptoms were distressing or made functioning at work, home, or in relationships difficult (criterion F). Study participants were classified as meeting criteria for Ike-related PTSD in the month before the interview if they reported that symptoms most recently occurred in the past month and they met all DSM-IV criteria for PTSD,<sup>[22]</sup> including reporting terror or helplessness during the event, at least one re-experiencing symptom, at least three avoidance symptoms, at least two arousal

symptoms, duration of symptoms of at least 1 month, and moderate or severe impairment or distress resulting from symptoms. The PCL-C has demonstrated excellent internal consistency (Cronbach’s  $\alpha$  .94)<sup>[19,20]</sup> and substantial agreement with diagnoses of PTSD<sup>[21]</sup> and symptom ratings.<sup>[19]</sup> Our PTSD measure incorporates all PTSD DSM-IV criteria rather than relying on a particular PCL cutpoint; validation of this method for identifying probable cases of PTSD against the CAPS in recent work suggests that this modified measure has excellent psychometrics and is highly specific for PTSD.<sup>[23]</sup>

Depression in the month before the interview was assessed using the Patient Health Questionnaire-9 (PHQ-9).<sup>[24–27]</sup> Respondents were asked to report whether there was ever a 2-week period in which they were bothered by each of nine symptoms; if so, they were asked how often they were bothered (several days, more than half the days, or nearly every day) and whether that occurred in the past month. Study participants met criteria for depression in the month before the interview if they met all criteria for major depressive disorder or other depressive disorder<sup>[22]</sup> by reporting that at least two symptoms occurred at least “more than half the days” over a 2-week period in the past month (suicidal thoughts were counted if present at least “several days”), with one of those symptoms being depressed mood or anhedonia.<sup>[24]</sup> Respondents also had to report that the symptoms occurred together. The PHQ-9 has been found to have excellent internal consistency, test–retest reliability, and construct validity in primary-care settings<sup>[25]</sup> as well as in the general population<sup>[26]</sup> and, in a recent validation against the Structured Clinical Interview for DSM-IV Disorders, the specific scoring used in this study demonstrated excellent psychometrics and high specificity for depression.<sup>[23]</sup>

ANALYSIS

We compared the distribution of socio-demographic characteristics in the sample to 2000 US Census data for Galveston and Chambers counties.<sup>[28]</sup> We then conducted bivariate Wald  $\chi^2$  tests of the relations between socio-demographic characteristics, Hurricane Ike experiences, and lifetime traumatic events and stressors and Ike-related PTSD and depression in the past month. For these and multivariable analyses, categories of some socio-demographic variables were collapsed to increase group size and stability of estimates of association. Adjusted logistic regression models were fit for each outcome, including covariates that were statistically significant in bivariate analyses, identified by Wald  $\chi^2$  *P*-values < .1. In these models, the numbers of hurricane exposures, hurricane-related traumatic events, and hurricane-related stressors were included as dichotomous variables. We then fit separate multivariable logistic regression models for each outcome disaggregating the three Hurricane Ike experience categories into the individual experiences that comprised the sum; these adjusted models included all individual hurricane experiences that were statistically significant at *P* < .1 in bivariate analyses, and also adjusted for socio-demographic characteristics and lifetime traumatic events and stressors significant in bivariate analyses. Although many of these individual hurricane experiences were significantly correlated with each other, variance inflation factors calculated in SAS (Version 9.2, SAS Institute Inc., 2008) were close to one for all variables included in models together, suggesting that regression estimates and standard errors were not influenced by multicollinearity.<sup>[29]</sup>

All analyses were weighted to account for differential sampling probabilities across the five study strata, probabilities of selection within households, nonresponse, and differences between the sample and the 2000 US Census population on race/ethnicity, age, educational attainment, and household income.<sup>[28]</sup> Race/ethnicity and educational attainment information was missing on approximately 20 respondents, and household income in the year before Hurricane Ike was missing for 75 respondents. We conducted multiple imputation using the Sequential Regression Imputation Method implemented in IVEWARE,<sup>[30,31]</sup> creating five imputed data sets based on other demographic information, Hurricane Ike experiences, and lifetime history of traumatic events and stressors. All analyses were conducted in SUDAAN (Version 10.0.1, RTI International, 2009) to properly account for the complex survey design and multiple imputation.

RESULTS

There were no significant differences between the study sample and the 2000 US Census population in the sampling frame of Galveston and Chambers counties, TX (Table 1). The majority of participants were White (67.8%), had completed some college or higher education (52.6%), reported a household income of at least \$40,000 in the year before Hurricane Ike (55.6%), and were married (54.5%).

Study participants reported a variety of Hurricane Ike-related exposures, traumatic events, and stressors. The most common hurricane experiences reported by study participants were loss of or damage to personal property (86.1%), being without any resource for over a week (65.4%), being present during hurricane force winds or major flooding (57.9%), being unsure about the safety or whereabouts of family members or close friends during or after the hurricane (43.2%),

TABLE 1. Demographic and socioeconomic characteristics of the sample compared to US Census 2000 data for Chambers and Galveston counties, TX

	Sample		Census 2000		<i>P</i> -value <sup>a</sup>
	<i>n</i>	%	<i>N</i>	%	
Total	658		201,796		
Gender					
Female	394	50.6	104,196	51.6	.836
Male	264	49.4	97,600	48.4	
Age					
18–24 years	56	10.4	23,885	11.8	.483
25–34 years	105	17.9	36,233	18.0	
35–44 years	109	18.9	47,081	23.3	
45–54 years	120	17.2	40,036	19.8	
55–64 years	117	17.6	24,446	12.1	
≥ 65 years	151	18.0	30,115	14.9	
Race/ethnicity					
White non-Hispanic	399	67.8	135,708	67.3	.820
Black non-Hispanic	102	13.5	28,354	14.1	
Hispanic	123	13.8	31,004	15.4	
Other non-Hispanic	34	4.9	6,730	3.3	
Educational attainment					
< High school degree	89	19.4	42,152	20.9	.929
High school degree or equivalent	151	28.0	54,850	27.2	
> High school degree	418	52.6	104,925	52.0	
Household income					
< \$20,000	145	19.1	23,683	22.8	.936
\$20,000–\$39,999	136	25.4	24,773	23.8	
\$40,000–\$59,999	102	18.2	18,580	17.9	
\$60,000–\$99,999	125	23.4	23,471	22.6	
≥ \$100,000	149	14.0	13,470	13.0	
Marital status <sup>b</sup>					
Married	311	54.5	121,487	60.2	n/a <sup>b</sup>
Living with a partner	33	7.4	–	–	
Separated	35	6.0	5,420	2.7	
Divorced	84	8.6	24,154	12.0	
Widowed	75	4.9	13,496	6.7	
Never been married	120	18.6	37,370	18.5	

<sup>a</sup>Chi-square test comparing distribution from sample and Census 2000; two-tailed *P*-value.

<sup>b</sup>Marital status was not reported in a manner similar to that used by the Census, with the inclusion of “living with a partner” as an option.

experiencing financial loss as a result of the hurricane (38.6%), and being displaced from home for over a week (38.3%). The proportion of study participants reporting hurricane experiences was similar across socio-demographic groups, except that participants declaring a race/ethnicity other than non-Hispanic White were more likely to have experienced one or more hurricane-related traumatic events (18.0 versus 6.5% among non-Hispanic Whites). Overall, 61.2% of the sample reported feeling terrified (46.3%) and/or helpless (48.0%) during Hurricane Ike.

Table 2 shows Ike-related PTSD and depression in the past month by socio-demographic characteristics, Hurricane Ike experiences, and lifetime traumatic events and stressors. The prevalence of past month

**TABLE 2. Bivariate associations and multivariable logistic regression models predicting Hurricane Ike-related PTSD and depression in the past month**

	Hurricane Ike-related PTSD					Depression				
	Unadjusted relations			Adjusted model		Unadjusted relations			Adjusted model	
	<i>n</i> PTSD	% PTSD	<i>P</i> -value	OR	95% CI	<i>n</i> Dep	% Dep	<i>P</i> -value	OR	95% CI
Total	59	6.1				44	4.9			
<i>Socio-demographic characteristics</i>										
<i>Gender</i>										
Female	46	8.2	.161	–	–	32	4.4	.758	–	–
Male	13	3.9		–	–	12	5.3		–	–
<i>Age</i>										
≥ 55 years	26	5.6	.511	–	–	15	3.4	.474	–	–
35–54 years	18	4.6		–	–	17	4.2		–	–
18–34 years	15	8.5		–	–	12	7.5		–	–
<i>Race/ethnicity</i>										
White non-Hispanic	28	4.4	.095	1.00	–	23	4.3	.497	–	–
Non-White <sup>a</sup>	31	9.5		1.74	0.70–4.28	21	6.1		–	–
<i>Educational attainment</i>										
> High school degree	37	6.2	.978	–	–	22	2.1	.028	1.00	–
High school degree or equivalent	15	5.6		–	–	16	8.0		3.99	1.17–13.68
< High school degree	7	6.4		–	–	6	7.7		4.45	0.91–21.70
<i>Household income</i>										
≥ \$60,000	17	4.4	.900	–	–	9	0.7	.004	1.00	–
\$40,000–\$59,999	12	6.4		–	–	9	6.7		7.12	1.41–36.07
\$20,000–\$39,999	13	7.7		–	–	12	7.7		11.27	2.77–45.91
< \$20,000	17	6.6		–	–	14	7.4		5.76	1.34–23.17
<i>Marital status</i>										
Married	22	5.3	.838	–	–	10	3.3	.385	–	–
Separated/Divorced/Widowed	20	6.5		–	–	20	8.3		–	–
Never been married/Living with a partner	17	7.3		–	–	14	5.4		–	–
<i>Hurricane experiences</i>										
<i>Number of Hurricane Ike exposures<sup>b</sup></i>										
0–1	30	3.4	.004	1.00	–	21	2.7	.016	1.00	–
≥ 2	29	11.9		2.08	0.77–5.61	23	9.4		3.53	0.98–12.65
<i>Number of Hurricane Ike-related traumatic events<sup>c</sup></i>										
0	39	4.4	.003	1.00	–	33	4.7	.685	–	–
≥ 1	20	21.1		2.74	0.75–10.05	11	6.0		–	–
<i>Number of Hurricane Ike-related stressors<sup>d</sup></i>										
0–3	16	2.9	.004	1.00	–	14	1.7	.001	1.00	–
≥ 4	43	11.9		2.73	0.82–9.07	30	10.8		2.83	0.81–9.95
<i>Lifetime traumatic events and stressors</i>										
<i>Number of traumatic events before Hurricane Ike</i>										
0–1	13	4.0	.696	–	–	9	2.8	.484	–	–
2–3	22	6.7		–	–	12	5.4		–	–
≥ 4	24	7.0		–	–	23	5.9		–	–
<i>Number of stressors before Hurricane Ike</i>										
0–3	16	2.9	.204	–	–	13	1.4	.004	1.00	–
4–5	20	9.3		–	–	7	8.1		9.79	2.53–37.94
≥ 6	23	7.7		–	–	24	6.8		6.70	1.77–25.30

<sup>a</sup>Non-White includes those reporting Hispanic ethnicity or Black, Native American, Asian, Pacific Islander, or other race.

<sup>b</sup>Hurricane Ike exposures included being present during hurricane force winds or major flooding, being unsure about the safety or whereabouts of family or friends during the storm, being stranded during or after the storm, and performing dangerous activities.

<sup>c</sup>Hurricane Ike-related traumatic events included being physically injured, having a family member or close friend killed as a result of Ike, seeing dead bodies as a result of Ike, or experiencing other traumatic events like robbery or assault as a result of Ike.

<sup>d</sup>Hurricane Ike-related stressors included being displaced or without resources (e.g., electricity, food, water) for more than 1 week, reporting loss or damage of personal property or sentimental possessions, health problems of self or family member as a result of Ike, experiencing financial loss as a result of Ike, or reporting increased demands or relationship problems as a result of Ike.

Ike-related PTSD in the sample was 6.1%, whereas the prevalence of past month depression was 4.9%. Higher numbers of hurricane exposures were associated with a higher prevalence of PTSD, as were higher numbers of Hurricane Ike-related traumatic events and stressors. Latino and non-White study participants were more likely than non-Hispanic White participants to meet criteria for Ike-related PTSD (9.5 versus 4.4%), but other socio-demographic characteristics and traumatic events and stressors before Hurricane Ike were not associated with Ike-related PTSD. For depression in the month before the interview, lower education and household income, and higher numbers of lifetime stressors, were associated with a higher prevalence in bivariate analyses. As for PTSD, a greater number of hurricane exposures and hurricane-related stressors were associated with depression. However, hurricane-related traumatic events were not significantly associated with depression.

In models adjusting for variables significant at  $P < .1$  in bivariate analyses, none of the three hurricane experience variables remained independently significantly associated with Ike-related PTSD in the past month, also controlling for race/ethnicity (Table 2). Having a high school degree or equivalent (compared to some college or higher education) was associated with increased odds of depression (OR = 3.99, 95% CI: 1.17–13.68), as was lower household income (compared to \$60,000 or higher income: OR = 7.12, 95% CI: 1.41–36.07 for \$40,000–\$59,999; OR = 11.27, 95% CI: 2.77–45.91 for \$20,000–\$39,999; OR = 5.56, 95% CI: 1.34–23.17 for <\$20,000), and 4 or more stressors before Hurricane Ike (OR = 7.68, 95% CI: 2.39–24.71 for 4–5 stressors; OR = 5.23, 95% CI: 1.63–16.73 for 6 or more stressors, both compared to 0–3 stressors). Reporting 2 or more hurricane exposures (compared to 0–1), and 4 or more hurricane-related stressors (compared to 0–3) were also associated with increased odds of depression, although no longer statistically significant.

In separate models examining each of the three types of Hurricane Ike experiences by disaggregating the summary variables into their component parts (Table 3), we found that uncertainty about the safety or whereabouts of family members or friends remained a significant predictor of Ike-related PTSD (OR = 3.25, 95% CI: 1.28–8.25), when adjusting for other hurricane exposures and race/ethnicity. Being physically injured as a result of Ike was a significant predictor of PTSD (OR = 3.62, 95% CI: 1.37–9.51) in a model adjusting for other hurricane-related traumatic events and race/ethnicity. Loss of or damage to sentimental possessions (OR = 3.12, 95% CI: 1.33–7.31) and experiencing the health problem of oneself or a family member (OR = 3.18, 95% CI: 1.37–7.38) were associated with PTSD when adjusting for other hurricane-related stressors and race/ethnicity.

Uncertainty about the safety or whereabouts of family members or close friends was also a significant

predictor of past month depression (OR = 5.20, 95% CI: 1.65–16.40), when adjusting for other hurricane exposures as well as education, household income, and lifetime stressors before Hurricane Ike (Table 3). Among hurricane-related stressors, loss of or damage to sentimental possessions (OR = 3.22, 95% CI: 1.16–8.99) and financial loss as a result of Hurricane Ike (OR = 4.74, 95% CI: 1.78–12.63) emerged as significant predictors of depression.

## DISCUSSION

In a population representative sample of residents of Galveston and Chambers counties affected by Hurricane Ike, the prevalence of past month hurricane-related PTSD and depression was 6.1 and 4.9%, respectively. Although lower than the prevalence observed in populations affected by Hurricane Katrina,<sup>[8,9]</sup> these estimates are comparable to those previously reported in general population samples after hurricanes and other natural disasters.<sup>[2,32]</sup> We found that experiences during and immediately following Hurricane Ike were the primary determinants of PTSD, with no associations between demographic and socioeconomic characteristics of study participants and risk of PTSD with the exception of race/ethnicity, suggesting that event experiences play a central role in PTSD pathogenesis across groups defined by gender, socioeconomic position (SEP) and marital status. This is consistent with recent literature.<sup>[9]</sup> By contrast, risk for depression varied across educational attainment and household income groups. Although other postdisaster studies have found evidence of increased risk of depression with lower SEP,<sup>[1,33,34]</sup> population-based studies in nondisaster contexts have alternately suggested that low SEP is associated with a greater risk of depression,<sup>[35–37]</sup> whereas others have found no association or only weak associations especially when controlling for other risk and mediating factors.<sup>[38–40]</sup> The observation here of a strong link between low SEP and depression, particularly when other hurricane-related events and stressors are accounted for, suggests that there might be other underlying vulnerabilities among those with low SEP that importantly shape the risk of psychopathology after mass traumatic events. Although lifetime traumatic events before Hurricane Ike were not strongly associated with either PTSD or depression, lifetime stressors continued to be associated with current depression even when accounting for demographics and stressors specifically brought on by the hurricane, further demonstrating the potential role of prior vulnerability in postdisaster depression etiology.

The direct link between traumatic events and risk of PTSD is not surprising and is consistent with our conception of this pathology as a postevent disorder, particularly when the events experienced are substantial and outside of the normal range of human experience. However, we also documented a role for particular nontraumatic events in the determination of PTSD.

**TABLE 3. Bivariate associations and multivariable logistic regression models predicting Hurricane Ike-related PTSD and depression from Hurricane Ike-related exposures, traumatic events, and stressors**

	Hurricane Ike-related PTSD						Depression					
	Unadjusted relations			Adjusted model <sup>a,b</sup>			Unadjusted relations			Adjusted model <sup>a,b</sup>		
	n PTSD	% PTSD	P-value	OR	95% CI	n Dep	% Dep	P-value	OR	95% CI		
Total	59	6.1				44	4.9					
<i>Hurricane Ike exposures</i>												
Present during hurricane force winds or major flooding												
No	28	4.3	.190	—	—	22	5.8	.542	—	—		
Yes	31	7.3		—	—	22	4.2		—	—		
Unsure about safety of family or friends												
No	18	2.7	.002	1.00	—	12	2.2	.012	1.00	—		
Yes	41	10.6		3.25	1.28–8.25	32	8.4		5.20	1.65–16.40		
Stranded during or after storm												
No	51	5.2	.016	1.00	—	36	4.2	.035	1.00	—		
Yes	8	26.2		3.51	0.91–13.46	8	18.3		2.42	0.48–12.31		
Self or household member performed dangerous activity												
No	42	4.5	.010	1.00	—	30	3.5	.026	1.00	—		
Yes	17	16.4		2.86	1.00–8.20	14	13.7		1.69	0.52–5.43		
<i>Hurricane Ike-related traumatic events</i>												
Physically injured as a result of Ike												
No	46	5.3	.027	1.00	—	38	4.9	.646	—	—		
Yes	13	25.4		3.62	1.37–9.51	6	3.6		—	—		
Family member or close friend killed as a result of Ike												
No	52	4.7	.009	1.00	—	42	4.8	.966	—	—		
Yes	7	32.3		6.37	0.64–63.55	2	5.0		—	—		
Saw dead bodies during or after Ike												
No	54	5.2	.052	1.00	—	39	4.7	.531	—	—		
Yes	5	31.4		1.01	0.04–27.43	4	8.3		—	—		
Any other hurricane-related traumatic event												
No	57	5.5	.082	1.00	—	42	4.9	.713	—	—		
Yes	2	26.8		1.96	0.50–7.68	2	3.6		—	—		
<i>Hurricane Ike-related stressors</i>												
Displaced from home for more than one week												
No	24	5.7	.702	—	—	22	2.5	.017	1.00	—		
Yes	35	6.7		—	—	22	8.6		1.76	0.63–4.91		
Without any resource for more than one week												
No	18	4.6	.378	—	—	15	4.6	.878	—	—		
Yes	41	6.8		—	—	29	5.0		—	—		
Any loss of or damage to personal property												
No	5	4.5	.589	—	—	3	0.6	.001	1.00	—		
Yes	54	6.3		—	—	41	5.5		3.97	0.96–16.44		
Any loss of or damage to sentimental possessions												
No	20	3.0	.001	1.00	—	20	2.0	<.001	1.00	—		
Yes	39	14.9		3.12	1.33–7.31	24	13.3		3.22	1.16–8.99		

Health problem of self or family member related to Ike									
No	22	3.3	.001	1.00	-	18	4.4	.419	-
Yes	37	15.7		3.18	1.37-7.38	26	6.5		-
Financial loss as a result of Ike									
No	21	3.3	.014	1.00	-	18	1.4	<.001	1.00
Yes	38	10.5		1.77	0.69-4.58	26	10.3		4.74 1.78-12.63
Increased demands or relationship problems as a result of Ike									
No	32	3.9	.025	1.00	-	25	5.1	.706	-
Yes	27	10.7		2.14	0.93-4.94	19	4.2		-

<sup>a</sup>Separate models were fit for (1) Hurricane Ike exposures, (2) Hurricane Ike-related traumatic events (for PTSD only), and (3) Hurricane Ike-related stressors. <sup>b</sup>Models for PTSD were also adjusted for race/ethnicity (White non-Hispanic versus non-White); models for depression were also adjusted for education, household income, and number of lifetime stressors before Hurricane Ike.

This suggests that a wide range of perturbations in personal experience linked to the disasters is associated with risk of PTSD. It is certainly plausible that these perturbations are all triggering the same neurochemical cascade that we suspect explains PTSD pathogenesis,<sup>[41,42]</sup> suggesting that a fuller conception of the cluster of symptoms currently described as PTSD might require us to consider greater heterogeneity in the nature of the triggering event than is currently normative.

Hurricane-related traumatic events were not associated with depression, as has been shown in some other work after disasters.<sup>[7,43]</sup> This, coupled with the observation that postevent nontraumatic stressors were associated with risk of depression, suggests that elevated prevalence of depression after disasters does not, in contrast to PTSD, rest on the experience of specific traumatic events. Rather it may rest on elevated exposure to stressors in the postdisaster context, consistent with literature affirming the role of stressful life events in depression onset<sup>[44,45]</sup> and the ability of stressful consequences of acute experiences to explain relations between acute events and depression.<sup>[46]</sup>

When we considered the specific hurricane-related traumatic events and stressors that were associated with PTSD and depression, a few clear differences emerged. Loss of or damage to sentimental possessions was associated with both PTSD and depression risk; however, being displaced from home and financial loss as a result of the hurricane were most strongly associated with depression, not PTSD, risk. Although several prior studies have found associations between disaster-related losses and the severity and persistence of both PTSD and depressive symptoms,<sup>[5,9,47-49]</sup> our results demonstrate potentially stronger effects of financial loss and displacement for depression rather than PTSD in the immediate aftermath of a mass traumatic event. Stronger effects of relocation after disasters on depression than on PTSD risk have been confirmed in previous studies.<sup>[50,51]</sup> Furthermore, these findings demonstrate that including dichotomous measures of hurricane experiences in models masked important differences in the specific disaster-related events that were associated with PTSD and depression, arguing for greater specificity in future research that assesses determinants of postdisaster psychopathology.

There are limitations to be taken into account when considering these findings, most of which are typical of research in the field. First, absent a predisaster baseline sample, our inference about elevated prevalence of depression rests on comparing across studies in different contexts. We note that this limitation does not pertain to PTSD, which is here expressly linked to Hurricane Ike experiences. Second, we have not considered pre-event assessments of psychopathology among participants in this study, again suggesting that we cannot infer incidence of depression but rather prevalence. Although PTSD linked to Hurricane Ike is, by definition, incident in the posthurricane period it is possible that persons



with Ike-related PTSD also had prior PTSD linked to previous traumatic events. Our failure to find an association between prior lifetime traumatic events and PTSD somewhat mitigates this concern. Third, as in all population-based samples in the aftermath of disruptive events there remains a concern that our sample was not representative of those persons who experienced the hurricane. However, we took extraordinary measures to obtain a representative sample of prehurricane residents and the high response rate compared to other studies in the field is reassurance in this regard.<sup>[52]</sup> Fourth, it is possible that current experience of psychological symptoms influenced reports of traumas and stressors, although this is unlikely when using these highly structured measures that have been applied extensively in comparable contexts. Fifth, about one-third of those meeting criteria for current Ike-related PTSD and nearly half of those meeting criteria for current depression actually met criteria for both disorders ( $n = 21$ ). However, we were able to identify several differences in predictors for PTSD and depression, suggesting that this comorbid group did not impair our ability to treat each disorder as a distinct entity with potentially distinct etiology. Sixth, the relatively small sample size and low number of PTSD and depression cases resulted in wide confidence intervals for some covariates, although large associations were still observed. Observed null associations must be considered within the context of the sample size and the covariates included within the multivariable models. Our observation that in multivariable models accounting for traumatic event experiences and stressors there was largely no difference in risk of PTSD across demographic groups does not obviate demographic differences in risk of psychopathology in larger samples but simply underscores the centrality of these immediate exposures as core drivers of psychopathology in this context. Finally, absent a clinician assessment we cannot diagnose psychopathology and therefore caution in interpreting reports of both PTSD and depression is warranted. Mitigating this concern, we applied widely used instruments, with recent validation results suggesting that these are highly specific instruments concordant with clinician diagnosis.

Notwithstanding these limitations, we document here clear differences in the determinants of PTSD and depression, suggesting that while PTSD is indeed a disorder of event exposure, risk of depression is more clearly driven by personal vulnerability and exposure to stressors. The role of elevated postdisaster nontraumatic stressors in shaping risk of both pathologies further makes a robust case that alleviating stressors of daily living after disasters should be a priority of public health policy, given the potential of such efforts to mitigate the psychological sequelae of these events.

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