Journal of Traumatic Stress, Vol. 21, No. 4, August 2008, pp. 357–368 (© 2008)

Financial and Social Circumstances and the Incidence and Course of PTSD in Mississippi During the First Two Years After Hurricane Katrina

Sandro Galea
Department of Epidemiology, School of Public Health, University of Michigan, Ann Arbor, MI; Survey Research Center, Institute for Social Research, University of Michigan, Ann Arbor, MI; Department of Epidemiology, Mailman School of Public Health, Columbia University, New York, NY; and National Center for Disaster Mental Health Research, Ann Arbor, MI

Melissa Tracy
Department of Epidemiology, School of Public Health, University of Michigan, Ann Arbor, MI; and National Center for Disaster Mental Health Research, Ann Arbor, MI

Fran Norris
National Center for Posttraumatic Stress Disorder, Veterans Affairs Medical Center, White River Junction, VT; Department of Psychiatry, Dartmouth Medical School, Lebanon, NH; and National Center for Disaster Mental Health Research, White River Junction, NH

Scott F. Coffey
Department of Psychiatry and Human Behavior, University of Mississippi Medical Center, Jackson, MS, and National Center for Disaster Mental Health Research, White River Junction, NH

Hurricane Katrina was the most devastating natural disaster to hit the United States in the past 75 years. The authors conducted interviews of 810 persons who were representative of adult residents living in the 23 southernmost counties of Mississippi before Hurricane Katrina. The prevalence of posttraumatic stress disorder (PTSD) since Hurricane Katrina was 22.5%. The determinants of PTSD were female gender, experience of hurricane-related financial loss, postdisaster stressors, low social support, and postdisaster traumatic events. Kaplan-Meier survival curves suggest that exposure to both hurricane-related traumatic events and to financial and social stressors influenced the duration of PTSD symptoms. Postdisaster interventions that aim to improve manipulable stressors after these events may influence the onset and course of PTSD.

Hurricane Katrina made landfall on the Mississippi–Louisiana border on August 29, 2005. It was the deadliest hurricane in the United States to occur over the last 75 years, with at least 1,604 deaths in its aftermath. It was by far the most expensive natural disaster in U.S. history, with costs estimated at $100 billion (Department of Homeland Security [DHS]; Rosenbaum, 2006). More than 2 years after the hurricane, substantial parts of New Orleans have remained uninhabitable and the population in many other parts of Southern Louisiana and Mississippi is a small fraction of what it was before the hurricane.

The mental health and behavioral consequences of natural disasters in previous studies have ranged from mild to very severe (Galea, Nandi, & Vlahov, 2005). There is, however, every reason to believe that the effects of Hurricane Katrina would be substantial. Survivors of Hurricane Katrina experienced an extraordinary array of known risk factors for heightened pathology after disasters including threat to life, bereavement, exposure to the dead and dying, and lingering social and community disruption (Armenian et al., 2000; Glesser, Green, & Winget, 1981; Kaniasty & Norris, 1993; Norris, Murphy, Baker, & Perilla, 2004; Norris & Uhl,

This study was supported by grant MH 078152 from the National Institutes of Health.

Correspondence concerning this article should be addressed to: Sandro Galea, Professor, Department of Epidemiology, University of Michigan School of Public Health, 109 Observatory St, Room 3663, Ann Arbor, MI 48109-2029. E-mail: sgalea@umich.edu.

 DOI: 10.1002/jts.20355

1993). Reports that have been published about the aftermath of Hurricane Katrina thus far all have suggested that the scope of traumatic events experienced by residents of the Gulf Coast after the hurricane was substantial (Galea et al., 2007; Gallup Poll News Service, 2005; Kessler, Galea, Jones, Parker, & Hurricane Katrina Community Advisory Group, 2006).

The existing assessments about the consequences of Hurricane Katrina, although important, have been limited in three important ways. First, most have focused on the assessment of specific risk groups, like evacuees (Centers for Disease Control and Prevention [CDC], 2006; Coker et al., 2006; DeSalvo et al., 2007; Rodriguez et al., 2006), each of which represented a very small proportion of the prehurricane residents of the affected areas. Second, the only population-based study that has been published thus far of which we are aware (Galea et al., 2007; Kessler et al., 2006) primarily drew participants from volunteer list-based samples compiled from agencies concerned with posthurricane relief and from local random telephone dialing. Third, no extant study has considered the burden of psychopathology in the longer term, over several years, and how the course of this psychopathology changed over time.

We conducted a study to document posttraumatic stress disorder (PTSD), the sentinel psychopathology associated with traumatic event experiences, after Hurricane Katrina, building on the previous work in three ways. First, we recruited a population-based sample of persons who were living in the areas affected by Hurricane Katrina before the hurricane hit. Second, we assessed PTSD 18–24 months after Hurricane Katrina, allowing us to document both PTSD onset and progression after this event. Third, we used a comprehensive assessment of PTSD, allowing us to draw inference about dimensions of PTSD that extends previous work.

METHOD

Participants

Our sampling frame of interest was adults (18 years of age or older) who were living in the 23 southernmost counties of Mississippi prior to Hurricane Katrina (Figure 1). The study area was divided into three strata, representing different levels of damage inflicted by the hurricane (Figure 2).

Due to the severe damage inflicted in the six counties included in Strata A and B, substantial efforts were undertaken to account for and identify all housing units that existed prior to the hurricane. An area probability sampling frame was created through systematic enumeration of all addresses in 32 randomly selected segments (consisting of aggregations of 2000 Census blocks) in each of the two strata by trained listers. A random selection of addresses was then sampled within each segment. Extensive tracking was

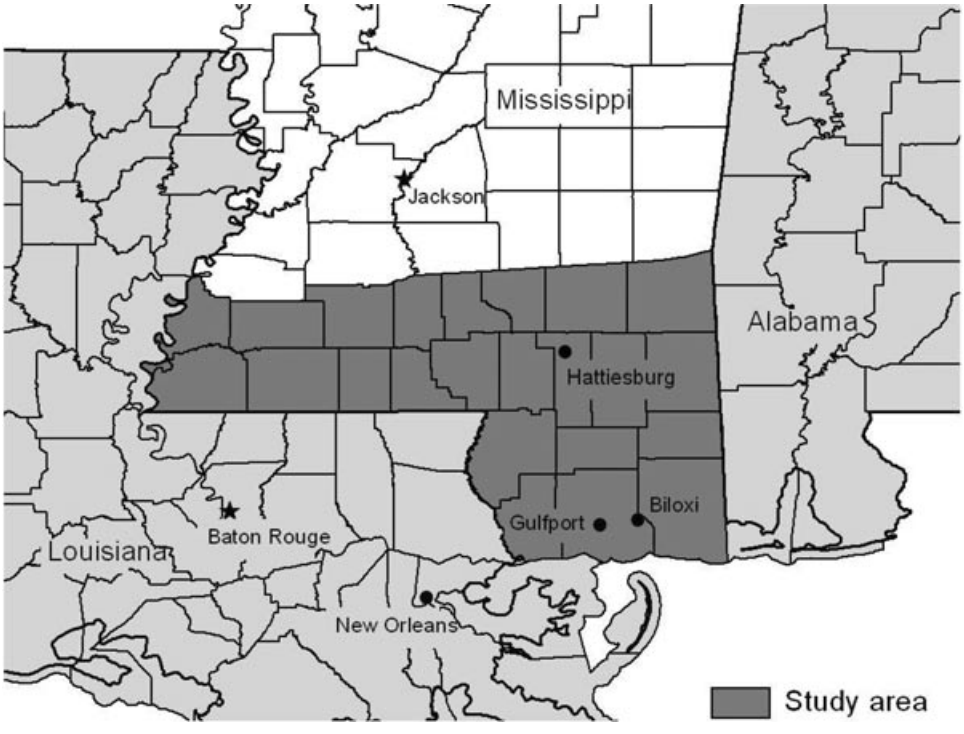

Figure 1. Map of Mississippi counties included in the study area.

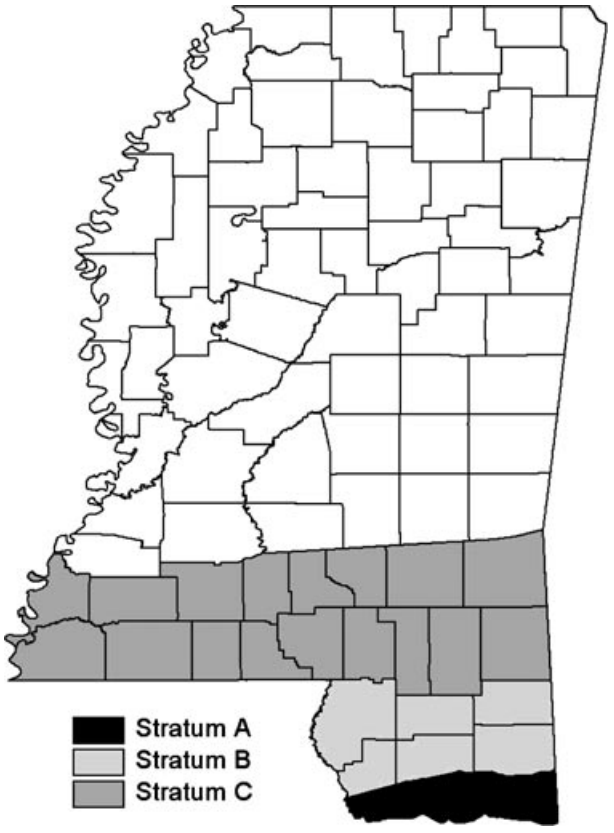

Figure 2. Map of sampling strata. Stratum A was directly along the Gulf Coast and consisted of the portions of Hancock, Harrison, and Jackson counties south of Interstate-10; Stratum B consisted of the portions of Hancock, Harrison, and Jackson counties north of Interstate-10, as well as George, Pearl River, and Stone counties; and Stratum C consisted of the 17 counties north of stratum B (Adams, Amite, Covington, Forrest, Franklin, Greene, Jefferson Davis, Jones, Lamar, Lawrence, Lincoln, Marion, Perry, Pike, Walthall, Wayne, and Wilkinson).

conducted by trained interviewers to locate persons (wherever they were in the country at the time of the study) who had resided at the selected addresses prior to Hurricane Katrina, including a combination of Internet, telephone, archival (including Post Office and Department of Motor Vehicle records), and in-person research. Because the counties included in Stratum C experienced less severe damage as a result of Hurricane Katrina, a random digit dial sampling frame was used to sample potential respondents in this stratum, which was covered by one telephone area code. At the time of the interview, 109 respondents (13.5% of the sample) were living at a different address from where they lived in the immediate period before Hurricane Katrina; 22 of these respondents were living in states other than Mississippi.

Interviews were conducted using a computer-assisted interview system (32% of interviews in Strata A and B were conducted in-person, with the remaining 68% conducted via telephone). A complete enumeration of all adult household members was solicited and the respondent was randomly selected from all eligible household members. Interviews took place between February 24, 2007 and July 31, 2007 and lasted 37 minutes on average. After a complete description of the study to the participants, oral informed consent was obtained. This study was approved by the Institutional Review Board of the University of Michigan and oral informed consent was obtained from participants.

Measures

We collected information on sociodemographic characteristics (gender, age, race/ethnicity, educational attainment, household income, and marital status) from each respondent. We also assessed experiences during Hurricane Katrina, including whether the respondent was exposed to any traumatic events during the hurricane (being physically injured, knowing someone who was injured or killed, seeing dead bodies) or experienced financial loss as a result of the hurricane (reporting "a lot" of damage to property or possessions, losing a job, experiencing a decline in household income as a result of the hurricane). Other stressors related to Hurricane Katrina were also assessed, including being displaced from home, losing sentimental possessions like photographs, and experiencing any of six stressors in the 6 months after the hurricane (e.g., shortage of food or water, difficulty finding sufficient housing). These items were modified from scales that have been used after other natural disasters, including Hurricane Andrew. The number of posthurricane stressors was calculated (ranging from 0 to 8; Cronbach's $\alpha = .72$) and categorized into low (0–2 stressors) and high (3 or more stressors) exposure to posthurricane stressors.

The Crisis Support Scale (Joseph, Williams, & Yule, 1992) was used to measure social support in the 2 months after Hurricane Katrina; items were summed for a total social support score ranging from 6 to 42 (Cronbach's $\alpha = .77$), which was categorized into tertiles.

Information about lifetime traumatic events experienced by respondents was collected using a modified version of Criterion A traumatic events from the Composite International Diagnostic Interview (CIDI; Kessler & Ustun, 2004). For each event reported, respondents were asked whether the event occurred before or after Hurricane Katrina. The number of traumatic events experienced prior to Hurricane Katrina was categorized into low (0–1), medium (2–3), and high (4 or more) exposure, whereas the number of events experienced after Hurricane Katrina was categorized into low (0–1) and high (2 or more).

Posttraumatic stress disorder related to Hurricane Katrina was measured using the PTSD module of the CIDI for the *Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition* (*DSM-IV*; Kessler & Ustun, 2004) criteria; we used Hoge et al.'s (2004)

convention of presenting both "broad" and "strict" definitions of PTSD in this analysis (Hoge et al., 2004). Respondents met broad criteria for PTSD if they reported feeling "terrified" or "helpless" when Hurricane Katrina happened and they reported one or more reexperiencing symptom (e.g., kept "remembering Katrina even when didn't want to"), three or more avoidance symptoms (e.g., "avoided places or people or activities that might have reminded you of Katrina"), and two or more arousal symptoms (e.g., "trouble sleeping") since Hurricane Katrina. Symptoms were required to have lasted at least one month. We note that we assessed PTSD explicitly in reference to Hurricane Katrina when possible. Therefore, all of the questions in the Katrina-related PTSD measure were asked specifically with reference to Katrina (e.g., "Did you keep remembering Katrina even when you didn't want to?" and "Did you deliberately try not to think or talk about Katrina?"). We also note that when the CIDI is administered in non-postdisaster situations, one of the questions asked to establish a Criterion A traumatic event, is whether "a natural disaster, such as a major earthquake, hurricane, flood, or tornado" has ever happened to the respondent. In this context, it seems reasonable that all of our study respondents would answer yes to this question because of their area of residence, so all of our respondents, would, by CIDI standards, be considered exposed to a traumatic event. Restricting our participants to those who reported feeling terrified or helpless when the event happened (Criterion A2 for *DSM-IV* PTSD) further ensures that respondents meeting criteria for PTSD were sufficiently exposed. Respondents met strict criteria for PTSD if, in addition to the above, they reported that symptoms interfered with their life or activities a lot. We also asked respondents whether symptoms related to Hurricane Katrina had occurred in the month prior to the interview to assess current PTSD.

Data Analysis

We described the sociodemographic characteristics, hurricane-related experiences of respondents, PTSD prevalence (since Hurricane Katrina, past month), and lifetime traumatic event experiences, overall and within the three sampling strata. We conducted bivariate analyses of the relation between covariates and PTSD since Hurricane Katrina, using two-tailed chi-square tests. We fit a logistic regression model predicting PTSD since Hurricane Katrina including all covariates theorized to be related to PTSD. The results were very similar when using the broad versus strict PTSD criteria; we focus on results using the broad criteria. We assessed interactions between severity of exposure to hurricane-related events and stressors and social support after Hurricane Katrina, as well as history of PTSD symptoms. Finally, we created Kaplan-Meier curves demonstrating time from Hurricane Katrina to remission of PTSD symptoms among respondents who met broad criteria for PTSD and who reported onset of symptoms within one month of Hurricane Katrina, by variables reflecting severity of exposure to hurricane-related events and stressors. All analyses were conducted using SUDAAN (Version 9.0.3; RTI International, 2007) or Stata (Version 9.2; Stata Corp., 2005). Analyses were weighted to account for differential probability of selection within households (incorporating number of eligible household members for all study strata, as well as number of telephone numbers in the household for Stratum C), sampling probabilities in the three study strata, and to account for differences with age, race/ethnicity, gender, and educational attainment reported by the 2000 U.S. Census (Bureau of the Census, 2000).

RESULTS

The sociodemographic characteristics of the 810 respondents are presented in Table 1, within study strata and overall. Overall, 50.3% of eligible sampled households completed interviews; only 9.4% of contacted households refused to participate; these participation rates and consistent with, and better than, those documented in most population-based studies conducted under comparably difficult conditions (Galea & Tracy, 2007). The respondents were representative of the 2000 U.S. Census population in the study area after application of weights; characteristics of respondents within each stratum were also representative of the underlying Census populations, with the exception of household income in Stratum C, where higher income groups were overrepresented in the sample.

A large proportion of respondents reported Katrina-related traumatic events or financial loss (Table 2); as expected, respondents in Strata A and B were more likely to report hurricane-related traumatic events than those in Stratum C (40.7% and 31.5%, respectively, versus 19.2% in Stratum C, $p < .01$). Respondents in Strata A and B were also more likely to report a high level of exposure to posthurricane stressors than those in Stratum C (56.9% and 46.0%, respectively, versus 27.0% in Stratum C, $p < .001$). The overall prevalence of PTSD related to Hurricane Katrina was 22.5% using broad criteria, and 15.5% using strict criteria (Table 3). The prevalence of PTSD was higher in the study strata closer to the Gulf Coast (broad criteria: 24.8% in Stratum A, 25.5% in Stratum B, 19.4% in Stratum C; strict criteria: 19.8% in Stratum A, 19.6% in Stratum B, 10.6% in Stratum C, both $p > .05$). In the month prior to the interview, 14.8% of respondents met broad criteria for PTSD related to Hurricane Katrina, while 11.8% met strict criteria.

Bivariate associations between covariates of interest and PTSD since Hurricane Katrina (using broad criteria) are presented in Table 4. In a multivariable logistic regression model (Table 4), determinants of PTSD related to Hurricane Katrina were female gender, financial loss as a result of Hurricane Katrina, high level of stressors after the hurricane, low social support after the hurricane, and high level of traumatic events after the hurricane.

There were no significant interactions between level of posthurricane social support and hurricane-related traumatic events or

Table 1. Sociodemographic Characteristics of Respondents, Compared with 2000 U.S. Census Population[a,b]

	Stratum A[c] $n = 272$		Stratum B[d] $n = 267$		Stratum C[e] $n = 271$		Total $N = 810$		U.S. Census 2000 $N = 655642$	
Characteristic	*n*	Weighted %[f]	*n*	Weighted %[f]	*n*	Weighted %[f]	*n*	Weighted %[f]	*n*	%
Gender										
Male	94	47.1	120	53.7	88	45.0	302	47.8	314869	48.0
Female	178	52.9	147	46.3	183	55.0	508	52.2	340773	52.0
Age										
≥65yrs	73	17.9	52	13.3	81	20.8	206	18.1	109031	16.6
55–64 yrs	57	13.7	60	12.9	61	17.8	178	15.4	80989	12.4
45–54 yrs	53	12.9	55	13.4	51	13.8	159	13.4	115729	17.7
35–44 yrs	52	30.3	43	24.6	42	21.6	137	24.8	136026	20.7
25–34 yrs	25	12.6	36	20.7	22	10.2	83	13.6	118667	18.1
18–24 yrs	12	12.5	21	15.2	14	15.9	47	14.8	95200	14.5
Race/ethnicity										
White non-Hispanic	190	76.2	228	90.2	177	61.6	595	73.1	475413	72.5
Black non-Hispanic	55	19.4	26	8.5	78	35.4	159	24.0	157190	24.0
Hispanic	6	1.8	7	0.7	3	1.1	16	1.2	10010	1.5
Asian/PI non-Hispanic	5	0.7	1	0.1	1	0.1	7	0.2	6484	1.0
Other non-Hispanic	14	1.8	4	0.5	6	0.7	24	1.0	2213	0.3
Mixed race non-Hispanic	2	0.1	1	0.1	4	1.1	7	0.6	4332	0.7
Educational attainment										
Bachelor's degree or higher	82	18.6	50	9.5	71	13.9	203	14.1	92187	14.1
Some college	74	33.1	80	32.9	63	27.0	217	30.2	197572	30.1
High school or equivalent	81	26.0	92	33.5	93	33.3	266	31.3	203879	31.1
<High school	35	22.4	45	24.1	41	25.9	121	24.4	162324	24.7
Household income										
≥$100,000	17	8.1	16	5.5	25	11.9	58	9.1	18853	5.7
$60,000–$99,999	47	20.5	38	12.1	44	18.2	129	17.3	48826	14.6
$40,000–$59,999	57	17.5	46	23.0	30	11.6	133	16.2	61651	18.5
$20,000–$39,999	73	31.1	82	32.4	60	25.0	215	28.8	97306	29.2
<$20,000	58	23.2	58	27.0	68	33.3	184	28.7	106980	32.1
Marital status										
Married	131	49.1	146	59.4	139	52.6	416	53.4	373266	56.9
Divorced	51	12.5	39	11.3	37	9.1	127	10.6	76511	11.7
Separated	6	1.2	5	1.4	9	4.8	20	2.9	17157	2.6
Widowed	35	7.0	33	6.7	46	8.1	114	7.4	53446	8.1
Never been married	49	30.2	43	21.2	39	25.5	131	25.7	135582	20.7

[a]All data are restricted to the population 18 years and older. [b]There were no statistically significant differences between the weighted sample characteristics and 2000 Census estimates for the overall sampling frame and within strata, with the one exception of household income in Stratum C, where higher income groups were overrepresented in the sample. [c]Stratum A includes Hancock, Harrison, and Jackson counties below Interstate-10. [d]Stratum B includes Hancock, Harrison, and Jackson counties above Interstate-10, and George, Pearl River, and Stone counties. [e]Stratum C includes Adams, Amite, Covington, Forrest, Franklin, Greene, Jefferson Davis, Jones, Lamar, Lawrence, Lincoln, Marion, Perry, Pike, Walthall, Wayne, and Wilkinson counties. [f]Weight accounts for number of persons (and telephone numbers for Stratum C) in the household, probability of household selection within strata, and poststratification weights to make the sample representative of population by age, gender, race/ethnicity, and educational attainment.

Table 2. Hurricane Katrina Experiences Reported by Respondents, by Sampling Strata

	Stratum A[a] $n = 272$		Stratum B[b] $n = 267$		Stratum C[c] $n = 271$		Total $N = 810$	
	n	Weighted %[d]	*n*	Weighted %[d]	*n*	Weighted %[d]	*n*	Weighted %[d]
Hurricane Katrina event experiences								
Present during hurricane force winds or major flooding	148	54.1	190	71.8	246	93.2	225	76.7
Unsure about the safety or whereabouts of family or friends	178	66.0	181	68.7	165	65.5	524	66.5
Involved in rescue or recovery efforts	77	29.1	77	29.3	56	20.7	210	25.3
Hurricane Katrina-related traumatic events								
Physically injured	24	6.8	10	2.5	9	4.6	43	4.7
Know someone who was injured or killed	93	31.9	69	25.2	37	16.1	199	22.9
Saw dead bodies	26	16.1	20	8.6	5	3.1	51	8.2
Exposure to any hurricane-related traumatic events[e]	114	40.7	84	31.5	45	19.2	243	23.4
Financial loss related to Hurricane Katrina								
A lot of damage to property or possessions	140	52.3	91	33.0	57	19.9	288	32.4
Lost job as a result of Hurricane Katrina	55	24.9	44	22.2	11	7.0	110	16.0
Household income declined as a result of Hurricane Katrina	68	26.1	47	18.2	22	9.8	137	16.5
Any financial loss as a result of Hurricane Katrina[f]	170	66.3	129	49.8	79	29.9	378	45.2
Exposure to stressors after Hurricane Katrina								
Lost sentimental possessions, like photographs	158	59.8	87	35.2	27	14.5	272	32.5
Displaced from home	128	46.6	88	33.4	44	16.9	260	29.6
Number of days displaced from home, *M* (*SD*)	389.4 (299.3)		163.7 (287.5)		187.0 (452.0)		270.6 (356.2)	
Shortage of food or water[g]	77	31.7	78	31.3	95	37.4	250	34.2
Unsanitary conditions[g]	86	31.9	81	33.5	43	16.2	210	25.0
Fear of crime[g]	96	36.6	102	38.3	70	29.6	268	33.8
Difficulty receiving checks from government or insurance agencies[g]	119	40.7	85	32.6	63	21.2	267	29.6
Difficulty finding sufficient housing[g]	77	32.5	37	16.7	24	11.3	138	18.7
Difficulty finding a contractor[g]	96	38.0	81	28.9	69	23.6	246	29.0
Exposure to hurricane-related stressors[h]								
Low (0–2 stressors)	124	43.1	146	54.1	200	73.0	470	59.8
High (3 or more stressors)	148	56.9	121	46.0	71	27.0	340	40.2
Social support received in the 2 months after Hurricane Katrina[i]								
High	114	45.9	100	36.5	102	37.1	316	39.4
Medium	88	28.2	98	36.1	83	32.0	269	32.0
Low	69	26.0	69	27.5	86	30.9	224	28.6

[a]Stratum A includes Hancock, Harrison, and Jackson counties below Interstate-10. [b]Stratum B includes Hancock, Harrison, and Jackson counties above Interstate-10, and George, Pearl River, and Stone counties. [c]Stratum C includes Adams, Amite, Covington, Forrest, Franklin, Greene, Jefferson Davis, Jones, Lamar, Lawrence, Lincoln, Marion, Perry, Pike, Walthall, Wayne, and Wilkinson counties. [d]Weight accounts for number of persons (and telephone numbers for Stratum C) in the household, probability of household selection within strata, and poststratification weights to make sample representative of population by age, gender, race/ethnicity, and educational attainment. [e]Exposure to hurricane-related traumatic events includes being physically injured, knowing someone who was injured or killed, and seeing dead bodies during or after Hurricane Katrina. [f]Financial loss includes *a lot* of damage to property or possessions, losing a job, or experiencing decline in household income as a result of Hurricane Katrina. [g]Stressors assessed for the 6 months after Hurricane Katrina; "yes" responses include those who reported experiencing *some* or *a lot* of stress associated with the item. [h]Sum of eight hurricane-related stressors. [i]Social support score was created by summing responses indicating the frequency (ranging from *never* to *always*) of six items ("someone willing to listen to you when you need to talk," "contact with people who were in a similar situation," "able to talk about your thoughts and feelings with others," "sympathy and support from others," "practical help from others," and "let down by others"; the last item was reverse coded).

Table 3. Posttraumatic Stress Disorder (PTSD) since Hurricane Katrina and in the Past Month, and Traumatic Event Experiences, by Sampling Strata

	Stratum A[a] $n = 272$		Stratum B[b] $n = 268$		Stratum C[c] $n = 271$		Total $N = 810$	
	n	Weighted %[d]	*n*	Weighted %[d]	*n*	Weighted %[d]	*n*	Weighted %[d]
PTSD since Hurricane Katrina								
Broad definition[e]	63	24.8	68	25.5	37	19.4	168	22.5
Strict definition[f]	50	19.8	51	19.6	22	10.6	123	15.5
PTSD in past month								
Broad definition[e]	42	18.8	38	13.7	22	13.0	102	14.8
Strict definition[f]	36	16.9	31	11.5	15	8.8	82	11.8
Exposure to traumatic events prior to Hurricane Katrina[g]								
Low (0–1 traumatic events)	53	24.8	49	22.0	70	25.8	172	24.6
Medium (2–3 traumatic events)	83	27.2	92	33.0	100	40.4	275	34.8
High (4 or more traumatic events)	136	48.0	126	45.0	101	33.8	363	40.6
Exposure to traumatic events after Hurricane Katrina[g]								
Low (0–1 traumatic events)	239	82.9	224	82.8	237	81.8	700	82.4
High (2 or more traumatic events)	33	17.2	43	17.2	34	18.2	110	17.7

[a]Stratum A includes Hancock, Harrison, and Jackson counties below Interstate-10. [b]Stratum B includes Hancock, Harrison, and Jackson counties above Interstate-10, and George, Pearl River, and Stone counties. [c]Stratum C includes Adams, Amite, Covington, Forrest, Franklin, Greene, Jefferson Davis, Jones, Lamar, Lawrence, Lincoln, Marion, Perry, Pike, Walthall, Wayne, and Wilkinson counties. [d]Weight accounts for number of persons (and telephone numbers for Stratum C) in the household, probability of household selection within strata, and poststratification weights to make sample representative of population by age, gender, race/ethnicity, and educational attainment. [e]At least one reexperiencing symptom, at least three avoidance symptoms, and at least two arousal symptoms, symptoms lasting at least one month, and reported feeling "terrified" or "helpless" when Hurricane Katrina happened. [f]Respondents additionally reported that symptoms interfered a lot with life or activities. [g]Traumatic events assessed were natural disaster other than Hurricane Katrina, serious accident, physical assault with or without a weapon, unwanted sexual contact, physical abuse or serious neglect as a child (for time prior to Hurricane Katrina only), military combat, diagnosis with a life-threatening illness, unexpected death of someone close, traumatic experience of someone close, and any other extraordinarily stressful event.

financial loss, or posthurricane stressors or traumatic events in predicting PTSD after Hurricane Katrina (data not shown).

Figure 3 presents Kaplan-Meier survival curves of time from Hurricane Katrina (here defined as August 29, 2005, when the hurricane first made landfall in Mississippi) to remission of PTSD symptoms, among the 155 respondents who met broad criteria for PTSD and who reported onset of symptoms within one month of Hurricane Katrina, stratified by exposure to hurricane-related traumatic events, financial loss, posthurricane stressors, and posthurricane traumatic events. Respondents with greater exposure to hurricane-related events and stressors demonstrated longer duration of PTSD symptoms, although level of exposure to traumatic events after Hurricane Katrina did not distinguish duration of PTSD symptoms in respondents.

DISCUSSION

There are three central and novel observations that emerge from this study. First, we show a higher burden of PTSD in the disaster-affected area than is typically demonstrated in population-based studies after these events. Second, we found that it was ongoing stressors and traumatic events that were primarily associated with the risk of PTSD in this sample. Third, we showed that these stressors and traumatic events were associated with both the incidence and the course of PTSD after this disaster.

The high burden of PTSD in Mississippi documented here is consistent with a large body of evidence that shows substantial psychological impact of disasters and mass trauma, particularly disasters that are accompanied by substantial population exposure to traumas and stressors (Galea et al., 2005; Norris et al., 2002). However, most general population studies after natural disasters have reported a prevalence of PTSD that is approximately half the prevalence in this study (Cao, McFarlane, & Klimidis, 2003; Carr et al., 1995; Kaiser, Sattler, Bellack, & Dersin, 1996; Shannon, Lonigan, Finch, & Taylor, 1994). What is remarkable in this study is that this high a prevalence of PTSD was documented among a population-representative sample of a very large geographic area. The area sampled is about 13,000 square miles in area and had, before Hurricane Katrina, a population of approximately 655,642 adults. The documented prevalence of PTSD in this study then suggests that about 160,000 adults who were residents of Mississippi before Hurricane Katrina had PTSD at some point in the 2 years after the hurricane. We note that although higher prevalence of PTSD has been reported among specific groups after

Table 4. Bivariate Associations Between Covariates and Posttraumatic Stress Disorder (PTSD) Since Hurricane Katrina, and Adjusted Model Predicting PTSD Since Hurricane Katrina

	PTSD (Broad definition)[a]		Adjusted model	
	n PTSD	% PTSD	Odds Ratio[c]	95% CI
Total[b]	168	22.5		
Gender				
Male	52	20.0	1.00	–
Female	116	24.8	1.79*	1.06–3.03
Age*				
≥55yrs	71	15.1	1.00	–
35–54 yrs	71	23.4	1.18	0.65–2.15
18–34 yrs	26	30.0	1.74	0.83–3.62
Race/ethnicity				
White non-Hispanic	111	19.2	1.00	–
Black non-Hispanic	43	32.4	1.35	0.73–2.50
Hispanic	4	44.1	1.87	0.14–25.09
Other non-Hispanic	10	15.9	1.03	0.35–3.06
Educational attainment*				
≥High school or equivalent	133	19.2	1.00	–
<High school	35	33.3	1.30	0.67-2.52
Household income**				
≥$100,000	15	25.3	1.00	–
$60,000–$99,999	17	15.4	0.47	0.17–1.27
$40,000–$59,999	29	19.4	0.54	0.19–1.56
$20,000–$39,999	40	20.1	0.57	0.21–1.50
<$20,000	54	36.9	0.92	0.33–2.53
Missing	13	7.7	0.29	0.08–0.98
Marital status				
Married	78	18.3	1.00	–
Divorced/separated/widowed	57	24.8	0.78	0.41–1.47
Never been married	33	29.4	1.08	0.50–2.34
Exposure to Hurricane Katrina-related traumatic events[d]**				
No	90	18.3	1.00	–
Yes	78	33.2	1.52	0.87–2.64
Financial loss as a result of Hurricane Katrina[e]***				
No	53	14.8	1.00	–
Yes	115	31.8	1.95*	1.17–3.26
Exposure to stressors after Hurricane Katrina[f]***				
Low (0–2 stressors)	50	11.6	1.00	–
High (3 or more stressors)	118	38.6	2.57***	1.50–4.40
Social support received in the 2 months after Hurricane Katrina[g]**				
High	44	14.1	1.00	–
Medium	56	22.1	1.77	0.96–3.29
Low	68	34.5	2.90**	1.51–5.59
Exposure to traumatic events prior to Hurricane Katrina[h]***				
Low (0–1 traumatic events)	28	16.5	1.00	–
Medium (2–3 traumatic events)	46	19.7	1.39	0.66–2.92
High (4 or more traumatic events)	94	28.5	1.70	0.85–3.40

(Continued)

Table 4. Continued

	PTSD (Broad definition)[a]		Adjusted model	
	n PTSD	% PTSD	Odds Ratio[c]	95% CI
Exposure to traumatic events after Hurricane Katrina[h]				
Low (0–1 traumatic events)	128	16.2	1.00	–
High (2 or more traumatic events)	40	52.0	3.15***	1.68-5.89

[a]At least one reexperiencing symptom, at least three avoidance symptoms, and at least two arousal symptoms, symptoms lasting at least one month, and reported feeling "terrified" or "helpless" when Hurricane Katrina happened. [b]Two-tailed p-value from chi-squared test indicated next to variable name if variable is statistically significant at the 0.05 level or smaller; $^{*}p < .05$. $^{**}p < .01$. $^{***}p < .001$. [c]Two-tailed Wald p-value from F test indicated if overall variable is statistically significant at the .05 level; $^{*}p < .05$. $^{**}p < .01$. $^{***}p < .001$. [d]Exposure to hurricane-related traumatic events includes being physically injured, knowing someone who was injured or killed, and seeing dead bodies during or after Hurricane Katrina. [e]Financial loss includes *a lot* of damage to property or possessions, losing a job, or experiencing decline in household income as a result of Hurricane Katrina. [f]Sum of eight hurricane-related stressors (displaced from home, loss of sentimental possessions, and experiencing *some* or *a lot* of stress from shortage of food or water, unsanitary conditions, fear of crime, difficulty receiving checks from government of insurance agencies, difficulty finding sufficient housing, and difficulty finding a contractor. [g]Social support score was created by summing responses indicating the frequency (ranging from *never* to *always*) of six items ("someone willing to listen to you when you need to talk," "contact with people who were in a similar situation," "able to talk about your thoughts and feelings with others," "sympathy and support from others," "practical help from others," and "let down by others,"; the last item was reverse coded). [h]Traumatic events included natural disaster other than Hurricane Katrina, serious accident, assault with or without a weapon, unwanted sexual contact, physical abuse or serious neglect as a child, military combat, diagnosis with a life-threatening illness, witnessing someone seriously injured or killed, unexpected death of someone close, traumatic experience of someone close, any other extraordinarily stressful situation or event.

disasters, this is almost invariably among special groups including clinical samples (Livanou, Basoglu, Salcioglu, & Kalendar, 2002) and among persons in areas that were heavily affected by a natural disaster (Bodvarsdottir & Elklit, 2004; Najarian, Goenjian, Pelcovitz, Mandel, & Najarian, 2001; Suar, Mandal, & Khuntia, 2002).

Traumatic event and stressor exposure during and after the hurricane was centrally associated with the risk and rate of resolution of PTSD. Interestingly, the hurricane-related events and stressors reported here were not necessarily those that were burned into the national consciousness through repeated broadcasting of television images. For example, only about 8% of respondents reported seeing dead bodies. However, 32% of respondents reported a lot of damage to their property or possessions as a result of the hurricane; the vast majority of the sample (81%) reported at least one other substantial stressor. Postdisaster financial stressors, which are neither easily visible, nor in many respects television-worthy, were independently associated with risk of PTSD.

Although the observation that ongoing traumatic events are associated with PTSD in long-term follow-up after disaster exposure is not new, the findings documented here reinforce the notion that greater exposure to traumatic events and stressors during and after a disaster are the key determinants of PTSD risk and resolution after these events. Although the event experiences associated with a hurricane hitting land may, to some extent, be unavoidable (barring timely prehurricane evacuation), it is reasonable to suggest that a proportion of the stressors incurred after the hurricane had hit, including, for example, adversity with housing reconstruction, are avoidable and suggest points for intervention after these events. This is a strong argument for efficient practical and logistical assistance to persons who are in disaster-affected areas. Such assistance may both influence the return of disaster-affected areas to economic viability and productivity, but also have a substantial impact on the burden of psychopathology after such events. The observations about the influence of stressors after a mass disaster are consistent with other work that has been published after Hurricane Katrina that used a different sampling frame, different sampling methods, and a different timeframe (Galea et al., 2007). We think that this replication of findings lends further weight to the suggestion that in the aftermath of large natural disasters, practical interventions aimed at minimizing tangible stressors are indeed a health intervention that needs to be at the forefront of postdisaster policy making in the short and longer term after these events.

There were few associations documented between sociodemographic variables and the likelihood of PTSD in models that took into account both sociodemographics and exposure to traumas and stressors. Although the role of poverty in shaping the aftermath of Hurricane Katrina has received substantial public attention, this work suggests that in the context of a mass disaster where traumatic events were near ubiquitous, sociodemographic characteristics may play less of a role than in circumstances where there is more heterogeneity of population exposure. We did find an association between gender and the risk of PTSD in this sample, consistent with most postdisaster studies (Norris et al., 2002). Low social support also was associated with the risk of PTSD in this study. This is consistent with several other postdisaster studies (Norris & Kaniasty, 1996; North et al., 1999). It is plausible that low social support may further exacerbate the contribution of traumatic event exposure during and after disasters to the burden

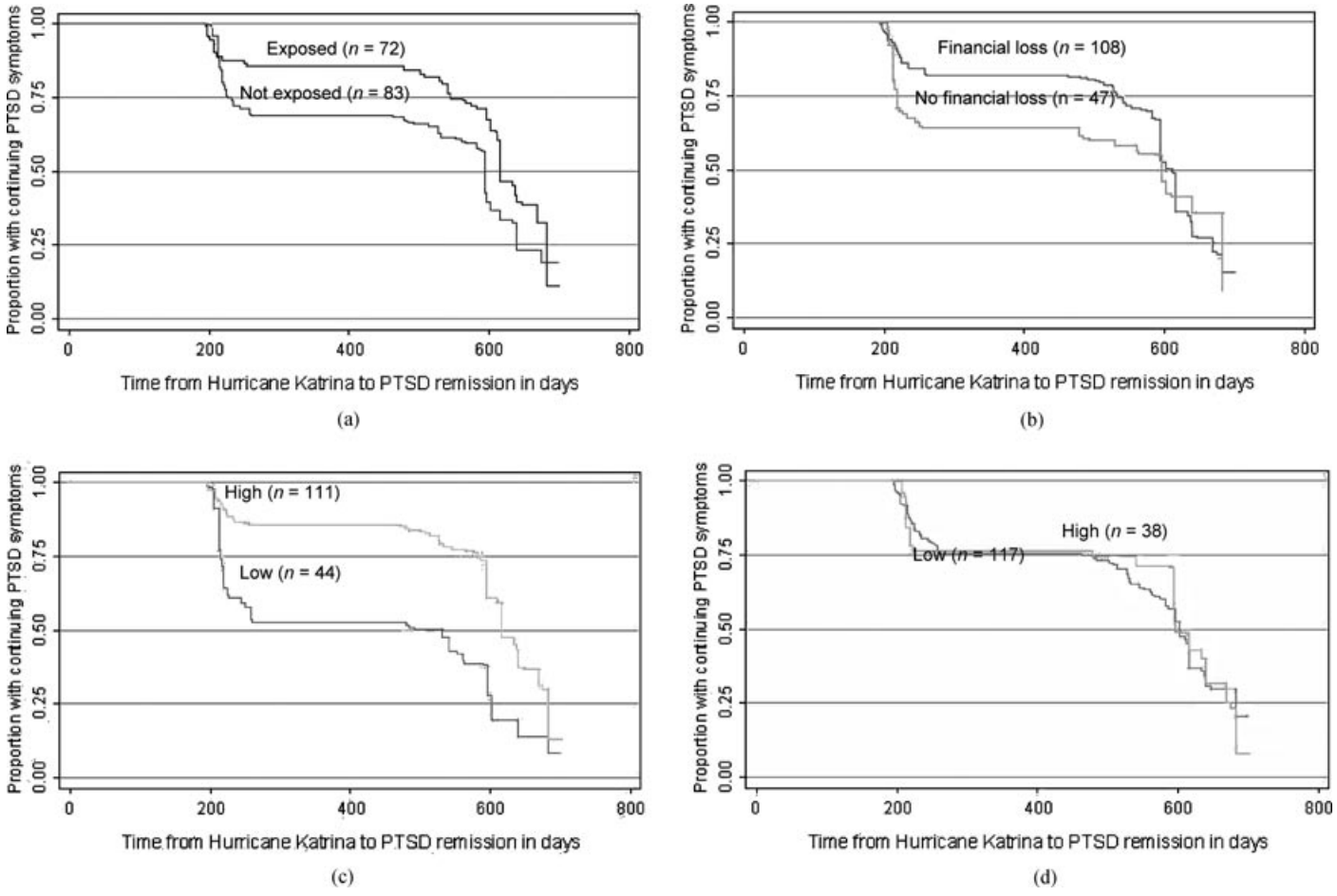

Figure 3. Kaplan-Meier survival curves showing time from Hurricane Katrina to PTSD remission, among respondents meeting criteria for PTSD who reported onset of symptoms within one month of Hurricane Katrina ($N = 155$), by exposure to events and stressors during and after Hurricane Katrina. The group experiencing high exposure to hurricane-related stressors is comprised of those who reported three or more stressors, whereas the low exposure is comprised of those who reported 0–2 stressors; the group experiencing high exposure to posthurricane traumatic events includes those who reported two or more traumatic events in the time between Hurricane Katrina and the interview, whereas those with low exposure reported 0 or 1 post-hurricane traumatic event. (a) Exposure to hurricane-related traumatic events. (b) Financial loss as a result of Hurricane Katrina. (c) Exposure to stressors after Hurricane Katrina. (d) Exposure to traumatic events after Hurricane Katrina.

of psychopathology; however, we did not find evidence of an interaction between social support and experiences during and after Hurricane Katrina in this sample.

There are six central limitations to the results reported here. First, as with all other population-based surveying, it is possible that there is mismeasurement of the constructs of interest. Posttraumatic stress disorder was assessed by the CIDI, a structured interview designed for lay interviewers, rather than by clinician-administered diagnostic instruments. The CIDI, however, has been widely used (for example, in the National Comorbidity Survey and Replication) and validated (Haro et al., 2006; Kessler et al., 1998, 2004; Wittchen et al., 1999). Second, we did not include a measure of prior history of PTSD in this analysis. Although prior work has demonstrated the importance of history of psychopathology in influencing future risk (Daviss et al., 2000; Delahanty & Nugent, 2006; Zatzick et al., 2002), prior PTSD is unlikely to be a confounder of the relations between events and experiences during and after the hurricane and hurricane-related

PTSD, which were of central interest here. Third, because the study occurred between a year and a half and 2 years after Hurricane Katrina, it is possible that there was imperfect recall about the events that transpired around the hurricane and that acute cases of PTSD were missed. It is possible that the length of time after the event promotes an underestimation of the true scope of both the traumatic events and stressors experienced, as well as mental health symptoms after the hurricane. Conversely, it is possible that the centrality of this event to the lives of persons in Mississippi may result in overestimation. Furthermore, the timing of the study allowed us to examine the longer-term consequences of Hurricane Katrina. Fourth, the small sample size of PTSD cases limited our ability to assess the relation between covariates and duration of PTSD symptoms in multivariable models. Fifth, as in many general population epidemiologic studies we were limited in our assessment of domains. For example, although we did ask about financial loss we were limited in our quantification of that loss and we did not assess attempts to rebuild or recover losses. Future qualitative work or work using assessments that are more detailed perhaps in smaller samples may be better suited to a fuller determination of the mechanisms explaining the associations that are documented here. Sixth, although our response rate was comparable to many other population-based studies there is always a concern that our findings were particular to this sample and systematically different to what may be the case in the underlying general population. The comparability of our sample to expected demographics somewhat mitigates this concern. Perhaps more importantly, the best available evidence suggests that most survey nonresponse is random and that its influence on documentation of both prevalences and associations within such survey-based work is limited (Galea & Tracy, 2007).

Overall, we found that there was a high prevalence of stressors and traumatic events experienced by residents of Mississippi and that these experiences were associated with a substantial burden of PTSD after the hurricane. There was little variability in the risk of PTSD across sociodemographic characteristics, perhaps reflecting the pervasive nature of the traumatic events and stressors experienced during this event that were centrally associated with a high burden of PTSD across sociodemographic groups. Both direct experience of traumatic events during and after the hurricane and hurricane-related financial adversity and other posthurricane stressors were key determinants of PTSD. Postdisaster management plans that mitigate the stressful practical challenges faced by postdisaster survivors may contribute to a reduction in the burden of mental illness after these events.

REFERENCES

Armenian, H. K., Morikawa, M., Melkonian, A. K., Hovanesian, A. P., Haroutunian, N., Saigh, P. A., et al. (2000). Loss as a determinant of PTSD in a cohort of adult survivors of the 1988 earthquake in Armenia: Implications for policy. Acta Psychiatrica Scandinavica, 102, 58–64.

Bodvarsdottir, I., & Elklit, A. (2004). Psychological reactions in Icelandic earthquake survivors. Scandinavian Journal of Psychology, 45, 3–13.

Bureau of the Census. (2000). Census summary tape, file 3A (STF 3A). Washington, DC: US Department of Commerce.

Cao, H., McFarlane, A. C., & Klimidis, S. (2003). Prevalence of psychiatric disorder following the 1988 Yun Nan (China) earthquake—the first 5-month period. Social Psychiatry and Psychiatric Epidemiology, 38, 204–212.

Carr, V. J., Lewin, T. J., Webster, R. A., Hazell, P. L., Kenardy, J. A., & Carter, G. L. (1995). Psychosocial sequelae of the 1989 Newcastle earthquake: I. Community disaster experiences and psychological morbidity 6 months post-disaster. Psychological Medicine, 25, 539–555.

Centers for Disease Control and Prevention (CDC). (2006). Assessment of health-related needs after Hurricanes Katrina and Rita: Orleans and Jefferson parishes, New Orleans area, Louisiana, October 17–22, 2005. Morbidity and Mortality Weekly Report, 55(2), 38–41.

Coker, A. L., Hanks, J. S., Eggleston, K. S., Risser, J., Tee, P. G., Chronister, K. J., et al. (2006). Social and mental health needs assessment of Katrina evacuees. Disaster Management & Response, 4, 88–94.

Daviss, W. B., Mooney, D., Racusin, R., Ford, J. D., Fleischer, A., & McHugo, G. J. (2000). Predicting posttraumatic stress after hospitalization for pediatric injury. Journal of the American Academy of Child and Adolescent Psychiatry, 39, 576–583.

Delahanty, D. L., & Nugent, N. R. (2006). Predicting PTSD prospectively based on prior trauma history and immediate biological responses. Annals of the New York Academy of Science, 1071, 27–40.

Department of Homeland Security (DHS). Hurricane Katrina: What government is doing. Retrieved October 8, 2007, from http://www.dhs.gov/katrina

DeSalvo, K. B., Hyre, A. D., Ompad, D. C., Menke, A., Tynes, L. L., & Muntner, P. (2007). Symptoms of posttraumatic stress disorder in a New Orleans workforce following Hurricane Katrina. Journal of Urban Health: Bulletin of the New York Academy of Medicine, 84, 142–152.

Galea, S., Brewin, C. R., Gruber, M., Jones, R. T., King, D. W., King, L. A., et al. (2007). Exposure to hurricane-related stressors and mental illness after Hurricane Katrina. Archives of General Psychiatry, 64, 1427–1434.

Galea, S., Nandi, A., & Vlahov, D. (2005). The epidemiology of post-traumatic stress disorder after disasters. Epidemiologic Reviews, 27, 78–91.

Galea, S., & Tracy, M. (2007). Participation rates in epidemiologic studies. Annals of Epidemiology, 17, 643–653.

Gallup Poll News Service. (2005). At least 100,000 Katrina victims still separated from families. Retrieved October 14, 2005, from http://www.galluppoll.com/content/?ci=19225&pg=1&VERSION=p

Glesser, G. C., Green, B. L., & Winget, C. N. (1981). Prolonged effects of disaster: A study of Buffalo Creek. New York: Academic Press.

Haro, J. M., Arbabzadeh-Bouchez, S., Brugha, T. S., de Girolamo, G., Guyer, M. E., Jin, R., et al. (2006). Concordance of the Composite International Diagnostic Interview version 3.0 (CIDI 3.0) with standardized clinical assessments in the WHO world mental health surveys. International Journal of Methods in Psychiatric Research, 15, 167–180.

Hoge, C. W., Castro, C. A., Messer, S. C., McGurk, D., Cotting, D. I., & Koffman, R. L. (2004). Combat duty in Iraq and Afghanistan, mental health problems, and barriers to care. New England Journal of Medicine, 351, 13–22.

Joseph, S., Williams, R., & Yule, W. (1992). Crisis support, attributional style, coping style, and post-traumatic symptoms. Personality and Individual Differences, 13, 1249–1251.

Kaiser, C. F., Sattler, D. N., Bellack, D. R., & Dersin, J. (1996). A conservation of resources approach to a natural disaster: Sense of coherence and psychological distress. Journal of Social Behavior and Personality, 11, 459–476.

Kaniasty, K., & Norris, F. H. (1993). A test of the social support deterioration model in the context of natural disaster. Journal of Personality and Social Psychology, 64, 395–408.

Kessler, R. C., Abelson, J., Demler, O., Escobar, J. I., Gibbon, M., Guyer, M. E., et al. (2004). Clinical calibration of DSM-IV diagnoses in the World Mental Health (WMH) version of the World Health Organization (WHO) Composite International Diagnostic Interview (WMHCIDI). International Journal of Methods in Psychiatric Research, 13, 122–139.

Kessler, R. C., Galea, S., Jones, R. T., Parker, H. A., & Hurricane Katrina Community Advisory Group. (2006). Mental illness and suicidality after Hurricane Katrina. Bulletin of the World Health Organization, 84, 930–939.

Kessler, R. C., & Ustun, T. B. (2004). The World Mental Health (WMH) Survey initiative version of the World Health Organization (WHO) Composite International Diagnostic Interview (CIDI). International Journal of Methods in Psychiatric Research, 13, 93–121.

Kessler, R. C., Wittchen, H. U., Abelson, J. M., McGonagle, K., Schwarz, N., Kendler, K. S., et al. (1998). Methodological studies of the Composite International Diagnostic Interview (CIDI) in the US National Comorbidity Survey. International Journal of Methods in Psychiatric Research, 7, 33–55.

Livanou, M., Basoglu, M., Salcioglu, E., & Kalendar, D. (2002). Traumatic stress responses in treatment-seeking earthquake survivors in Turkey. Journal of Nervous and Mental Disease, 190, 816–823.

Najarian, L. M., Goenjian, A. K., Pelcovitz, D., Mandel, F., & Najarian, B. (2001). The effect of relocation after a natural disaster. Journal of Traumatic Stress, 14, 511–526.

Norris, F. H., Friedman, M. J., Watson, P. J., Byrne, C. M., Diaz, E., & Kaniasty, K. (2002). 60,000 disaster victims speak: Part I. An empirical review of the empirical literature, 1981–2001. Psychiatry, 65, 207–239.

Norris, F. H., & Kaniasty, K. (1996). Received and perceived social support in times of stress: A test of the social support deterioration deterrence model. Journal of Personality and Social Psychology, 71, 498–511.

Norris, F. H., Murphy, A. D., Baker, C. K., & Perilla, J. L. (2004). Postdisaster PTSD over four waves of a panel study of Mexico's 1999 flood. Journal of Traumatic Stress, 17, 283–292.

Norris, F. H., & Uhl, G. A. (1993). Chronic stress as a mediator of acute stress: The case of Hurricane Hugo. Journal of Applied Social Psychology, 23, 1263–1284.

North, C. S., Nixon, S. J., Shariat, S., Mallonee, S., McMillen, J. C., Spitznagel, E. L., et al. (1999). Psychiatric disorders among survivors of the Oklahoma City bombing. Journal of the American Medical Association, 282, 755–762.

Rodriguez, S. R., Tocco, J. S., Mallonee, S., Smithee, L., Cathey, T., & Bradley, K. (2006). Rapid needs assessment of Hurricane Katrina evacuees-Oklahoma, September 2005. Prehospital and Disaster Medicine, 21, 390–395.

Rosenbaum, S. (2006). US health policy in the aftermath of Hurricane Katrina. Journal of the American Medical Association, 295, 437–440.

RTI International. (2007, October). SUDAAN Release 9.0.3. [Computer Software]. Research Triangle Park, NC: Research Triangle Institute.

Shannon, M. P., Lonigan, C. J., Finch, A. J., Jr, & Taylor, C. M. (1994). Children exposed to disaster: I. Epidemiology of post-traumatic symptoms and symptom profiles. Journal of the American Academy of Child and Adolescent Psychiatry, 33, 80–93.

Stata Corporation. (2005). Stata statistical software (Version 9.2) [Computer Software]. College Station, TX: StataCorp LP.

Suar, D., Mandal, M. K., & Khuntia, R. (2002). Supercyclone in Orissa: An assessment of psychological status of survivors. Journal of Traumatic Stress, 15, 313–319.

Wittchen, H. U., Hofler, M., Gander, F., Pfister, H., Storz, S., Uestuen, B., et al. (1999). Screening for mental disorders: Performance of the Composite International Diagnostic-Screener (CID-S). International Journal of Methods in Psychiatric Research, 8, 59–70.

Zatzick, D. F., Kang, S. M., Muller, H. G., Russo, J. E., Rivara, F. P., Katon, W., et al. (2002). Predicting posttraumatic distress in hospitalized trauma survivors with acute injuries. American Journal of Psychiatry, 159, 941–946.