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*Research Article*

# RECOVERY FROM PTSD FOLLOWING HURRICANE KATRINA

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**Background:** *We examined patterns and correlates of speed of recovery of estimated posttraumatic stress disorder (PTSD) among people who developed PTSD in the wake of Hurricane Katrina.* **Method:** *A probability sample of prehurricane residents of areas affected by Hurricane Katrina was administered a telephone survey 7–19 months following the hurricane and again 24–27 months posthurricane. The baseline survey assessed PTSD using a validated screening scale and assessed a number of hypothesized predictors of PTSD recovery that included sociodemographics, prehurricane history of psychopathology, hurricane-related stressors, social support, and social competence. Exposure to posthurricane stressors and course of estimated PTSD were assessed in a follow-up interview.* **Results:** *An estimated 17.1% of respondents had a history of estimated hurricane-related PTSD at baseline and 29.2% by the follow-up survey. Of the respondents who developed estimated hurricane-related PTSD, 39.0% recovered by the time of the follow-up survey with a mean duration of 16.5 months. Predictors of slow recovery included exposure to a life-threatening situation, hurricane-related housing adversity, and high income. Other socio-demographics, history of psychopathology, social support, social competence, and posthurricane stressors were unrelated to recovery from estimated PTSD.* **Conclusions:** *The majority of adults who developed estimated PTSD after Hurricane Katrina did not recover within 18–27 months. Delayed onset was common. Findings document the importance of initial trauma exposure severity in predicting course of illness and suggest that pre- and posttrauma factors typically associated with course of estimated PTSD did not influence recovery following Hurricane Katrina. Depression and Anxiety 28:439–446, 2011.* 

**Key words:** *disasters; posttraumatic stress disorders; PTSD; stressful events; time factors*

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# INTRODUCTION

Hurricane Katrina was one of the most devastating natural disasters in the US history, with more than 1,000 people killed, 500,000 displaced, and more than $100 billion in damage.[1] People in hurricane-affected areas were exposed to many stressors, including death of loved ones, risk of death, property loss, difficulty obtaining food and clothing, and exposure to violence after the storm.[2] Prior research has reported strong associations between severity of disaster-related trauma and posttraumatic stress disorder (PTSD).[3,4] It is thus unsurprising that high rates of PTSD symptoms were found among adults exposed to Hurricane Katrina and were related to hurricane-related stressors.[2,5,6] Little is yet known, though, about the course of PTSD after Katrina. In the one previous study, mean post-Katrina PTSD duration was approximately 600 days in a sample of Mississippi residents.[6] This is similar to estimates in studies of PTSD associated with a broader set of traumas.[7,8] Greater exposure to hurricane-related stressors and postdisaster stress were associated with estimated PTSD persistence, but social support and sociodemographic factors were not.[6] However, that study excluded individuals living in New Orleans, where hurricane-related trauma exposure was the greatest, and examined PTSD course only among individuals who developed symptoms within 1 month of the hurricane. The study was also retrospective. Prospective studies of PTSD find marked fluctuations in PTSD symptoms following disasters,[9,10] which might be obscured in a retrospective study.[11]

Previous studies of PTSD course in other populations suggest that course varies substantially across individuals,[11,12] with 30–40% of cases recovering in the year following onset and another 30–40% exhibiting a chronic course.[7,8,13] Predictors of PTSD persistence include female gender, history of psychiatric disorder, and exposure to additional traumatic events.[13,14] Degree of combat exposure, racial minority status, and low social support have been found to predict chronicity of combat-related PTSD.[15,16]

Although course of PTSD following disasters has been found to be similar to that associated with other traumas,[17] persistence varies across disasters.[18] Certain features of Hurricane Katrina may have contributed to increased chronicity of PTSD: elevated stress exposure persisted after the storm due to forced relocation, difficulty obtaining housing and employment, and lack of access to basic necessities,[2] as well as community disruption and dissolution of support networks. Identification of predictors of chronic PTSD is important in targeting postdisaster treatment planning.

This report uses longitudinal data to study patterns and predictors of PTSD persistence in the Hurricane Katrina Community Advisory Group (CAG), a representative sample of prehurricane residents of hurricane-affected areas who were interviewed on multiple occasions. We examined sociodemographics, prehurricane history of psychopathology, personality characteristics, hurricane-related stressors, and posthurricane stressors and social resources as predictors of recovery.

# MATERIALS AND METHODS

## SAMPLE

We recruited English-speaking adults ($\geq$18 years of age) using a multiframe sample design that included random digit dial calls to households in the FEMA-defined disaster area and a selection of families that applied for assistance from the American Red Cross or FEMA. Overlap across frames was corrected with a weighting adjustment. The baseline CAG included three subsamples: The first was surveyed January–March 2006, 5–7 months posthurricane ($n$ = 1,043, 41.9% cooperation rate); the second was interviewed April–June 2006, 7–10 months posthurricane ($n$ = 723, 33.1% cooperation rate); and the third was interviewed December 2006–April 2007, 15–19 months posthurricane, ($n$ = 1,322, 32.3% cooperation rate). The low cooperation rates resulted from difficulties tracking prehurricane residents of the disaster area, many of whom changed residences, and our requirement that respondents make a long-term commitment to complete multiple interviews. This report focuses only on the second and third subsamples, as complete information about onset and offset of our screening measure of PTSD was not available for the first subsample. All respondents provided informed consent. Recruit and consent procedures were approved by the Human Subjects Committee of Harvard Medical School.

A nonresponse survey was carried out to compare CAG participants with nonparticipants. The two groups were similar on sociodemographics, but nonparticipants had somewhat higher levels of hurricane-related stress exposure and psychological distress than participants. The data were weighted to adjust for these biases. Weights also were used to account for variation in within-household probabilities of selection and residual discrepancies between the CAG and the 2000 Census population on a range of sociodemographic and prehurricane housing variables. These sampling and weighting procedures are described in detail elsewhere.[2,19]

A follow-up interview was carried out with a subsample of respondents from the second and third subsamples in August–November 2007 (24–27 months posthurricane). All respondents estimated to have PTSD or moderate–serious psychological distress at baseline and a probability subsample of other respondents were selected for follow-up,[19] resulting in 1,195 baseline respondents traced (including 16 deceased) and 901 interviewed, for a conditional response rate of 76.4% and an overall cooperation rate of 24.9%. This sample was weighted to adjust for undersampling of baseline respondents without evidence of PTSD or psychological distress and for small differences between baseline and follow-up survey respondents on sociodemographic characteristics.

## MEASURES

**Estimated PTSD.** PTSD was assessed with the validated 12-item Trauma Screening Questionnaire (TSQ).[20,21] TSQ responses are described as measures of "estimated" PTSD because only a subset of the DSM-IV symptoms of PTSD was assessed. Dimensional response options (never, less than once a week, about once a week, 2–4 days a week, and almost every day) were used to assess 30-day symptoms, resulting in a 0–48 total score. A clinical reappraisal study of 30 baseline respondents (20 probable cases and 10 randomly selected others) to calibrate TSQ responses to DSM-IV diagnoses of PTSD used blinded clinical interviewers to assess

current PTSD with the Structured Clinical Interview for DSM-IV.[22] A TSQ cut-point of 20 was found in the weighted (for undersampling of asymptomatic respondents) clinical reappraisal study to generate a case threshold that most closely approximated the SCID diagnostic threshold. Sensitivity (.89), specificity (.93), and area under the receiver operating characteristic curve (.91) for this screen were all excellent in reproducing DSM-IV/SCID PTSD diagnoses. Respondents provided information on frequency of PTSD symptoms during the month their symptoms were worst, which we used to estimate PTSD prevalence since the hurricane. Respondents who screened positive indicated when they began experiencing symptoms at least once a week, which we defined as onset of estimated PTSD. The most recent month with symptoms was used to define PTSD recency.

**Sociodemographics.** Sociodemographics assessed included age, sex, race/ethnicity, education, pre- and posthurricane family income, marital status, and health insurance. Age was coded 18–39, 40–59, and 65 and older. Race/ethnicity was coded non-Hispanic White versus Other. Education was coded high school or less (0–12 years) versus at least some college (13+ years). Family income was coded low/low–average (less than or equal to the population median on the ratio of pretax income to number of family members) and high–high/average (greater than 1.0 on this ratio). Marital status was coded married, previously married, and never married. Health insurance was coded yes–no. We distinguished prehurricane residence: New Orleans Metropolitan Area (which experienced a flood) versus the remaining hurricane area. Analyses investigating the implications of using continuous rather than discretized measures of sociodemographics found no evidence of difference in significance. Results are consequently reported for the discretized measures, as these allow inspection of nonlinear associations.

**Prehurricane psychopathology.** Baseline respondents completed screening scales assessing lifetime history of mood, anxiety, and substance disorders, intermittent explosive disorder, and suicidality. These scales were adapted from the Family History Research Diagnostic Criteria interview,[23,24] whereas suicidality items were from the Self-Injurious Thoughts and Behaviors Interview.[25] A number of specifications of these measures were investigated in predicting estimated persistence of PTSD. The most parsimonious specification was a truncated count of the number of prehurricane lifetime disorders (0, 1, and 2+).

**Hurricane-related stressors.** Exposure to hurricane-related stressors was assessed at baseline. Ten categories generated from preliminary qualitative interviews were sufficiently common to be studied: life-threatening experiences (e.g., narrow escape from flood waters requiring emergency rescue), death of a loved one, victimization after the storm (e.g., robbery–assault), victimization of a loved one, physical illness/injury caused or exacerbated by the storm, extreme physical adversity (e.g., difficulty obtaining food–clothing), extreme psychological adversity (e.g., living in circumstances where the respondent had to use the toilet or change clothes without privacy), major property loss, income loss, and housing adversity (e.g., multiple moves).[2]

**Social resources.** Social network structure, perceived social support, and social competence were briefly assessed at baseline. Network structure was assessed with a question about number of friends who lived in the county/parish. Perceived social support was assessed with questions about number of people in the county/parish with whom the respondent could discuss private feelings without feeling embarrassed. These variables were coded dichotomously (none versus 1+) based on preliminary analysis showing these were optimal specifications. Social competence was assessed with a 12-item scale[26] that asked respondents to rate themselves on a variety of abilities reflecting competence (e.g., staying calm in a crisis, getting along with people, acting responsibly). The scale had high internal consistency (Cronbach's $\alpha = .87$) and was divided into tertiles for analysis, again based on preliminary analysis showing this specification to be optimal. A 0–3 summary measure of social resources summed these three variables (one point given for the top two tertiles of social competence).

**Posthurricane stressors.** Exposure to posthurricane stressors was assessed at follow-up for events occurring in the 12 months before interview, including serious illness/injury of respondent or loved one, death of loved one, marital separation/divorce, break-up of close relationship, serious interpersonal problems, job loss, major financial crisis, legal problems, and property loss. Respondents also rated current hurricane-related difficulties in finances, employment, housing, transportation, interpersonal problems, physical and mental health, and neighborhood crime on a 5-point scale ranging from 1 (none) to 5 (extreme difficulty). We also assessed posthurricane relocation, coded as living in either the same prehurricane area or in a different area.

### ANALYSIS METHODS

Prevalence of PTSD at baseline, follow-up, and at any point since the hurricane was estimated along with the proportion of respondents with PTSD that had remitted by the follow-up. Speed of PTSD recovery was estimated by calculating a survival curve based on duration reports. Multivariate associations of predictors with PTSD recovery were estimated using discrete-time survival analysis with person–months as the unit of analysis.[27] As noted above, we examined a variety of strategies for coding predictor variables and estimating their associations with PTSD recovery. Coefficients and standard errors were exponentiated to create odds ratios (ORs) and 95% confidence intervals (CIs). Because the data were weighted, the Taylor series linearization method was used to calculate design-based significance tests. Statistical significance was evaluated using two-sided .05 level tests.

## RESULTS

### ESTIMATES OF PTSD PREVALENCE AND RECOVERY

An estimated 29.2% respondents ($n = 324$) had hurricane-related PTSD at some time before the follow-up interview (Table 1). Median time-to-onset of symptoms was 1 week (interquartile range: 1–30 days). Nearly half (41.2%) of respondents estimated to have PTSD had delayed onsets that began only after the baseline interview (and thus more than 6 months after the hurricane). Less than half (39.0%) of all estimated cases were resolved by the follow-up, and only about 10% were resolved within the first year following onset. Median time-to-recovery among those who recovered was 16.5 months, but time-to-recovery was greater than 27 months among all estimated cases (Fig. 1). The estimated point prevalence of PTSD was 17.1% at baseline and 17.8% at follow-up. Prevalence estimates were quite similar across the two subsamples of respondents.

### ASSOCIATIONS OF PREHURRICANE CHARACTERISTICS WITH ESTIMATED PTSD RECOVERY

Associations of sociodemographics with estimates of PTSD recovery were examined in a multivariate

**TABLE 1. Estimated prevalence and course of DSM-IV/TSQ posttraumatic stress disorder (PTSD) in the total follow-up sample[a]**

| | Total sample | | Subsample 2 | | Subsample 3 | |
|---|---|---|---|---|---|---|
| | % | (*SE*) | % | (*SE*) | % | (*SE*) |
| Period prevalence since the hurricane | 29.2 | (2.0) | 29.1 | (3.5) | 29.2 | (2.5) |
| 30-day prevalence at baseline | 17.1 | (1.6) | 18.7 | (3.0) | 16.3 | (1.9) |
| 30-day prevalence at follow-up | 17.8 | (1.6) | 19.7 | (3.1) | 16.8 | (1.9) |
| Delayed onset[b] | 41.2 | (3.9) | 35.7 | (6.5) | 44.1 | (4.8) |
| Recovered by follow-up[b] | 39.0 | (3.9) | 32.3 | (6.2) | 42.6 | (4.9) |
| (*n*) | (901) | | (313) | | (588) | |

[a]Estimates of PTSD prevalence were based on the Trauma Screening Questionnaire (TSQ).[23] See "Methods" section for details.
[b]Expressed as a proportion of all cases; that is, 41.2% of the 29.2% of respondents who had hurricane-related PTSD had onsets subsequent to the baseline survey, whereas 39.0% of the 29.2% were recovered as of the time of the follow-up survey.

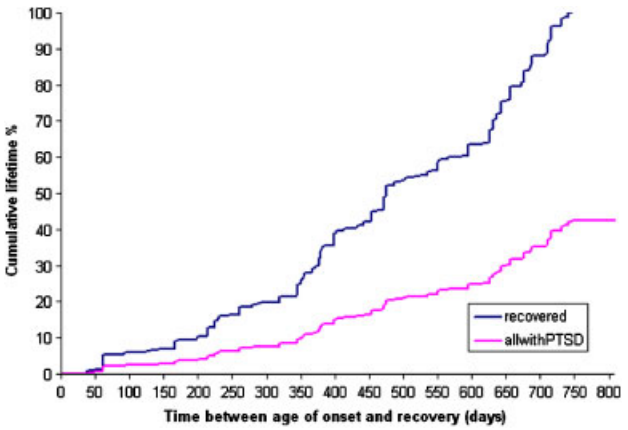


**Figure 1. Speed of recovery from PTSD among individuals who developed PTSD following Hurricane Katrina ($n = 324$).**

survival model. Family income was inversely related to recovery; respondents with low/low–average income had the highest odds of recovery (OR = 2.8, $\chi^2_1 = 11.7$, $P < .001$ compared to the high–average/high income). Other sociodemographics and prior history of psychopathology ($\chi^2_2 = 0.3$, $P = .84$) were unrelated to recovery. Associations did not differ for immediate versus delayed onset cases.

## ASSOCIATIONS OF HURRICANE-RELATED STRESSORS WITH ESTIMATED PTSD RECOVERY

We next examined associations of hurricane-related stressors with estimated PTSD recovery in multivariate survival models that controlled for sociodemographics and prior psychopathology. Two stressors were significant predictors of recovery: experiencing a life-threatening situation and housing adversity (Table 2). None of the 14 respondents with estimated PTSD who experienced a life-threatening situation recovered, whereas the odds of recovery among those who experienced housing adversity was 0.4 ($\chi^2_1 = 6.4$, $P = .012$). None of the other hurricane-related stressors was related to recovery, either in univariate or multivariate models. We examined univariate models to make sure the negative results were not due to multicollearity among these stressors.[2] We also created a continuous variable representing a number of hurricane-related stressors who experienced exclusive of life-threatening situations and housing adversity. This composite measure was not significantly related to recovery (OR = 0.9, $\chi^2_1 = 0.6$, $P = .443$). Associations between hurricane-related stressors and recovery did not differ for immediate versus delayed onset cases.

## ASSOCIATIONS OF POSTHURRICANE STRESSORS WITH ESTIMATED PTSD RECOVERY

Posthurricane stressors were assessed only at follow-up and no information about timing of those stressors was collected, precluding firm conclusions regarding associations of posthurricane stressors with estimates of PTSD recovery. We conducted an exploratory analysis, though, of these associations. Eighteen of the 21 stressors (85.7%) were negatively associated with estimated recovery in models that added one stressor at a time and controlled for sociodemographics, prior psychopathology, housing adversity, and exposure to a life-threatening situation. (Detailed results not reported but available on request.) Difficulties with physical health was the only stressor significantly associated with recovery (OR = 0.5, $\chi^2_1 = 5.0$, $P = .025$).

## ASSOCIATIONS OF SOCIAL RESOURCES WITH ESTIMATED PTSD RECOVERY

Measures of social resources were added one at a time to the same base model used to examine posthurricane stressors. Neither social network structure (OR = 1.9, $\chi^2_1 = 1.9$, $P = .165$), perceived social support (OR = 1.5, $\chi^2_1 = 1.1$, $P = .299$), social

**TABLE 2. Multivariate associations of prehurricane sociodemographics and hurricane-related stressors with recovery from DSM-IV/TSQ posttraumatic stress disorder (PTSD) among respondents who developed PTSD following Hurricane Katrina ($n = 324$)[a,b]**

| | OR | (95% CI) | $\chi^2$ | *P*-value |
|---|---|---|---|---|
| I. Sociodemographics | | | | |
| Age | | | | |
| 18–39 | 0.9 | (0.4, 2.2) | 5.8 | .055 |
| 40–59 | 0.5* | (0.2, 0.9) | | |
| 60+ | 1.0 | – | | |
| Sex | | | | |
| Male | 0.9 | (0.5, 1.6) | 0.2 | .674 |
| Female | 1.0 | – | | |
| Race–ethnicity | | | | |
| Not non-hispanic white | 0.8 | (0.4, 1.5) | 0.6 | .444 |
| Non-hispanic white | 1.0 | – | | |
| Family income | | | | |
| Low/low-middle | 2.8* | (1.5, 5.0) | 11.4* | .001 |
| Middle/high | 1.0 | – | | |
| Education | | | | |
| 0–12 | 1.4 | (0.8, 2.5) | 1.6 | .205 |
| 13+ | 1.0 | – | | |
| Health insurance | | | | |
| No | 0.9 | (0.4, 1.8) | 0.1 | .762 |
| Yes | 1.0 | – | | |
| Prehurricane residence | | | | |
| Flood area | 1.2 | (0.7, 1.9) | 0.4 | .543 |
| Hurricane area | 1.0 | – | | |
| Marital status | | | | |
| Married | 0.9 | (0.4, 1.9) | 1.0 | .597 |
| Previously married | 0.6 | (0.2, 1.7) | | |
| Never married | 1.0 | – | | |
| History of psychopathology | | | | |
| 2+ | 1.4 | (0.7, 3.1) | 1.7 | .436 |
| 1 | 1.9 | (0.7, 5.3) | | |
| 0 | 1.0 | – | | |
| II. Hurricane-related stressors | | | | |
| Life-threatening experience | 0.0*,[c] | (–)[c] | –*,[c] | –[c] |
| Victimized | 0.9 | (0.3–2.6) | 0.0 | .867 |
| Death of loved one | 1.3 | (0.7–2.4) | 0.8 | .380 |
| Loved one victimized | 0.6 | (0.1–1.3) | 1.9 | .165 |
| Property loss | 1.0 | (0.5, 1.8) | 0.0 | .911 |
| Income loss | 1.4 | (0.7, 2.6) | 0.8 | .364 |
| Physical illness or Injury | 1.5 | (0.8, 2.7) | 1.8 | .175 |
| Housing adversity | 0.4* | (0.2, 0.8) | 6.4* | .012 |
| Physical adversity | 0.8 | (0.4, 1.6) | 0.3 | .596 |
| Psychological adversity | 0.7 | (0.4, 1.2) | 1.4 | .241 |

*Significant at the .05 level, two-sided test.

[a]Based on a multivariate discrete-time survival model. Estimates of PTSD prevalence are based on the Trauma Screening Questionnaire (TSQ).[23] See "Methods" section for details.

[b]To determine whether associations differed for delayed onset versus other cases, we examined interactions between each set of predictors and a dummy variable for delayed onset. These global interaction tests were not significant for sociodemographics ($\chi^2_9 = 7.2$, $P = .62$), hurricane-related stressors ($\chi^2_9 = 14.1$, $P = .12$), or for the entire set of predictors examined simultaneously $\chi^2_{18} = 21.7$, $P = .24$).

[c]None of the 14 respondents with PTSD who reported a life-threatening experience recovered.

competence ($\chi^2_2 = 1.4$, $P = .257$), nor a summary measure of social resources was associated with estimated recovery ($\chi^2_1 = 2.0$, $P = .155$). None of the social resources interacted with hurricane-related stress to predict estimated recovery. The associations of social resources with estimated recovery did not differ for immediate versus delayed onset cases (Table 3).

# DISCUSSION

Nearly 30% of adults exposed to Hurricane Katrina were estimated to have had PTSD at some point after the hurricane. As previously reported,[19] this estimate is high relative to estimates of PTSD prevalence following other natural disasters in the United

**TABLE 3. Multivariate associations of social resources with recovery from DSM-IV/TSQ posttraumatic stress disorder (PTSD) among respondents who developed PTSD following Hurricane Katrina ($n = 324$)[a,b]**

| | | OR | (95% CI) | $\chi^2$ | *P*-value |
|---|---|---|---|---|---|
| Social network structure[c] | | | | 1.9 | .196 |
| | 1+ | 1.9 | (0.8, 4.6) | | |
| | 0 | 1.0 | – | | |
| Perceived social support[d] | | | | 1.1 | .299 |
| | 1+ | 1.5 | (0.7, 3.2) | | |
| | 0 | 1.0 | – | | |
| Social competence | | | | 1.4 | .257 |
| | Low | 1.7 | (0.9, 3.3) | | |
| | Average | 1.8 | (0.8, 3.9) | | |
| | High | 1.0 | – | | |

[a]Based on a multivariate discrete-time survival model that included controls for prehurricane sociodemographic and history of psychopathology. Estimates of PTSD prevalence are based on the Trauma Screening Questionnaire (TSQ).[23] See "Methods" section for details.
[b]To determine whether associations differed for delayed onset versus other cases, we examined an interaction between the social resource predictors and a dummy variable for delayed onset. This global interaction test was not significant ($\chi^2_3 = 1.1$, $P = .77$).
[c]Social network structure was assessed with questions regarding the number of friends the respondent had in their county or parish.
[d]Perceived social support was assessed with questions regarding the county or parish the respondent could confide in about their private feelings without feeling embarrassed.

States.[28] The estimated prevalence of PTSD at baseline was slightly higher and at follow-up slightly lower than in the previous reports of the CAG,[2,19] because we excluded the first subsample of baseline respondents due to incomplete information on course. Among respondents estimated to have PTSD, approximately 40% had recovered by the time of follow-up. Only about 10% of cases were estimated to have had the disorder for 1 year or less. This pattern of recovery contrasts with epidemiological evidence on PTSD associated with a wider range of traumas showing that 30–40% of cases recover within the first year.[7,8] Average duration of estimated PTSD among those who recovered was 16.5 months, whereas median duration of estimated PTSD among all cases was more than 27 months. These findings suggest a more persistent course of PTSD associated with Hurricane Katrina than previous US disasters;[4,29,30] however, caution is needed here because prior studies generally defined remission as the absence of full diagnostic at follow-up,[4,29,30] whereas we defined offset as having no significant PTSD symptoms. Of note, we found high rates of delayed onset estimated PTSD, which may have resulted from prolonged exposure to traumatic events and stressors following the hurricane, although this possibility remains to be examined in future research.

Of the prehurricane characteristics examined here, only family income was associated with course of illness. The finding of a negative association between income and persistence is surprising given that hurricane damage was most pronounced in lower-income areas,[31] and resulted in higher rates of forced migration and stress exposure among individuals with fewer economic resources. Because greater vulnerability to stressful events among low-SES individuals is well documented,[32] this finding warrants further investigation in future research. However, such a result is not unprecedented, as some previous research suggests that unexpected traumas might be less able to shatter world views of fairness and safety among low-income compared to middle-income people, due to the fact that low-income people are less likely to hold such views in the first place, leading to lower risk of psychopathology after some extreme stressors.[33,34] Also surprising was the lack of association between prehurricane psychopathology and PTSD course, which contradicts prior findings regarding predictors of recovery from PTSD associated with other stressors in community samples.[13,14]

Exposure to hurricane-related stressors was the only other factor associated with recovery. No one with estimated PTSD who experienced a life-threatening event recovered, consistent with evidence that exposure to life-threatening situations during natural disasters is associated with long-term elevations in psychiatric symptoms.[35] Trauma severity has also been found to predict course of combat-related PTSD,[16] as well as PTSD after Hurricane Katrina in a cross-sectional survey of Mississippi residents.[6] We also found lower odds of recovery among respondents with hurricane-related difficulties in housing. Housing-related stressors were often ongoing following the hurricane and may be markers of chronic strain associated with repeated relocation and poor quality housing.

Other posthurricane stressors were unrelated to recovery, with the exception of perceived stress related to physical health problems. Previous studies have shown stress exposure following natural disasters to predict prolonged psychological distress,[30,36] PTSD onset,[37,38] and PTSD persistence after Katrina.[6] Our failure to find such associations should be interpreted with caution, because we did not have information about the timing of stressors relative to either onsets or offsets of estimated PTSD, and therefore were unable to evaluate temporal sequencing. Other studies have been similarly limited.[6,30] Although our finding of few predictors of recovery may have been related to relatively better measurement of exposures that occurred during the hurricane than of posthurricane stressors, these results are broadly consistent with prior research that finds numerous predictors of PTSD onset but few predictors of course.[16,28]

None of the social resources examined was associated with recovery. Prior research found that social support is associated with PTSD recovery among combat

veterans[15,16,38] and with low distress following natural disasters.[39,40] Personality characteristics reflecting competence also have been found to protect against PTSD and distress following extreme stressors.[38,41] The lack of association between these factors and recovery in our study mirrors a number of previous findings in the CAG that factors typically associated with psychopathology following trauma and disaster did not predict mental health after Hurricane Katrina.[19,42,43] Taken together, these findings suggest that the devastation caused by Hurricane Katrina was so severe and persistent that it overwhelmed the influence of factors that typically promote resilience and recovery.

Study findings should be interpreted in light of several important limitations. First, PTSD was estimated using a screening scale rather than diagnostic interview. Although the TSQ demonstrated excellent psychometric properties in a CAG clinical reappraisal study, screening scales are less precise than clinical interviews, potentially resulting in misclassification. Because misclassification was likely nondifferential, this would have resulted in attenuated associations. Second, the CAG response rate was low and the sampling frame excluded individuals who were unreachable by telephone, which likely resulted in underrepresentation of those with the highest levels of stress exposure and mental illness. This likely resulted in conservative estimates of PTSD prevalence and inflated estimates of recovery. Third, assessment of hurricane-related and posthurricane stressors was retrospective and subject to recall bias, although available evidence suggests that reports of acute traumatic events are reliable and largely free of recall bias.[44,45] Assessment of posthurricane stressors might have been most susceptible to such biases. Findings related to posthurricane stressors should, therefore, be interpreted with special caution. Fourth, some individuals estimated to have PTSD may have remitted and relapsed between surveys, which would not have been detected in our assessment. Finally, although the TSQ was only validated as a screen for current PTSD symptoms,[21] we also used it to estimate PTSD retrospectively during the week when symptoms were the worst. It is unknown whether the psychometric properties of such a retrospective assessment are equivalent to those associated with screening for current symptoms.

## CONCLUSION

We found a high estimated prevalence of PTSD among adults exposed to Hurricane Katrina and a more persistent course of illness than found in other US disaster-exposed populations. A host of factors associated with PTSD course in other studies were unrelated to recovery following Hurricane Katrina. High family income and exposure to hurricane-related stressors were the only factors associated with reduced odds of recovery. Although it is possible that discrepancies in our measurement of PTSD onset and offset compared to previous studies explain these differences, it might be that the findings are due to the magnitude of devastation caused by the hurricane outweighing the importance of other factors typically associated with PTSD course. Individuals exposed to life-threatening situations and housing-related stressors were at elevated risk for delayed recovery, and therefore represent important targets for mental health intervention.

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## REFERENCES

1. Rosenbaum S. US health policy in the aftermath of Hurricane Katrina. J Am Med Assoc 2006;295:437–440.
2. Galea S, Brewin CR, Gruber M, et al. Exposure to hurricane-related stressors and mental illness after Hurricane Katrina. Arch Gen Psychiatry 2007;64:1427–1434.
3. Cao H, McFarlane AC, Klimidis S. Prevalence of psychiatric disorder following the 1988 Yun Nan (China) earthquake: the first 5-month period. Soc Psychiatry Psychiatr Epidemiol 2003; 38:204–212.
4. Norris FH, Baker CK, Perilla JL. Postdisaster PTSD over four waves of a panel study of Mexico's 1999 flood. J Trauma Stress 2004;17:283–292.
5. DeSalvo KB, Hyre AD, Ompad DC, et al. Symptoms of posttraumatic stress disorder in a New Orleans workforce following Hurricane Katrina. J Urban Health: Bull NY Acad Med 2007;84:142–152.
6. Galea S, Tracy M, Norris FH, et al. Financial and social circumstances and the incidence and course of PTSD in Mississippi during the first two years after Hurricane Katrina. J Trauma Stress 2008;21:357–368.
7. Breslau N, Kessler RC, Chilcoat HD, et al. Trauma and posttraumatic stress disorder in the community: the 1996 Detroit area survey of trauma. Arch Gen Psychiatry 1998;55:626–632.
8. Kessler RC, Sonnega A, Bromet E, et al. Posttraumatic stress disorder in the National Comorbidity Survey. Arch Gen Psychiatry 1995;52:1048–1060.
9. Grace MC, Green BL, Lindy JD, et al. The Buffalo Creek disaster: a 14-year follow-up. In: Wilson JP, Raphael B, editors. International Handbook of Traumatic Stress Syndromes. New York, NY: Plenum Press; 1993:441–449.
10. McFarlane AC, Papay P. Multiple diagnoses in posttraumatic stress disorder in the victims of natural disaster. J Nerv Ment Dis 1992;180:498–504.
11. McFarlane AC. Posttraumatic stress disorder: a model of the longitudinal course and the role of risk factors. J Clin Psychiatry 2000;61:15–20.
12. Foa EB, Stein DJ, McFarlane AC. Symptomatology and psychopathology of mental health problems after disaster. J Clin Psychiatry 2006;67:15–25.
13. Perkonigg A, Pfister H, Stein MB, et al. Longitudinal course of posttraumatic stress disdorder and posttraumatic stress disorder

symptoms in a community sample of adolescents and young adults. Am J Psychiatry 2005;162:1320–1327.
14. Breslau N, Davis CG. Posttraumtic stress disorder in an urban population of young adults: risk factors for chronicity. Am J Psychiatry 1992;149:671–675.
15. King DW, King LA, Foy DF, et al. Posttraumatic stress disorder in a national sample of Vietnam veterans: risk factors, war-zone stressors, and resilience-recovery factors. J Abnorm Psychol 1999;108:164–170.
16. Koenen KC, Stellman JM, Stellman SD, et al. Risk factors for course of posttraumatic stress disorder in Vietnam veterans: a 14-year follow-up of American Legionnaires. J Consult Clin Psychol 2003;71:980–986.
17. Norris FH, Friedman MJ, Watson PJ. 60,000 disaster victims speak, pt 1: an empirical review of the empirical literature, 1981–2001. Psychiatry 2002;65:207–239.
18. Davidson JRT, McFarlane AC. The extent and impact of mental health problems after disaster. J Clin Psychiatry 2006;67:9–14.
19. Kessler RC, Galea S, Gruber MJ, et al. Trends in mental illness and suicidality after Hurricane Katrina. Mol Psychiatry 2008;13: 374–384.
20. Brewin CR. Systematic review of screening instruments for adults at risk of PTSD. J Trauma Stress 2005;18:53–62.
21. Brewin CR, Rose S, Andrews B, et al. Brief screening instrument for post-traumatic stress disorder. Br J Psychiatry 2002;181: 158–162.
22. First M, Spitzer RL, Gibbon M, et al. Structured Clinical Interview for DSM-IV Axis I Disorders, Research Version, Non-Patient Edition (SCID-I/NP). New York, NY: Biometrics Research, New York State Psychiatric Institute; 2002.
23. Endicott J, Andreasen N, Spitzer RL. Family History Research Diagnostic Criteria. New York, NY: Biometrics Research, NY State Psychiatric Institute; 1978.
24. Kendler KS, Silberg JL, Neale MC, et al. The family history method: whose psychiatric history is measured? Am J Psychiatry 1991;148:1501–1504.
25. Nock MK, Holmberg EB, Photos VI, et al. The self-injurious thoughts and behaviors interview: development, reliability, and validity in an adolescent sample. Psychol Assess 2007;19:309–317.
26. Merikangas KR, Avenevoli S, Costello EJ, et al. Background and measures in the National Comorbidity Survey Adolescent Supplement (NCS-A). J Am Acad Child Adolesc Psychiatry 2009; 48:367–369.
27. Singer JD, Willett JB. It's about time: using discrete-time survival analysis to study duration and timing of events. J Educ Stat 1993;18:155–195.
28. Galea S, Nandi A, Vlahov D. The epidemiology of post-traumatic stress disorder after disasters. Epidemiol Rev 2005;27:78–91.
29. Karamustafalioglu OK, Zohar J, Guveli M, et al. Natural course of posttraumatic stress disorder: a 20-month prospective study of Turkish earthquake survivors. J Clin Psychiatry 2006;67:882–889.
30. Norris FH, Perilla JL, Riad JK, et al. Stability and change in stress, resources, and psychological distress following natural disaster: findings from Hurricane Andrew. Anxiety Stress Coping 1999;12:363–396.
31. Abramson D, Garfield R. On the Edge: Children and Families Displaced By Hurricanes Katrina and Rita Face a Looming Medical and Mental Health Crisis. New York, NY: Columbia University Mailman School of Public Health; 2006.
32. McLeod JD, Kessler RC. Socioeconomic status differences in vulnerability to undesirable life events. J Health Soc Behav 1990; 31:162–172.
33. Downey G, Silver RC, Wortman CB. Reconsidering the attribution–adjustment relation following a major negative event: coping with the loss of a child. J Pers Soc Psychol 1990;59:925–940.
34. Wortman CB, Silver RC. Reconsidering assumptions about coping with loss. In: Montada L, Filip SH, Lerner MJ, editors. Life Crises and Experiences of Loss in Adulthood. Hillsdale, NJ: Lawrence Erlbaum Associates; 1992:341–366.
35. Hollifield M, Hewage C, Gunawardena CN, et al. Symptoms and coping in Sri Lanka 20–21 months after the 2004 tsunami. Br J Psychiatry 2008;192:39–44.
36. Norris FH, Uhl GA. Chronic stress as a mediator of acute stress: the case of Hurricane Hugo. J Appl Soc Psychol 1993;23: 1263–1284.
37. Brewin CR, Andrews B, Valentine JD. Meta-analysis of risk factors for posttraumatic stress disorder in trauma-exposed adults. J Consult Clin Psychol 2000;68:748–766.
38. King DW, King LA, Fairbank JA, et al. Resilience–recovery factors in post-traumatic stress disorder among female and male Vietnam veterans: hardiness, postwar social support, and additional stressful life events. J Pers Soc Psychol 1998;74:420–434.
39. Kaniasty K, Norris FH. A test of the social support deterioration model in the context of natural disaster. J Pers Soc Psychol 1993; 64:395–408.
40. Norris FH, Kaniasty K. Received and perceived social support in times of stress: a test of the social support deterioration deterrance model. J Pers Soc Psychol 1996;71:498–511.
41. Florian V, Mikulincer M, Taubman O. Does hardiness contribute to mental health during a stressful real-life situation? The roles of appraisal and coping. J Pers Soc Psychol 1995;68:687–695.
42. McLaughlin KA, Fairbank JA, Gruber MJ, et al. Serious emotional disturbance among youths exposed to Hurricane Katrina 2 years postdisaster. J Am Acad Child Adolesc Psychiatry 2009;48:1069–1078.
43. McLaughlin KA, Fairbank JA, Gruber MJ, et al. Trends in serious emotional disturbance among youths exposed to Hurricane Katrina. J Am Acad Child Adolesc Psychiatry 2010;49: 990–1000.
44. Dohrenwend BP, Turner JB, Turse NA, et al. The psychological risks of Vietnam for U.S. veterans: A revisit with new data and methods. Science 2006;313:979–982.
45. Norris FH, Kanlasty KA. A longitudinal study of the effects of various crime prevention strategies on criminal victimization, fear of crime, and psychological distress. Am J Comm Psychol 1992;20:207–239.