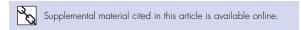# Trends in Serious Emotional Disturbance Among Youths Exposed to Hurricane Katrina

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Objective: To examine patterns and predictors of trends in *DSM-IV* serious emotional disturbance (SED) among youths exposed to Hurricane Katrina. **Method:** A probability sample of adult pre-hurricane residents of the areas affected by Katrina completed baseline and follow-up telephone surveys 18 to 27 months post-hurricane and 12 to 18 months later. Baseline adult respondents residing with children and adolescents (4-17 years of age) provided informant reports about the emotional functioning of these youths ($n = 576$) with the Strengths and Difficulties Questionnaire (SDQ). The surveys also assessed hurricane-related stressors and ongoing stressors experienced by respondent families. **Results:** SED prevalence decreased significantly across survey waves from 15.1% to 11.5%, although even the latter prevalence was considerably higher than the pre-hurricane prevalence of 4.2% estimated in the US National Health Interview Survey. Trends in hurricane-related SED were predicted by both stressors experienced in the hurricane and ongoing stressors, with SED prevalence decreasing significantly only among youths with moderate stress exposure (16.8% versus 6.5%). SED prevalence did not change significantly between waves among youths with either high stress exposure (30.0% versus 41.9%) or low stress exposure (3.5% versus 3.4%). Pre-hurricane functioning did not predict SED persistence among youths with high stress exposure, but did predict SED persistence among youth with low-moderate stress exposure. **Conclusions:** The prevalence of SED among youths exposed to Hurricane Katrina remains significantly elevated several years after the storm despite meaningful decrease since baseline. Youths with high stress exposure have the highest risk of long-term hurricane-related SED and consequently represent an important target for mental health intervention. J. Am. Acad. Child Adolesc. Psychiatry, 2010;49(10):990–1000. **Key Words:** Hurricane Katrina, SED, natural disaster, child mental health, stress

Hurricane Katrina was a devastating natural disaster with unprecedented effects on New Orleans and other Gulf Coast areas. The hurricane killed more than 1,000 persons, displaced more than 500,000 persons, and caused more than $100 billion in property damage.[1] Individuals in hurricane-affected areas were exposed to a wide range of stressors during and in the immediate aftermath of the storm, including risk of death, difficulty obtaining food and clothing, exposure to violence, and substantial losses—

of loved ones, property, jobs, and of their communities and way of life.[2] In fact, exposure to these kinds of hurricane-related stressors was so common that more than 80% of individuals living in hurricane-affected areas reported experiencing at least one such stressor.[2] Because exposure to disaster-related stressors is known to be strongly associated with psychological problems among children and adolescents following natural disasters,[3-9] it is not surprising that high rates of mental health problems have been documented in studies of youths exposed to Hurricane Katrina.[10,11]

In particular, elevations in symptoms of post-traumatic stress disorder (PTSD) and aggressive

Supplemental material cited in this article is available online.

behavior among children and adolescents were found in the year after the hurricane.[12-14] High rates of seriously impairing mental health problems among youths exposed to Hurricane Katrina have also been documented. We reported previously that the prevalence of serious emotional disturbance (SED) among hurricane-exposed youths 18 to 27 months after the storm was approximately 15%, and that nearly 10% of children and adolescents had serious emotional or behavioral problems that their parents judged to be directly attributable to the hurricane.[11] This prevalence estimate is more than three times greater than the pre-hurricane rate of SED found in hurricane-affected areas in the National Health Interview Survey (NHIS),[15] and suggests that the prevalence of mental health problems among youths exposed to Katrina is at least equivalent to, if not greater than, rates found after previous disasters.[5,6,16]

Although substantial decreases in the prevalence of child mental health problems typically occur in the first year postdisaster,[6,17] the slow pace of recovery in the Gulf Coast has resulted in unusually high rates of forced relocation, ongoing difficulties obtaining adequate housing and employment, and prolonged community disruption.[10,18] Continued exposure to these types of stressors may be associated with greater persistence of psychiatric symptoms among children. Evidence from previous natural disasters suggests that degree of stress exposure both during and after the disaster is associated with child mental health problems.[3-5] However, each of these studies, with one notable exception,[6] examined predictors of point prevalence. Longitudinal studies of child mental health after disasters are notably rare, and little research to date has examined patterns and predictors of the persistence of mental health problems among youths exposed to Hurricane Katrina.

To address this gap in the literature, we use data from the Hurricane Katrina Community Advisory Group (CAG), a representative sample of pre-hurricane residents of the areas in Louisiana, Mississippi, and Alabama designated by the Federal Emergency Management Administration (FEMA) as the official disaster area, who have been followed since the hurricane. We extend our previous report, which presented SED prevalence estimates among children 18 to 27 months after the storm, by providing estimates of the change in SED prevalence in the 12 to 18 months after our initial assessment. We examine sociodemographic factors, hurricane-related stressors, ongoing stress post-hurricane, and pre-hurricane functioning as predictors of SED prevalence and persistence.

METHOD

Sample

We recruited English-speaking adults (≥18 years of age) for the initial survey either by random-digit–dial telephone calls of households in the FEMA-defined disaster area or from a random selection of families applying for assistance from the American Red Cross database. The initial CAG interviews were carried out in three waves (Table 1). The first wave was collected 5 to 7 months after the hurricane (n = 1,043; 41.9% cooperation rate); the second wave was carried out 7 to 10 months post-hurricane (n = 723; 33.1% cooperation rate), and the third wave occurred 15 to 19 months post-hurricane (n = 1322; 32.3% cooperation rate). The three waves together resulted in 3,088 interviews for an estimated cooperation rate of 35.2%. This low cooperation rate is due in part to our requirement that respondents make a long-term commitment to involvement in the CAG to participate in the initial survey, as the CAG aimed to track the progress of recovery over time.

A nonresponse survey found that individuals who did not participate in the interviews were similar to participants on sociodemographic variables, but had a somewhat higher level of hurricane-related stress exposure (median and interquartile range [IQR] were 8.0 (6.0-10.0) among non-respondents and 7.0 (5.0-9.0) among CAG members), and more psychological distress (median and IQR were 2.9 (1.2-4.4) among non-respondents and 1.7 (0.6-3.5) among CAG members). A weight was applied to adjust for these response biases. A within-household probability of selection weight and a poststratification weight were used to adjust for residual discrepancies between the CAG and the 2000 Census population on a range of sociodemographic and pre-hurricane housing variables.

A 12-month follow-up interview was conducted with 815 wave 1 respondents 18 to 22 months post-hurricane (79.1% response rate) and with 910 wave 2 and wave 3 respondents 24 to 27 months post-hurricane (of 1,195 attempted, response rate was 76.4%). We attempted to contact all wave 2 and wave 3 respondents with PTSD or moderate to serious psychological distress at baseline and a probability subsample of the remaining respondents. Differences between the follow-up sample compared to the initial sample in sociodemographics, traumatic stress exposure, and mental health were adjusted for by using a propensity score adjustment and follow-up weights.[19] A third interview was completed 36 to 39 months after the

TABLE 1 Hurricane Katrina Community Advisory Group (CAG) Sample Description and Timeline of Assessments

	Dates (mo/y)	Months Since Hurricane	Attempted	Interviewed	Response Rate (%)
Initial interview[a]					
Wave 1	1-3/2006	5-7	2,489	1,043	41.9
Wave 2	4-6/2006	7-10	2,187	723	33.1
Wave 3	12/2006-4/2007	15-19	4,093	1,322	32.3
Baseline interview[b]					
Wave 1	3-6/2007	18-22	1030	815	79.1
Waves 2 and 3	8-11/2007	24-27	1179	901	76.4
Child interviews[c]	3-11/2007	18-27	880	797	90.6
Follow-up interview[d]					
Waves 1-3	8-11/2008	36-39	1,584	1,346	85.0
Child interviews[e]	8-11/2008	36-39	602	576	95.7

Note: [a]Initial interviews were conducted in three separate waves. Number of attempted represents number of households determined to be eligible for participation in CAG. Respondents did not provide information on children or adolescents in these initial interviews.
[b]Baseline informant interviews about children and adolescents were conducted in two separate waves: wave 1 and in a probability subsample of respondents from waves 2 and 3 (detailed in "Method" section).
[c]Informant interviews were attempted in all households with a child or adolescent in the age range 4 through 17 years.
[d]Follow-up informant interviews about children and adolescents were conducted in one wave using the same subsampling strategy for respondents from all waves.
[e]Follow-up informant interviews were attempted with the same informant/respondent in all households that completed a baseline informant interview.

hurricane, with 1,346 of the 1,584 respondents whom we attempted to interview (response rate 85.0%), again oversampling those respondents with PTSD and moderate to serious psychological distress at the initial interview. Weights were applied to adjust for sampling and selection probabilities.

Initial interviews with a parent or legal guardian of up to two children or adolescents 4 through 17 years of age and living with the respondent were conducted during the first follow-up survey, 18 to 27 months post-hurricane (hereafter referred to as the baseline survey). We completed interviews on 797 of the 880 eligible children (90.6% response rate). At the second follow-up survey, 36 to 39 months post-hurricane (hereafter referred to as the follow-up survey), parents and guardians provided information on the same children they were asked about in the initial child interview. A total of 576 child interviews were conducted among 602 attempted, for a response rate of 95.7%. A child weight was assigned by adjusting the household reinterview weight for the probability of selection of male and female children in the household and by including a poststratification adjustment by sex and age.

Measures

Serious emotional disturbance. A six-item version of the Strength and Difficulties Questionnaire (SDQ)[20] was used to screen for serious emotional disturbance (SED) in the 12 months before the baseline interview in children of respondents. At the follow-up interview, we screened for SED in the 6 months preceding the interview. SED refers to a diagnosable mental disorder that results in significant impairment or decreased role functioning in family, school, or community activities.[21] The brief SDQ includes six items that assess conduct problems, hyperactivity–inattention, emotional symptoms, peer problems, and symptom-related impairment. Respondents were asked at both interviews to rate how much they believed their child's difficulties were caused by the hurricane on a scale of 0 to 3. Respondents whose children were classified as having SED and who indicated that their child's difficulties were caused by the hurricane either "some" or "a lot" were classified as having SED attributable to Hurricane Katrina (H-SED). The remaining SED cases were classified as unrelated to the hurricane (NH-SED).

In a previous validation study, the six-item SDQ was found to have good psychometric properties in predicting SED based on structured diagnostic interviews (Schedule for Affective Disorders and Schizophrenia in School-Age Children [K-SADS])[22] in a sample of adolescent participants (see McLaughlin and colleagues[11] for a detailed description).[23] Using a cut-off of 6 or more on the five symptom-related items, the SDQ had an area under the receiver operating characteristic curve of 0.85 in predicting SED based on diagnostic interviews.

Stress exposure. During the initial wave of data collection, respondent reports of exposure to hurricane-related stressors were broken into 10 categories for analysis: experiences that involved serious risk of

death, death of a family member/close friend, victimization resulting from lawlessness after the storm (e.g., robbery or physical assault), victimization of a loved one, physical illness/injury caused or exacerbated by the storm, physical adversity (e.g., sleeping in a church basement, difficulty obtaining food or clothing), psychological adversity (e.g., living in circumstances in which the respondent had to use the toilet or change clothes without adequate privacy), major property loss, income loss, and ongoing difficulties associated with housing (e.g., experiencing multiple moves).[2] To examine associations between hurricane-related stressors and SED we created a continuous variable ranging from 0 to 3 for hurricane-related stressors where 0 = no exposure, 1 = mild exposure (one or two stressors), 2 = moderate exposure (three or four stressors), and 3 = high exposure (five or more stressors).

Respondents rated the degree of stress they were experiencing because of ongoing problems associated with Hurricane Katrina in the 30 days before both the baseline and follow-up interviews on an 11-point scale ranging from no stress (0) to the most stress that they could imagine (10). Ongoing stress was coded as a continuous variable ranging from 0 to 3, where 0 = no stress, 1 = mild stress (one to three rating of perceived stress), 2 = moderate stress (four to eight rating of perceived stress), and 3 = high stress (nine or 10 rating of perceived stress).

We created an overall stress exposure index that combined respondents' exposure to hurricane-related stressors and ongoing stress. Respondents were coded as having low stress if they reported no ongoing stress at the follow-up, regardless of their level of exposure to hurricane-related stressors, mild ongoing stress and mild or no hurricane-related stressors, or moderate ongoing stress but no hurricane-related stressors. Respondents with either mild ongoing stress at the follow-up and moderate to high hurricane-related stress, or with moderate to high ongoing stress and moderate hurricane-related stress were coded as have moderate stress. The high-stress group included respondents with moderate to high ongoing stressors at the follow-up and high exposure to hurricane-related stressors.

Pre-Hurricane Functioning. A modified version of the global functioning scale from the K-SADS[22] was used for parents to rate their child's functioning in the 12 months before the hurricane in the domains of peer relationships, behavior/obeying rules, school performance, physical health, and mental health. Functioning in each domain was rated on a five-point scale (excellent, very good, good, fair, poor). A dichotomy that distinguished fair to poor functioning from excellent to good functioning was then created for each item, and principal axis factor analysis was carried out on the matrix of tetractoric correlations among the resulting five dichotomies. Only one meaningful factor (eigenvalue, 2.1) was found in the data. Based on this

result, a 0- to 5-count variable was created to describe the number of domains in which each child had pre-hurricane decrements in functioning.

Sociodemographic factors. We examined the associations between SED and age, sex, race/ethnicity, parent marital status, family income, and health insurance status at the time of interview. Age was examined as a continuous measure. Race/ethnicity was coded as non-Hispanic white versus nonwhite. Parent marital status was coded as unmarried versus married. Family income was coded in tertiles where low/low-average was defined as less than or equal to 0.5 to 1.0 of the population median on the ratio of pretax income to number of family members; high-average was defined as 1.0 to 3; and high was defined as 3+ on this ratio. Health insurance status was coded as insured versus uninsured. We also examined the associations between SED and both pre-hurricane residence, coded as New Orleans Metro versus the remainder of the hurricane area, and current living status, defined as living in the same pre-hurricane area or in a different place.

Data Analysis

SED prevalence, persistence, and recovery were examined in cross-tabulations that distinguished between H-SED and NH-SED. Within-respondent paired comparison tests were used to evaluate the significance of differences in SED prevalence at the baseline and follow-up assessments. SED at baseline and the follow-up were cross-classified to decompose the estimated prevalence into persistent, recovered, and delayed-onset cases. The independent and joint effects of sociodemographic factors, hurricane-related stressors, ongoing stress, and pre-hurricane vulnerabilities in predicting SED were examined in logistic regression analysis. Logistic regression coefficients and their standard errors were exponentiated to create odds ratios (ORs) and 95% confidence intervals (95% 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

Estimated prevalence and trends in SED

The estimated prevalence of SED decreased significantly from 15.1% at the baseline survey (18-27 months post-hurricane) to 11.5% at the follow-up survey (36-39 months post-hurricane) (t = 2.1, p = .03). (Table 2) The estimated prevalence of H-SED decreased from baseline (9.3%) to the follow-up (7.5%). A similar decrease was observed for the estimated prevalence of NH-SED (5.7% and 4.1%, respectively), although this decrease was not statistically significant for either H-SED or NH-SED.

TABLE 2 Estimated Prevalence of Serious Emotional Disturbance (SED)[a] Among Children and Adolescents Exposed to Hurricane Katrina at Baseline and Follow-up (n = 576)

	Baseline			Follow-up		
	(n)	%	(SE)	(n)	%	(SE)
Hurricane-related SED (H-SED)[b]	(54)	9.3	(1.5)	(39)	7.5	(1.4)
t (p)[c] 1.5 (.14)						
Non–hurricane-related SED (NH-SED)[b]	(31)	5.7	(1.2)	(25)	4.1	(0.9)
t (p)[c] 1.5 (.13)						
Total SED	(85)	15.1	(1.8)	(64)	11.5	(1.6)
t (p)[c] 2.1[d] (.030)						
(n)		(576)			(576)	

Note: SE = standard error.

[a]Estimates of SED were based on Strengths and Difficulties Questionnaire (SDQ) (detailed in Method section).

[b]Distinction between hurricane-related SED and non–related SED is based on informant judgments as to whether SED was related to hurricane.

[c]Within-respondent paired comparison t test.

[d]Significant difference between baseline and follow-up surveys at .05 level, two-sided test.

Cross-classification of baseline and follow-up cases shows that among those participants with SED at baseline, approximately one-third continued to have SED at the follow-up, and the remaining two-thirds had recovered (Table 3). Persistence of H-SED among baseline cases was slightly higher than persistence of NH-SED. Slightly less than one-half of the children with SED at the follow-up survey were estimated to have had SED at baseline. Delayed onset of SED was evident in more than one-half of follow-up cases. Approximately one-half of follow-up cases of H-SED were persistent cases, whereas closer to one-third of NH-SED follow-up cases had persisted from the baseline survey.

Associations of Sociodemographic Factors with SED

Sociodemographic factors were largely unrelated to SED prevalence at either the baseline or follow-up interview. The estimated prevalence of SED at baseline was higher among children whose families had lower incomes (OR = 5.2, χ^2_2 = 10.1, p = .007) (Table S1, available online). Older children were more likely to

TABLE 3 Decomposition of Individual-Level Changes in the Presence of Serious Emotional Disturbance (SED) Between the Two Surveys

	Hurricane-Related SED			Non–Hurricane-Related SED			Total SED		
	(n)	%	(SE)	(n)	%	(SE)	(n)	%	(SE)
Profiles of baseline cases									
Persistence[a]	(19)	37.8	(7.8)	(8)	27.6	(9.7)	(27)	33.9	(6.1)
Recovery[b]	(35)	62.2	(7.8)	(23)	72.4	(9.7)	(58)	66.1	(6.1)
Total	(54)	100.0		(31)	100.0		(85)	100.0	
Profiles of follow-up cases									
Persistence[c]	(18)	47.9	(8.5)	(9)	37.9	(11.8)	(27)	44.4	(7.1)
Delayed onsets[d]	(21)	52.1	(8.5)	(16)	62.1	(11.8)	(37)	55.6	(7.1)
Total	(39)	100.0		(25)	100.0		(64)	100.0	

Note: SE = standard error.

[a]Proportion of baseline cases with contining SED at follow-up.

[b]Proportion of baseline cases remitted by follow-up.

[c]Proportion of follow-up cases with had SED at baseline.

[d]The proportion of follow-up cases that did not have SED at baseline.

have SED at the follow-up interview (OR = 1.1, χ^2_1 = 4.9, p = .027). None of the sociodemographic factors examined was associated with SED at the follow-up after controlling for baseline SED.

Associations of Hurricane-Related Stressors and Ongoing Stress with SED

As we reported previously, 83.0% of respondents reported at least one major hurricane-related stressor.[11] Mean ongoing stress was higher at the baseline survey (3.7) than at the follow-up (2.6). Although most respondents indicated that their ongoing stress related to the hurricane had improved (44.4%) or stayed the same (39.8%) from baseline to follow-up, a substantial minority reported that their ongoing stress was higher at the follow-up survey (15.8%). The majority of youths with high exposure to hurricane-related stressors also experienced high levels of ongoing stress. More than one-half (58.4%) of those with five or more hurricane-related stressors continued to have moderate to high ongoing stress at the follow-up.

We examined the associations between SED and both hurricane-related and ongoing stress in a series of logistic regression models that controlled for age, sex, income, pre-hurricane residence, and current living location. A dummy variable was included in each of these models that distinguished between H-SED and NH-SED. A global interaction test between this variable and the stress predictor variables was examined to determine whether the stressors were differentially associated with H-SED or NH-SED. If this interaction was significant, we examined the model separately to predict H-SED and NH-SED. The first of these models examined the association of stressors with SED at baseline. Both ongoing stress (OR = 1.6, p = .010) and hurricane-related stress (OR = 1.5, p = .038) were associated with SED (Table S2, available online). The magnitude of these associations differed for H-SED and NH-SED (χ^2_2 = 17.7, p < .001). Ongoing stress (OR = 2.6, p < .001) and hurricane-related stress (OR = 1.5, p = .049) were both associated with H-SED, whereas only hurricane-related stress was associated with NH-SED (OR = 1.5, p = .049).

We next examined two models predicting SED at the follow-up, controlling for baseline SED. In the first model, we included a covariate for ongoing stress only at the follow-up. Hurricane-related stress (OR = 1.8, p = .004) was associated with SED, and the magnitude of the associations differed for H-SED and NH-SED (χ^2_3 = 14.3, p = .003). Both ongoing stress at the follow-up (OR = 1.9, p = .004) and hurricane-related stress (OR = 2.1, p = .010) were associated with H-SED, whereas neither was associated with NH-SED. The second model included a covariate for ongoing stress at the follow-up and a covariate representing change in ongoing stress from baseline to the follow-up. Here, neither hurricane-related nor ongoing stress was associated with SED, but the pattern of associations differed for H-SED and NH-SED (χ^2_4 = 17.6, p = .002). Hurricane-related stress (OR = 2.1, p = .017) and ongoing stress at the follow-up (OR = 2.4, p < .001) were associated with H-SED and change in ongoing stress was marginally associated with H-SED (OR = 0.7, p = .08). Neither hurricane-related stress nor ongoing stress was associated with NH-SED.

Our stress exposure index was associated significantly with H-SED prevalence both at baseline (χ^2_2 = 22.5, p < .001) and at follow-up (χ^2_2 = 13.3, p < .001) as well as with change in prevalence across the two interviews (t = 3.2, p < .001) (Table 4). The estimated prevalence of H-SED decreased significantly from 16.8% at baseline to 6.5% at the follow-up among respondents with moderate stress exposure, but was approximately 3% among youths with low stress exposure at both interviews. Among respondents with high stress exposure, the prevalence of H-SED was high and did not change significantly between baseline (30.0%) and follow-up (41.9%). Decomposition showed that stress exposure was related meaningfully both to persistence of H-SED among baseline cases (χ^2_2 = 6.9, p = .039) and to delayed onset of H-SED among baseline noncases (χ^2_2 = 5.6, p = .06). Fewer than 20% of baseline H-SED cases continued to have H-SED at the follow-up in the low and moderate stress groups, whereas 72.9% of baseline H-SED cases persisted in the high-stress group. Prevalence of delayed onsets of H-SED at follow-up among baseline was 29.2% in the high-stress group compared with 3.5% to 2.4% in the medium- and low-stress groups. These strong associations of stress exposure with H-SED are in striking contrast to the nonsignificant associations of stress with prevalence of NH-SED either at baseline or at follow-up. Furthermore, the prevalence of NH-

TABLE 4 Weighted Distribution and Conditional Probability of Serious Emotional Disturbance (SED)[a] Prevalence, Persistence, and Onsets as a Function of Stress Exposure

	Low Stress[a]		Moderate Stress[a]		High Stress[a]	
	Est	(SE)	Est	(SE)	Est	(SE)
H-SED						
Baseline	3.5	(1.1)	16.8	(3.3)	30.0	(8.1)
$\chi^2_2 = 22.5$, $p < .001$[b]						
Follow-up	3.4	(1.0)	6.5	(2.0)	41.9	(9.0)
$\chi^2_2 = 13.3$, $p < .001$						
t (p)[c]	0.1	(.90)	3.2[f]	(<.001)	−1.3	(.20)
Persistence[d]	17.8	(11.5)	19.7	(8.3)	72.9	(14.7)
$\chi^2_2 = 6.9$, $p = .039$						
Delayed onset[e]	2.4	(0.9)	3.5	(1.6)	29.2	(10.1)
$\chi^2_2 = 5.6$, $p = .06$						
NH-SED						
Baseline	4.8	(1.4)	11.3	(3.0)	0.0	(0.0)
$\chi^2_2 = 3.7$, $p = .06$						
Follow-up	3.4	(1.2)	6.1	(1.9)	5.9	(4.2)
$\chi^2_2 = 1.7$, $p = .44$						
t (p)	0.7	(.49)	1.9	(.06)	−0.8	(.43)
Persistence	6.9	(7.0)	32.5	(13.7)	0.0	(0.0)
$\chi^2_2 = 2.8$, $p = .10$						
Delayed onset	3.2	(1.2)	2.9	(1.3)	2.7	(2.8)
$\chi^2_2 = 0.04$, $p = .98$						
(n)	(337)		(194)		(45)	

Note: Est = Estimate; H-SED = SED attributable to Hurricane Katrina; NH-SED = SED unrelated to Hurricane Katrina; SE = standard error.
[a]High, moderate, and low stress groups were created based on reports of hurricane-related and ongoing stress (detailed in "Results" section).
[b]χ^2 test of association between stress exposure group and SED.
[c]Within-respondent paired comparison t test.
[d]Percentage of SED cases at follow-up with SED at baseline.
[e]Percentage of SED cases at follow-up without SED at baseline.
[f]Significant at .05 level, two-sided test.

SED did not change significantly from baseline to follow-up, in any of the stress exposure groups.

Joint Associations of Pre-Hurricane Vulnerabilities and Stressors with SED

We examined the effects of pre-hurricane functioning on estimated H-SED among youths in each stress exposure group. We estimated a model separately in each group that included a variable representing the number of areas in which each child had decrements in functioning and a covariate for baseline SED. Respondents with a greater number of such decrements were more likely to have H-SED at the follow-up in both the low (OR = 2.1, p = .005) and moderate (OR = 2.0, p = .001) stress exposure groups.

(Table 5) In contrast, pre-hurricane functioning was unrelated to H-SED among respondents with high stress exposure (OR = 1.0, p = .931).

DISCUSSION

The estimated prevalence of SED among children and adolescents exposed to Hurricane Katrina decreased significantly from 15.1% at our baseline assessment 18 to 27 months after the storm to 11.5% at our assessment 12 to 18 months later. This reduction is not surprising, given that the prevalence of youth mental health problems following natural disasters tends to decrease over time.[6,17] However, the prevalence of SED among youths exposed to Katrina continues to be considerably greater than the pre-hurricane preva-

TABLE 5 Associations of Pre-Hurricane Vulnerabilities Factors with Hurricane-Attributable Serious Emotional Disturbance (H-SED) According to Stress Exposure

	OR	(95% CI)
Group 1 (low stress)		
Baseline SED	4.8	(0.4-50.1)
Pre-hurricane functioning[a]	2.1[b]	(1.1-3.9)
χ^2_2 (p)	10.4	(.005)
Group 2 (moderate stress)		
Baseline SED	4.7[b]	(1.1-20.3)
Pre-hurricane functioning	2.0[b]	(1.2-3.4)
χ^2_2 (p)	3.8	(.001)
Group 3 (high stress)		
Baseline SED	6.7[b]	(1.2-36.6)
Pre-hurricane functioning	1.0	(0.6-1.7)
χ^2_2 (p)	0.3	(.93)

Note: CI = confidence interval; OR = odds ratio.
[a]Number of domains with fair–poor pre-hurricane functioning (0-5) (detailed in Method section).
[b]Significant at the .05 level, two-sided test.

lence of 4.2% estimated in the NHIS using the same measure as the current study.[15] Moreover, approximately 8% of youths were estimated to have SED that is directly attributable to the hurricane, indicating that seriously impairing mental health problems resulting from the disaster remain elevated 3 years after the hurricane. These findings are consistent with those of school-based surveys documenting decreases in psychological problems over time in youths exposed to Katrina, but high levels of ongoing symptomatology.[13,24]

Closer examination of the trends in SED shows that approximately two-thirds of children and adolescents with SED at our baseline assessment had recovered by the follow-up. This recovery is offset, however, by a high rate of new SED onsets during the follow-up period. More than one-half of SED cases at follow-up did not have SED at baseline. Although these new cases may represent delayed-onset mental health problems related to the hurricane or may simply reflect a normal ebb and flow of SED onsets and offsets that are unrelated to Katrina, the former interpretation is more consistent with the data in light of the fact that we observed a substantially higher number of onsets of H-SED than NH-SED. Furthermore, disaggregation of the trends in SED according to level of stress exposure showed that H-SED onsets were concentrated among youths with high levels of stress, whereas onsets of

NH-SED were not related to stress exposure. Together, these patterns suggest that new onsets of H-SED are likely delayed reactions to the hurricane. NH-SED onsets, in contrast, probably reflect normal changes of cases in the population. Although similarly high levels of delayed-onset youth mental health problems several years post-disaster have not been reported previously, exposure to ongoing stressors or traumatic events is associated with delayed onset of adult PTSD following disasters.[25] Consistent with this finding, a considerable number of delayed-onset mental health problems were observed among adults exposed to Hurricane Katrina.[26] This high rate of delayed-onset mental health problems in children and adults may be attributable to the high levels of ongoing stress, exposure to traumatic events, and community disruption that have persisted in Gulf Coast areas because of the slow pace of recovery.[10]

We found that disaster-related stress exposure was common and associated strongly with SED prevalence and persistence. After accounting for ongoing stress, hurricane-related stressors were associated with SED prevalence at both baseline and the follow-up. Although the associations of these stressors with H-SED were stronger than with NH-SED, the associations with NH-SED were nonetheless significant. In models that control for baseline SED, however, we found that hurricane-related stressors were associated with greater persistence of H-SED but not NH-SED. On one hand, these findings are not surprising, as exposure to disaster-related stressors is consistently identified as a predictor of child psychopathology in previous research[6-9] and was associated specifically with the persistence of PTSD symptoms among children exposed to Hurricane Andrew.[6] However, with one exception,[6] these studies were cross-sectional and did not control for ongoing stress. Evidence from longitudinal studies of adults, on the other hand, indicates that disaster-related traumatic events are not associated with the course of PTSD after accounting for ongoing stressors.[18,25,27] It is possible that the disaster-related stressors associated with Hurricane Katrina were more severe than those in previous disasters or more highly co-occurring, given that more than one-third of youths in our sample were exposed to three or more hurricane-related stressors,[11] thus resulting in a more enduring effect of these stressors on the course of child mental health problems following

the hurricane. Children and adolescents with the highest exposure to hurricane-related stressors in our sample were also more likely to experience ongoing stress: of the youths with five or more hurricane-related stressors, more than half continued to have moderate to high ongoing stress at the follow-up. This is not surprising, as families living in the areas that were most devastated by the hurricane experienced higher rates of forced relocation after the storm, housing instability, ongoing disruption and lack of access to services, and dissolution of support networks in their communities.[10]

Although rarely examined in longitudinal studies of children following natural disasters, the evidence regarding ongoing stress and child mental health has thus far been mixed with some studies reporting an association between postdisaster stressors and psychopathology persistence[6,24] and others reporting no association after accounting for disaster-related stress exposure.[28] Among adults, ongoing stress predicts greater persistence and delayed onset of PTSD following disasters.[18,25,27] Here, we found significant associations between ongoing stress and SED at the baseline and follow-up interviews, as well as with SED persistence after controlling for hurricane-related stressors. Ongoing stress associated with the hurricane has not subsided for many families because of the slow pace of community rebuilding in the Gulf Coast, and this lack of improvement may explain, in part, the continued elevations in youth mental health problems.

Unlike stressors, sociodemographic factors were largely unrelated to SED prevalence or persistence in children exposed to Hurricane Katrina, mirroring findings from our previous cross-sectional report.[11] These findings contrast with evidence from previous natural disasters[3,7,16] and from school-based surveys of youths exposed to Katrina[13,24] documenting higher rates of internalizing symptoms in females and in younger children. The lack of sociodemographic variation in our sample may have resulted from our examination of a wider range of mental health problems, including both internalizing and externalizing pathology. Alternatively, it may reflect that Hurricane Katrina was a disaster that had an impact on virtually all segments of society because of the depth and breadth of the devastation that it caused.

Children and adolescents who experienced decrements in functioning before the hurricane were more likely to have persistent SED than children without such difficulties. However, this effect was observed only among youths who experienced low to moderate stress during and after the hurricane. Youths exposed to the highest levels of stress exhibited markedly elevated rates of SED, and more than one-third of these children continued to have SED at the follow-up. The lack of association between pre-hurricane functioning and SED persistence in this group suggests that the magnitude of stress to which these youths were exposed was sufficient to overwhelm the coping resources of many children, regardless of their pre-hurricane functioning. These findings are consistent with previous research documenting strong associations between cumulative stressors and child mental health problems,[29-32] as well as with evidence suggesting that once children have been exposed to a high enough number of stressors, the prevalence of psychopathology increases dramatically.[31] Importantly, these results validate intuitive efforts that target mental health services to youths who experienced the highest levels of exposure to disaster-related trauma and ongoing stressors.

Our findings indicate that mental health problems among children and adolescents exposed to Hurricane Katrina have decreased over time but remain elevated three years post-disaster. Because SED is a marker of mental health problems that are severe enough to warrant treatment, our findings suggest a continued high level of need for treatment resources among hurricane-exposed children, particularly among youths exposed to high levels of stress. Although marked decreases in the availability of mental health treatment resources occurred following Hurricane Katrina,[33,34] recent efforts to identify children experiencing psychiatric impairment and to provide treatment within schools and existing service structures in hurricane-affected areas hold promise for addressing the ongoing mental health needs of hurricane-exposed youths.[35]

The above findings should be interpreted in light of study limitations. First, SED was estimated using a screening scale rather than a diagnostic interview. The SDQ has been previously validated and used in national epidemiologic surveys,[36] and demonstrated good psychometric properties in estimating SED based on diagnostic interviews in a clinical reappraisal study.[23] Nevertheless, screening scales are less precise than clinical interviews, resulting in potential misclassification. Because misclassification was likely nondifferential, any

imprecision would have resulted in attenuation of the associations between risk factors and SED. Because the SDQ did not include specific questions about PTSD symptoms, our estimates of SED prevalence are most likely conservative. Second, the low response rate to the CAG survey and the exclusion of individuals who were unreachable by telephone probably resulted in underrepresentation of individuals with high levels of stress exposure and mental health problems, most likely resulting in conservative estimates of the prevalence of SED. Third, we did not assess pre-hurricane SED, and parents' determinations of whether their child's emotional and behavioral problems were attributable to the hurricane were subjective and susceptible to bias. Parents who experienced high levels of stress during the hurricane may have been more likely to report that their children's problems were hurricane-related, leading to an overestimation of the association between stress exposure and SED. Although the estimated prevalence of NH-SED is similar to the prevalence of SED reported in the NHIS[15] and hurricane-related stressors were more consistently associated with H-SED than NH-SED, some associations between hurricane-related stressors and NH-SED were significant, suggesting some degree of misclassification in parents' determinations of whether their child's problems resulted from the hurricane. Fourth, we did not directly interview youths to determine the prevalence of emotional and behavioral problems from the child's perspective and to estimate parent–child agreement. This may have resulted in underestimates of SED prevalence, as some studies have reported low parent–child agreement on screening measures with parents tending to report fewer severe symptoms than children.[37] In subsequent waves of data collection, however, we interviewed a small number of adolescent respondents from the current sample, and these interviews revealed good concordance between adolescent and parent reports of SED using the SDQ. Fifth, because of sample size constraints, we were unable to distinguish persistent cases from new onsets in prediction models examining changes in SED. The extent to which disaster-related and ongoing stressors are differentially associated with persistent and delayed onset child mental health problems remains an important question for future research.

Despite these limitations, the results are quite clear in showing that the prevalence of SED among youths who lived through Hurricane Katrina continues to be substantially elevated several years post-hurricane compared with levels pre-hurricane. The fact that SED prevalence decreased is encouraging in that it documents some evidence of recovery. However, it is worrisome that SED prevalence did not decrease at all and, if anything, showed some evidence of an increase among youths exposed to the highest levels of stress. This finding points to the importance of expanding public health interventions to focus on the most highly exposed youths in an effort to reduce the burden of psychiatric problems. It will be important in this effort not to confuse the most highly *exposed* children and adolescents with the most highly *disadvantaged* or the most highly *vulnerable* youths, as we found that the continued high prevalence of SED among youths exposed to high levels of hurricane-related stress exists throughout the entire population irrespective of socioeconomic or other indicators of social disadvantage, and irrespective of the presence or absence of characteristics typically used as indicators of vulnerability. &

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TABLE S1 Associations of Sociodemographic Factors with Serious Emotional Disturbance (SED)[a] (n = 576)

	Baseline SED[b]		SED Reinterview[c]		SED Reinterview[c,d]	
	OR	(95% CI)	OR	(95% CI)	OR	(95% CI)
Age						
Continuous measure	1.0	(0.9-1.1)	1.1	(1.0-1.2)	1.1	(1.0-1.2)
$\chi^2{}_1$ (p)	0.1	(.722)	4.9[f]	(.027)	3.0	(.084)
Sex						
Male	1.1	(0.6-1.9)	1.2	(0.7-2.3)	1.2	(0.6-2.2)
Female	1.0	—	1.0		1.0	—
$\chi^2{}_1$ (p)	0.0	(.863)	0.4	(.511)	0.2	(.621)
Race/ethnicity						
Nonwhite	0.9	(0.4-1.8)	1.1	(0.5-2.2)	1.0	(0.5-2.1)
White	1.0	—	1.0	—	1.0	—
$\chi^2{}_1$ (p)	0.1	(.722)	0.0	(.890)	0.0	(.958)
Income						
Low	5.2	(1.8-14.5)	2.5	(0.9-7.2)	2.6	(0.8-8.6)
Middle	2.2	(1.1-4.5)	1.2	(0.6-2.8)	1.3	(0.5-3.1)
High	1.0	—	1.0	—	1.0	—
$\chi^2{}_1$ (p)	10.1[f]	(.007)	3.1	(.212)	2.7	(.256)
Health insurance						
None	0.5	(0.2-1.3)	1.1	(0.4-2.7)	0.7	(0.3-1.8)
Private/government/military	1.0	—	1.0	—	1.0	—
$\chi^2{}_1$ (p)	2.0	(.162)	0.0	(.872)	0.5	(.489)
Current living situation						
New Orleans/New Orleans Metro	1.7	(0.4-6.4)	1.6	(0.4-5.9)	1.1	(0.3-4.2)
Rest of hurricane area	0.8	(0.2-3.7)	2.0	(0.5-8.0)	2.3	(0.6-9.4)
Area outside of hurricane area	1.0	—	1.0	—	1.0	—
$\chi^2{}_2$ (p)	1.8	(.402)	1.0	(.597)	1.9	(.395)
Pre-hurricane residence						
New Orleans/New Orleans Metro	0.4	(0.1-1.2)	1.0	(0.4-2.7)	1.7	(0.5-5.3)
Rest of hurricane area	1.0	—	1.0	—	1.0	—
$\chi^2{}_1$ (p)	2.5	(.112)	0.0	(.931)	0.8	(.365)
Parent marital status[e]						
Yes	1.8	(0.9-3.8)	1.9	(0.9-4.0)	1.4	(0.5-3.5)
$\chi^2{}_1$ (p)	2.4	(.118)	2.7	(.100)	0.4	(.515)

Note: CI = confidence interval; OR = odds ratio.

[a]For each of the models, a dummy variable distinguishing SED attributable to Hurricane Katrina (H-SED) from SED unrelated to Hurricane Katrina (NH-SED) was included. A global test of the interaction between this dummy variable and each of the predictors indicate no difference in the association of socio-demographic factors with H-SED versus NH-SED: Model 1, $\chi^2{}_8 = 5.2$, p = 0.74; Model 2, $\chi^2{}_8 = 10.2$, p = 0.25; Model 3. $\chi^2{}_8 = 6.4$, p = 0.60.

[b]Demographics and SED were assessed at the baseline interview.

[c]Demographics and SED were assessed at the follow-up interview.

[d]Model controlled for SED at baseline.

[e]Parent marital status is coded yes if the adult informant is the child's biological parent and they are married.

[f]Significant at the .05 level, two-sided test.

TABLE S2 Associations Between Hurricane-Related Stressors, Ongoing Stress, and Serious Emotional Disturbance (SED)

	SED Baseline (Model 1)			SED Reinterview (Model 2)			SED Reinterview (Model 3)			SED Reinterview (Model 4)		
	Any SED Baseline[c]	NH-SED Baseline	H-SED Baseline	Any SED Reinterview[c]	NH-SED Reinterview	H-SED Reinterview	Any SED Reinterview[c]	NH-SED Reinterview	H-SED Reinterview	Any SED Reinterview[c]	NH-SED Reinterview	H-SED Reinterview
	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)
Ongoing stress (baseline)												
Continuous[a]	1.6[d] (1.1-2.2)	0.9 (0.6-1.5)	2.6[d] (1.7-3.9)									
χ^2_1 (p)	6.4 (.010)	0.2 (.70)	18.8 (<.001)									
Ongoing stress (follow-up)												
Continuous[a]				1.4 (1.0-1.9)	0.7 (0.5-1.1)	1.9[d] (1.3-2.9)	1.3 (1.0-1.9)	0.7 (0.5-1.1)	1.9[d] (1.2-3.0)	1.2 (0.8-1.8)	0.7 (0.5-1.1)	2.4[d] (1.5-3.8)
χ^2_1 (p)				3.5 (.06)	2.3 (.13)	9.4 (.002)	3.0 (.08)	2.4 (.12)	8.2 (.004)	1.1 (.29)	2.7 (.10)	12.3 (<.001)
Change in stress (follow-up – baseline)												
Continuous										0.9 (0.5-1.6)	1.0 (0.6-1.8)	0.7 (0.4-1.1)
χ^2_1 (p)										0.1 (.72)	0.0 (.99)	3.0 (.08)
SED (baseline)												
Yes							4.1[d] (2.1-8.2)	3.8[d] (1.4-10.6)	4.4[d] (1.9-10.4)	3.9[d] (1.4-11.0)	3.8[d] (1.3-11.3)	4.0[d] (1.7-9.6)
χ^2_1 (p)							16.2 (<.001)	6.6 (.01)	11.3 (<.001)	13.9 (<.001)	6.0 (.01)	9.9 (.002)
Hurricane-related stressors												
Continuous[b]	1.5 (1.0-2.2)	1.5[d] (1.0-2.1)	1.5[d] (1.0-2.1)	2.0[d] (1.4-3.0)	1.6[d] (1.0-2.6)	2.3[d] (1.3-4.1)	1.8[d] (1.2-2.7)	1.4 (0.9-2.3)	2.1[d] (1.2-3.7)	1.4 (0.9-2.3)	1.4 (0.9-2.3)	2.1[d] (1.1-3.7)
χ^2_1 (p)	4.3 (.038)	3.9 (.049)	3.9 (.049)	12.6 (<.001)	4.3 (.040)	8.0 (.005)	8.2 (.004)	2.4 (.12)	6.1 (.010)	2.0 (.16)	2.4 (.12)	5.7 (.017)

Note: CI = confidence interval; H-SED = SED attributable to Hurricane Katrine; NH-SED = SED unrelated to Hurricane Katrina; OR = odds ratio.
[a]Ongoing stressors coded as follows: 0 = none, 1 = 1-3; 2 = 4-8; 3 = 9-10.
[b]Hurricane-related stressors coded as follows: 0 = none; 1 = 1-2; 2 = 3-4; 3 = 5+.
[c]For each of the models, a dummy variable distinguishing H-SED from NH-SED was included. A global test of the interaction between this variable and each of the predictors was significant for each of the four models:
Model 1 (χ^2_2=17.7, p<.001); Model 2 (χ^2_2=13.8, p=.001); Model 3 (χ^2_3=14.3, p = .003); and Model 4 (χ^2_4 = 17.6, p = .002).
[d]Significant at the .05 level, two-sided test.