

The Impact of Hurricane Katrina on the Mental and Physical Health of Low-Income Parents in New Orleans

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The purpose of this study was to document changes in mental and physical health among 392 low-income parents exposed to Hurricane Katrina and to explore how hurricane-related stressors and loss relate to post-Katrina well-being. The prevalence of probable serious mental illness doubled, and nearly half of the respondents exhibited probable post-traumatic stress disorder. Higher levels of hurricane-related loss and stressors were generally associated with worse health outcomes, controlling for baseline sociodemographic and health measures. Higher baseline resources predicted fewer hurricane-associated stressors, but the consequences of stressors and loss were similar regardless of baseline resources. Adverse health consequences of Hurricane Katrina persisted for a year or more and were most severe for those experiencing the most stressors and loss. Long-term health and mental health services are needed for low-income disaster survivors, especially those who experience disaster-related stressors and loss.

Hurricane Katrina was one of the worst natural disasters in U.S. history (U.S. Department of Commerce, 2006). Beyond the physical devastation, the hurricane led to elevated health and mental health difficulties among survivors (Galea et al., 2007; Kessler, Galea, Jones, & Parker, 2006; Mills, Edmondson, & Park, 2007; Wang et al., 2007; Weisler, Barbee, & Townsend, 2006). Low-income, African American, single mothers were at particularly high risk for suffering these adverse effects (Adeola, 2009; Jones-DeWeever, 2008). Even among the most vulnerable groups, however, there is often considerable variation in survivors' resources, exposure, and responses (Dyson, 2006). The present study investigated how a sample of primarily single, low-income, African American women adjusted in the aftermath of Hurricane Katrina. Prehurricane data permitted an assessment of change in physical and mental health over time and of the role of material and social resources in protecting participants from both hurricane exposure and adverse outcomes following the event.

Background

Each year, excluding droughts and war, nearly 500 incidents across the globe meet the Red Cross definition of a disaster (Norris, Baker, Murphy, & Kaniasty, 2005). A substantial literature has examined the mental and physical health effects of exposure to disasters (Galea, Nandi, & Vlahov, 2005; Rubonis & Bickman, 1991). Much of this research focuses on the short-term implications and indicates that disaster survivors evidence a wide range of reactions, including symptoms of posttraumatic stress disorder (PTSD) as well as other, often comorbid, conditions such as depression, anxiety, somatization, substance abuse, and physical illness (Kessler et al., 2006; Pfefferbaum & Doughty, 2001; Solomon & Green, 1992). Specific transient symptoms may include distressing worries, difficulties sleeping and concentrating, and disturbing memories, many of which dissipate over time with solid emotional support (Norris et al., 2005).

Findings on the long-term health and mental health consequences of disasters are somewhat mixed. Whereas some studies have noted enduring effects (Green et al., 1990; Lima, Pai, Santacruz, Lozano, & Luna, 1987; Stein et al., 2004; Thienkrua et al., 2006), the majority find that problems are relatively short-lived, with survivors recovering from the initial shock and trauma within a matter of weeks or months of the event (e.g., Cook & Bickman, 1990; Salzer & Bickman, 1999; Sundin & Horowitz, 2003). Indeed, a meta-analysis of 52 disaster studies indicated that effects attenuate as the number of weeks from the event elapse (Rubonis & Bickman, 1991). Moreover, as many as

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half of survivors show resilience in the face of loss and trauma, displaying little or no grief beyond the first few months (Bonanno, 2008). Several personality factors appear to be associated with such resilience, including a tendency toward self-enhancement and positive emotions (Bonanno, Rennie, & Dekel, 2005). Likewise, certain demographic and contextual factors, including gender, education, social support, health, and less stress exposure, are associated with resilient functioning (Bonanno, Galea, Bucciarelli, & Vlahov, 2007). Nonetheless, the emotional and behavioral effects of Hurricane Katrina—which produced widespread community disruption, exposure to an array of known risk factors, and a protracted recovery—were more substantial than those resulting from most previous natural disasters (Galea, Tracy, Norris, & Coffey, 2008; Rateau, 2009; Sastry & VanLandingham, 2009).

Hurricane Katrina

Hurricane Katrina devastated the Gulf Coast region of the United States, contributing to the loss of nearly 2,000 lives and displacing approximately 1.5 million residents. Hurricane Rita occurred just 1 month later, also affecting some of the participants in this study. Hurricane Katrina was particularly stressful to the low-income and African American residents of New Orleans, many of whom were left homeless and isolated from their social and community networks (Adeola, 2009; Elliot & Pais, 2006; Galea et al., 2008; Sharkey, 2007). In the city of New Orleans, which was most heavily affected by the levee breaks, it is estimated that 60% of the housing stock was destroyed (U.S. Department of Commerce, 2006). The hurricane also seriously damaged or destroyed educational and health facilities in the city, leading to numerous school closures, destruction of medical records, and reductions in the number of hospital beds and health clinics. Large numbers of evacuees have still not returned to New Orleans (Fussell, Sastry, & VanLandingham, in press).

Growing evidence suggests that the hurricane had both immediate and lasting adverse health and mental health consequences. A rapid-needs assessment of returning New Orleans residents conducted by the Centers for Disease Control and Prevention in October 2005 revealed that more than 50% of respondents showed signs of a “possible” need for mental health treatment (Centers for Disease Control and Prevention, 2006; Weisler et al., 2006). A study of families living in FEMA-subsidized hotels or trailers conducted in February 2006 reported high rates of disability among caregivers of children, due to depression, anxiety, and other psychiatric problems (Abramson & Garfield, 2006). The survey also yielded high rates of reports of chronic health problems (34%) and numerous new mental health problems (nearly 50%) among children in these families. Another cross-sectional survey of 222 survivors found that over half (52%) continued to experience poor mental and physical health 15 months after Katrina (Kim, Plumb, Gredig, Rankin, & Taylor, 2008). Other researchers have noted an even longer term persistence of these symptoms (Galea et al., 2008; Ginzburg, 2008; Kessler et al., 2008; Schoenbaum et al., 2009; Wang et al., 2008), with young adults, women, parents of small children, and those with low income suffering the highest levels of PTSD and mental health

disorders (Bolin & Bolton, 1986; Galea et al., 2007; Jones-DeWeever, 2008; Kessler et al., 2008).

A major difficulty in assessing such effects, however, is the lack of information on the predisaster functioning. Few studies have access to true “baseline” information collected prior to the disaster. Among those studies of events that do have such data, few have been on the catastrophic scale of Hurricane Katrina. An extensive review by Norris et al. (2002) found that only 7 of the 160 studies reviewed had predisaster data on the individuals examined. Moreover, the samples used in these studies were generally small, with a median sample size of 149 across the 160 studies. The vast majority of disaster studies relied on postdisaster or retrospective data. Although it provides some measure of predisaster functioning, retrospective information is likely to be measured with error, leading to biased estimates of effects on postdisaster outcomes. For example, responses to retrospective questions about predisaster social support or living circumstances could be colored by postdisaster experiences. A closely related issue is that measures of the actual amount of stressors and loss during the course of a disaster may also be affected by the individual’s state of mind or mental health. For example, reports of actual stressors experienced during a disaster (e.g., fear that one’s life was in danger during the disaster) may be heightened by preexisting anxiety or depression. If so, it would not be surprising to find that anxiety or depression measured after the disaster is associated with reports of stressful experiences. However, this association would not provide information on whether the stressors heightened mental health problems.

One study examined how 1,043 survivors’ mental health changed from before to between 5 and 8 months after the hurricane (Kessler et al., 2006). Survivors’ reports of health problems were compared to those of 826 people who lived in hurricane-affected areas at the time of this survey and previously were participants in the National Comorbidity Survey–Replication (NCS–R), conducted between 2001 and 2003. This study found significantly higher rates of serious and mild–moderate rates of mental illness (based on the K6 screening scale; Kessler et al., 2002) among the post-Katrina sample, but found less suicidality among those in the post-Katrina sample. The much higher (doubled) rate of mental illness is striking. Unfortunately, because this study does not track individuals from before to after the storm, it is not possible to assess which pre-hurricane factors were protective against increases in mental illness and which were not.

It is also difficult, in the absence of baseline data, to account for variability in adaptive functioning among survivors. Even among the most vulnerable populations, there is often considerable heterogeneity in survivors’ responses to traumatic events. Baseline data permit an exploration of the economic, social, and health and mental health resources, alone and in combination, that might heighten vulnerability or strengthen resilience. Previous explanatory models of disaster responses have focused on the interrelationships between the severity of exposure and the resources available to the individual. Most of these models have posited that resources function to moderate or “buffer” the effects of hurricane experiences, influencing individuals’ perceptions of and their responses to the disaster. Survivors with initially low levels of health, social or economic resources are thought to be more vulnerable to the negative consequences of

the hurricane, and to experience relatively steeper declines in emotional and physical health outcomes. Social support has been shown to buffer against stress, and the lack of social support has been identified as a risk factor of PTSD (Galea et al., 2008; Kaniasty & Norris, 2008; Ozer & Weiss, 2004; Weems et al., 2007).

Researchers have also looked at the loss of social support and other resources in explaining variability in stress responses. Within this context, the conservation of resources (COR) theory posits that it is the threatened or actual loss of health, social, or economic resources that leads to psychological distress (Hobfoll, 1989). According to COR, individuals strive to obtain and retain personal and social resources, and experience stress when circumstances threaten or diminish these resources. Resources tend to beget more resources, whereas a loss of resources tends to result in further loss. In particular, those individuals who have fewer resources prior to a stressor are less equipped to invest resources in recovery, such that efforts to recover from losses lead to progressive depletion of resources. Previous research on natural disasters indicates that the loss of social, health, or economic resources is associated with declines in psychosocial functioning (Kaiser, Sattler, Bellack, & Dersin, 1996; Sattler et al., 2002; Smith & Freedy, 2000; Sümer, Karancı, Berument, & ve Güneş, 2005).

Resources can also affect the degree of hurricane-related stress that is experienced. Differential access to resources prior to the storm, such as reliable information, transportation, and more geographically extended social networks, can affect variations in exposure to the disaster (Adeola, 2009; Lieberman, 2006; Stephens, Hamedani, Markus, Bergsieker, & Eloul, 2009). Hobfoll and Parris Stevens (1990) have posited that social support may “directly prevent or limit resource loss and thereby insulate people from stressful circumstances” (p. 458). Likewise, Kaniasty and Norris (2009) noted that predisaster resources can influence the degree of disaster exposure. This was clearly the case with Hurricane Katrina, where low-income communities of color were more vulnerable to its impact (Adeola, 2009). Most high- and medium-income families evacuated in advance of the storm and secured places to stay in hotels or with family and friends in other cities. Low-income families, in contrast, were disproportionately stranded in the city or in shelters after the storm, increasing the chance that they experienced deprivation, stress, and fear (Elliot & Pais, 2006; Lavelle & Feagin, 2006; Spence, Lachlan, & Griffin, 2007). Brodie, Weltzien, Altman, Blendon, and Benson (2006) found that, among survivors who did not evacuate New Orleans, more than one third lacked a means of transportation. Others have noted that those with fewer economic resources are more likely to live in housing that is unable to withstand natural disasters (Ruscher, 2006; Weems et al., 2007). Moreover, those who are poor tend to receive and heed fewer evacuation warnings, heightening their risk for exposure (Dyson, 2006; Lieberman, 2006; Stephens et al., 2009).

Current Study

The current study examines the consequences of Hurricane Katrina on the physical and mental health of a particularly vulnerable group of survivors—low-income, predominantly African American, single mothers. Using a unique panel data

set that follows individuals from more than a year before the hurricane to approximately 18 months afterward, we document changes in the physical and mental health of study participants and examine how the degree of exposure to hurricane-related stressors experienced during the hurricane is related to their post-Katrina well-being. The existence of pre-hurricane data permits us to examine whether prehurricane resources—including economic, social, and health resources—had protective effects on posthurricane health outcomes. In particular, we examine the extent to which exposure to hurricane-related stressors, level of property damage, and water depth affected mental and physical health outcomes after Hurricanes Katrina and Rita after controlling for demographic and prehurricane mental and physical health. Given the extent to which mental health can affect perceptions of difficulties, we expected that objective measures of damage—such as flood depths obtained via geo-coding—would be less strongly related to prehurricane mental health than more subjective measures of perceived stressors and loss.

We also examine the protective role of resources that were available prior to Hurricane Katrina. Although previous studies have examined retrospective accounts of predisaster resources (or the buffering role of postdisaster resources), pre-Katrina data permit an examination of whether the social and material resources that the predominantly low-income, African American mothers had at their disposal prior to the natural disaster affected the severity of their exposure to the disaster.

Method

Data Collection and Sample Characteristics

Participants were initially part of a study of low-income parents who had enrolled in two community colleges in the city of New Orleans in 2004–2005. The purpose of the study was to examine whether performance-based scholarships affect academic achievement and therefore also health and well-being (Brock & Richburg-Hayes, 2006). Baseline demographic and health information was collected for all of the 1,019 participants in the study. By the time Hurricane Katrina struck, 492 participants had been enrolled in the program long enough to complete a 12-month follow-up survey, which included information on participants' economic status, social support, and physical and mental health. After Hurricane Katrina, between May 2006 and March 2007, 402 (81.7%) of those participants who had completed the 12-month survey were successfully located by a survey research firm and surveyed over the telephone. The post-disaster surveys, which were administered over the phone by trained interviewers, included the same questions as the predisaster 12-month follow-up survey, as well as a measure of PTSD and module that collected detailed information about hurricane experiences. Next, we refer to information from the baseline and 12-month surveys as “pre-Katrina” data, and information from the more recent survey as “post-Katrina” data. The analyses in this study draw on a sample of 392 respondents who reported living in an area affected by Hurricane Katrina at the time the hurricane struck.

All the participants experienced the hurricane and most (98.0%) evacuated, however, their trajectories varied: 85.4%

Table 1. *Baseline Characteristics of the Sample*

	Study sample ($N = 392$)
Age at the time of Hurricane Katrina, mean (SD)	26.55 (4.45)
Female, % [95% CI]	95.9 [94.0–97.9]
African American, % [95% CI]	84.2 [80.6–87.8]
Non-Hispanic White, % [95% CI]	10.7 [7.7–13.8]
Number of children, mean (SD)	1.92 (1.05)
Single (neither married nor cohabiting), % [95% CI]	64.0 [59.3–68.8]
Monthly individual earnings (\$), mean (SD)	651.7 (686.2)
Monthly individual earnings (\$), median	600.0
Monthly family income (\$), median	1,358.4
Received public assistance ^a , % [95% CI]	64.3 [59.6–69.0]
Owned working car, % [95% CI]	72.9 [68.6–77.4]

^aAny time during the month prior to the survey.

departed before the storm struck, while 4.9% left during the storm, and 9.6% left in the week of, or after, Katrina. The participants had moved an average of 2.5 times ($SD = 0.4$). At the time of the post-Katrina follow-up survey, 47.7% were living in the New Orleans MSA, 12.5% were living elsewhere in Louisiana, 24.9% were in Texas, 4.7 were in Georgia, and the remaining 10.2% were in other states.

Table 1 presents demographic information for the participants. The average age at the time of Hurricane Katrina was 26.6 years ($SD = 4.5$). The majority was female (95.9%). The majority was African American (84.2%), reflecting the demographics of the City of New Orleans in which 67.7% of the population was African American in 2004 (see Jones-DeWeever, 2008). Most were neither married nor cohabiting with a romantic partner (64.0%). More than two thirds (64.3%) received public assistance in the month prior to the pre-Katrina survey. Nearly three fourths (72.9%) owned a working car prior to the Hurricane.

Measures

Economic status. We used three measures of pre-Katrina economic status: the logarithm of total household income in the previous month; an indicator of the number of received public benefits in the past month including unemployment insurance, Supplemental Security Income, welfare, and food stamps; and a measure of car ownership prior to Katrina. Car ownership is important both as a measure of wealth as well as a form of transportation that may have made it easier to evacuate in advance of the hurricane.

Social support. Perceptions of social support were assessed at Times 1 and 2 using eight items from the Social Provisions Scale (Cutrona & Russell, 1987). These items assess the extent to which participants perceive that they have people in their lives who value them and on whom they can rely. Items are rated using a 4-point Likert-type scale ranging from 1 (*strongly disagree*) to 4 (*strongly agree*). Cronbach's alphas of this scale in this study were .84 for Time 1 (T1) and .81 for Time 2 (T2).

Hurricane experiences. We used three measures of hurricane experiences, two of which were based on individuals' survey responses. The first measure was a one-item question on respondents' assessments of the extent of damage to their personal property, rate on a 4-point scale ranging from 0 (*minimal*) to 3 (*enormous*). The second measure of hurricane experiences was a scale of the number of hurricane-related stressors experienced. The 17 questions, which assessed stressors experienced in the immediate aftermath of the storm, duplicated those used in a larger survey of the demographic and health characteristics, evacuation and hurricane experiences, and future plans of Hurricane Katrina evacuees. The scale was jointly designed by the *Washington Post*, the Kaiser Family Foundation, and the Harvard School of Public Health (Brodie et al., 2006). Participants were asked to indicate whether they had experienced any of the following conditions: (a) no fresh water to drink, (b) no food to eat, (c) felt their life was in danger, (d) lacked necessary medicine, (e) lacked necessary medical care, (f) had a family member who lacked necessary medical care, (g) lacked knowledge of safety of their children, and (h) lacked knowledge of safety of their other families members. These questions were asked about both Hurricane Katrina and Hurricane Rita. In addition, participants indicated whether a close friend or family member had lost their life due to the hurricane and its aftermath. A composite score (labeled as "hurricane-related stressors") was created with the count of affirmative responses to these 17 items. Inter-item reliability (KR-20) of the exposure scale was .84. The third measure gauges hurricane damage to the respondent's pre-Katrina home with the flood depth information for each address on September 2, 2005. This provides an objective measure of whether respondents lived in hard-hit areas. We were able to geo-code 372 of the 392 addresses; the remaining respondents used post office boxes that could not be matched with flood data.

Psychological distress. The K6 scale of nonspecific psychological distress (Kessler et al., 2002) was used to assess *DSM-IV* mood and anxiety disorders within the previous 30 days. The K6 scale has been shown to have good psychometric properties (Furukawa, Kessler, Slade, & Andrews, 2003) and has been used in previous research on the psychological functioning of Hurricane Katrina survivors (e.g., Galea et al., 2007; Wang et al., 2007). It includes items such as "During the past 30 days, about how often did you feel so depressed that nothing could cheer you up?" Respondents answered on a 5-point rating scale ranging from 0 (*none of the time*) to 4 (*all the time*). Scale scores range from 0 to 24. A previous validation study (Kessler et al., 2003) suggests that a scale score of 0–7 can be considered as probable absence of mental illness, a score of 8–12 can be considered as probable mild or moderate mental illness (MMI), and a score of 13 or greater can be considered as probable serious mental illness (SMI). Cronbach's alphas of the K6 scale in this study were .72 for T1 and .80 for T2. Our use of the K6 permits direct comparisons with results in the Kessler et al. (2006) study of mental illness after Hurricane Katrina.

PTSD symptoms. The Impact of Events Scale-Revised (IES-R), a 22-item self-report inventory of symptoms of PTSD (Weiss & Marmar, 1997) with good psychometric properties

(e.g., Creamer, Bell, & Failla, 2003), was used to measure PTSD symptoms as a result of hurricane experiences. The total score for this scale ranges from 0 to 88. Unlike the other mental health measures we used, this measure was specific to the respondent's hurricane experiences and was included only in the post-Katrina survey. Participants were asked how often, over the prior week, they were distressed or bothered by experiences related to the hurricane, with sample items including "Any reminders brought back feelings about it," "Pictures about it popped into my mind," and "I was jumpy and easily startled." The scale was rated in a 5-point scale, ranging from 0 (*not at all*) to 4 (*extremely*). Cronbach's alpha reliability for the IES-R scale in this study was .95.

Perceived stress. The Perceived Stress Scale (PSS4; Cohen, Kamarck, & Mermelstein, 1983; Cohen & Williamson, 1991), was used to measure perceptions of stress. This four-item scale, which measures the degree to which events in one's life are perceived to be stressful, has been widely used in studies of the role of stress in the development of health problems. Participants answered on a 5-point ratingscale ranging from 0 (*never*) to 4 (*very often*). Cronbach's alphas of the PSS4 scale in this study were .73 for T1 and .75 for T2.

Physical health. We assessed physical health using three measures. Respondents rated their health on a 5-point scale ranging from 1 (*excellent*) to 5 (*poor*). Respondent's body mass index (BMI) was calculated using a baseline report on height and pre- and posthurricane reported weight. Finally, we included a count of the number of diagnosed medical conditions, including diabetes, asthma, hypertension, and other conditions.

Results

Missing Data

Although the missing variables were not missing completely at random, the missing rate on each item was generally low, under 10%. Missing data were handled with multiple imputation: From the original data, five complete data sets with no missing variables were rendered using Amelia II (Honaker, King, & Blackwell, 2008) in R program. Each analysis was

conducted independently across the five data sets. Each result presented next represents an average of the five separate analyses. When appropriate, Rubin's (1987) correction was performed to derive the standard errors.

Exposure

All but 8 individuals left their homes for at least one night due to Hurricane Katrina or Rita. Half (50.2%) of the sample reported "enormous" property damage associated with the storm. They experienced, on average, 4.08 hurricane-related stressors ($SD = 3.50$). The most common stressor reported was "did not know if other family members were safe after Hurricane Katrina" (76.9%), which is consistent with the mass exodus of people from the area at the time of the storm. Substantial numbers also reported experiencing serious deprivation during Hurricane Katrina, including inadequate drinking water (26.0%), inadequate food (34.9%), or feeling that their lives were in danger (32.3%). In addition, 28.6% reported the death of a family member or close friend.

Health and Mental Health Outcomes

Mental health outcomes, as measured by the K6, worsened significantly over the period from before to after the hurricane (Table 2). Based on established cutoffs (Kessler et al., 2003), the prevalence of MMI or SMI rose from 23.5% to 37.5% (McNemar test $p < .001$), and that of probable SMI doubled (6.9%–14.3%, $p < .001$). The prevalence of high perceived stress (scale score > 7) rose from 20.2% to 30.9% ($p < .001$). All physical health outcomes also experienced statistically significant increases in prevalence (see Table 2). PTSD symptoms were not assessed prior to the hurricane. At the time of the post-Katrina survey, 47.7% of participants were classified as having probable PTSD (average IES-R item score > 1.5 ; Weiss & Marmar, 1997).

Hurricane-Related Stressors and Property Damage as Predictors of Mental Health Outcomes

Sequential regression was used to determine whether number of hurricane-related stressors, level of property damage, and the

Table 2. Prevalence of Physical Health and Mental Health Outcomes Before and After Hurricane Katrina

Outcome	Definition	Before Katrina	After Katrina	McNemar test
		% [95% CI]	% [95% CI]	<i>p</i> Value
MMI/SMI	Probable mild–moderate (K6 > 7) or serious (K6 > 12) mental illness	23.5 [19.3–27.7]	37.5 [32.7–42.3]	$< .001$
SMI	Probable serious (K6 > 12) mental illness	6.9 [4.4–9.4]	13.8 [10.4–17.2]	$< .001$
PTSD	Posttraumatic stress disorder: IES-R average score > 1.5	ND	47.7 [42.8–52.6]	NA
PSS	Perceived stress scale > 7	20.2 [16.2–24.1]	30.9 [26.3–35.4]	$< .001$
FPH	Fair or poor self-rated health status	12.8 [8.8–15.2]	19.1 [15.1–22.9]	$< .01$
HC	At least one diagnosed health condition	61.2 [56.4–66.0]	66.6 [61.9–71.3]	$< .05$
OVERW	Body mass index (kg/m^2) > 25	67.1 [62.4–71.7]	72.9 [68.6–77.4]	$< .01$

Note. The *p* value is from a *t* test of the hypothesis that the change is equal to 0. CI = confidence interval; IES-R = Impact of Event Scale-Revised; ND = not determined; NA = not applicable.

Table 3. *Sequential Regression of Hurricane, Demographic, and Prehurricane Health Variables on Posthurricane Health Outcomes*

Variables	K6		PSS		IES-R		BMI		No. medical conditions		General health	
	<i>B</i>	<i>SE</i>	<i>B</i>	<i>SE</i>	<i>B</i>	<i>SE</i>	<i>B</i>	<i>SE</i>	<i>B</i>	<i>SE</i>	<i>B</i>	<i>SE</i>
Step 1												
No. hurricane stressors	0.40	0.07**	0.19	0.05**	2.34	0.31**	0.22	0.10*	0.13	0.02**	0.08	0.04*
Level of property damage	0.45	0.27	0.20	0.18	2.72	1.12*	0.16	0.36	0.14	0.08	0.08	0.06
Water depth (log)	-0.01	0.33	0.13	0.25	1.37	1.55	0.21	0.50	-0.24	0.10*	-0.12	0.10
<i>R</i> ² Δ	.09**		.05**		.18**		.02		.11**		.06**	
Step 2 (Demographic variables controlled, not shown)												
No. hurricane stressors	0.40	0.08**	0.20	0.06**	2.09	0.33**	0.10	0.11	0.12	0.02**	0.08	0.03*
Level of property damage	0.51	0.28	0.28	0.19	2.99	1.12*	0.17	0.36	0.15	0.08	0.09	0.06
Water depth (log)	-0.11	0.34	0.12	0.26	0.78	1.56	0.01	0.51	-0.27	0.10*	-0.13	0.12
<i>R</i> ² Δ	.02		.03		.03*		.05*		.01		.01	
Step 3 (Prehurricane physical and mental health controlled)												
No. hurricane stressors	0.30	0.07**	0.14	0.05*	1.82	0.33**	0.10	0.05	0.09	0.07**	0.05	0.03
Level of property damage	0.50	0.26	0.34	0.18	2.92	1.10*	-0.01	0.18	-0.09	0.07	0.07	0.06
Water depth (log)	-0.01	0.32	0.14	0.24	0.82	1.53	0.21	0.24	-0.20	0.09*	-0.12	0.09
Age	0.12	0.06	0.11	0.04*	0.89	0.27**	-0.01	0.04	0.02	0.02	0.01	0.01
Own a car	-0.65	0.57	-0.17	0.40	-4.19	2.47	0.60	0.38	-0.15	0.16	-0.09	0.12
No. children	-0.34	0.25	-0.35	0.17*	-0.74	1.07	-0.11	0.17	-0.06	0.07	-0.01	0.05
Personal income (log)	0.12	0.17	0.08	0.12	0.50	0.75	-0.02	0.11	0.00	0.05	0.00	0.03
Single	-1.29	0.82	-0.36	0.57	-2.77	3.52	-0.04	0.54	0.03	0.22	0.04	0.16
Minority	-0.11	0.94	-0.49	0.06	7.99	3.83*	0.70	0.57	0.35	0.24	-0.05	0.16
Months since Katrina	-0.00	0.10	-0.03	0.07	-0.37	0.42	0.07	0.07	0.01	0.03	0.01	0.02
Public assistance	0.20	0.36	0.25	0.25	-2.17	1.57	0.20	0.27	-0.08	0.10	-0.01	0.07
K6	0.20	0.08**	-0.02	0.05	1.02	0.33**	0.01	0.05	0.00	0.02	-0.02	0.01
PSS	0.35	0.09**	0.39	0.07**	0.53	0.41	-0.03	0.06	0.04	0.03	0.06	0.02**
BMI	0.01	0.04	-0.02	0.03	0.01	0.16	0.89	0.03**	0.02	0.01*	0.01	0.01
No. medical conditions	0.15	0.20	0.07	0.14	-0.39	0.86	-0.20	0.14	0.40	0.05**	0.02	0.04
General health	0.21	0.26	0.19	0.18	0.96	1.12	0.20	0.17	0.10	0.07	0.36	0.05**
Perceived social support	-0.00	0.06	-0.05	0.05	0.13	0.28	-0.01	-0.04	0.03	0.02	-0.01	0.01
<i>R</i> ² Δ	.14**		.14**		.06**		.73**		.20**		.19**	
<i>M</i> (<i>SD</i>)	6.71 (5.19)		5.39 (3.59)		33.26 (22.97)		29.31 (6.72)		1.82 (1.50)		1.52 (1.04)	
<i>R</i> ²	.24**		.21**		.27**		.80**		.32**		.26**	
Adjusted <i>R</i> ²	.21		.18		.24		.79		.29		.23	

p* < .05. *p* < .008.

flood depth at participant’s pre-Katrina addresses were predictive of posthurricane mental health outcome variables (i.e., K6, PSS4, and IES-R) and whether the relationship holds after prehurricane sociodemographic variables and physical and mental health are taken into account. Controls for sociodemographic characteristics at the time of the hurricane included the respondents’ age, indicators for ethnicity, the number of children, an indicator for whether she or he was single, the logarithm of monthly income, an indicator for the number of forms of received public assistance (i.e., welfare, food stamps, unemployment insurance, or Supplemental Security Income), ownership of working car, and the number of months since the hurricane that the follow-up survey took place. Controls for pre-Katrina health measures included each of the five physical and mental health measures obtained prior to the hurricane: K6, PSS4,

BMI, number of diagnosable physical health problems, self-reported health, and social support. Number of stressors, level of property damage, and flood depth were entered in Step 1; demographic variables were entered in Step 2; and prehurricane physical and mental health problems as well as social support were entered in Step 3. Bonferroni-type adjustment was made for inflated Type I error; all alphas in model statistics (e.g., *R*) were set at .05/6 = .008.

Table 3 shows the results of the six univariate sequential regressions of the mental health and physical health outcomes on the measure of reported property damage, the number of reported hurricane-related stressors, and flood depth on September 2, 2005. When no additional controls were included (Step 1), there were large and significant associations between the number of hurricane stressors and all mental health outcomes, while the

level of property damage was only predictive of PTSD. Flood depth was not predictive of any mental health outcomes. These associations between loss or stressors and mental health outcomes held even after adjusting for pre-Katrina sociodemographic characteristics, although they generally declined in magnitude (Table 3, Step 2). The results in the second step may still be biased if loss or number of hurricane-related stressors are associated with pre-Katrina health status; that is, those with poor baseline health may have been less able to avoid stressors or protect their property against loss. Results in Step 3 of Table 3 controlled for pre-Katrina physical and mental health status in addition to sociodemographic characteristics, which reduced the parameter estimates for the number of hurricane-related stressors and loss relative to those in Step 2. Even controlling for predisaster health status, there were large and usually statistically significant adverse effects of loss and stressors on mental health. Notably, many of the pre-Katrina mental and physical health measures are predictive of posthurricane mental health, showing that the parameter estimates for stressors are biased by their associations with pre-Katrina mental health.

Hurricane-Related Stressors and Property Damage as Predictors of Physical Health Outcomes

There were smaller but still significant associations between stressors and physical health outcomes (see Table 3). Even with additional sociodemographic and prehurricane physical and mental controls, the number of hurricane-related stressors was strongly associated with the number of diagnosed medical conditions. It was also predictive of BMI and general health rating before any of the additional variables were included. Once they were entered into the equation, however, the associations between number of stressors and BMI and general health rating were no longer significant at the $p < .05$ level. Prehurricane physical health measures are strongly associated with posthurricane physical health.

Pre-Katrina Resources as Predictors of Exposure to Hurricane-Related Stressors

Given that exposure to a greater number of hurricane-related stressors was predictive of worse mental and physical health outcomes, we examined the extent to which pre-Katrina resources predicted the level of exposure. Higher resource individuals may have been more able to avoid hurricane-related stressors and loss. In addition, resources may have buffered individuals from the adverse effects of stressors and property damage. To examine these hypotheses, we performed a standard multiple regression, with nine indicators of pre-Katrina resources: (a) number of received public benefits in the past month (e.g., welfare benefits, food stamps, unemployment insurance), (b) household income (log transformed), (c) ownership of a working car, (d) level of perceived social support, (e) mental health as measured with K6, (f) level of stress as measured with PSS4, (g) physical health as measured with BMI, (h) number of diagnosed medical condition, and (i) general health rating. We examined whether these prehurricane variables predicted fewer stressors and losses. Results (not shown in Table 3) indicate that

owning a car prior to the hurricane ($B = -0.82$, $SE = 0.039$, $p < .05$), a higher prehurricane household income ($B = -0.35$, $SE = 0.12$, $p < .01$), and a higher level of prehurricane perceived social support ($B = -0.09$, $SE = 0.05$, $p < .05$) were predictive of fewer number of stressors experienced. No other significant relationships were found. Apparently, these resources minimized exposure to stressors.

To test whether these resources buffered the impact of exposure to stressors, we estimated each of the six health and mental health outcome variables using the nine pre-Katrina resource variables and the number of hurricane-related stressors experienced (first block), as well as the interaction terms between the resource variables and measures of stressors as predictors (second block). Bonferroni correction ($p < .008$) was used and continuous predictors were centered prior to analysis. Two significant interaction effects were found: Exposure to Disaster Stressors \times Car Ownership on BMI ($B = 2.99$, $SE = 0.10$, $p < .008$) and Exposure to Disaster Stressors \times Predisaster K6 on postdisaster general health rating ($B = -0.012$, $SE = 0.004$, $p < .008$). We found no other evidence that the effects of exposure to stressors were smaller for those with higher prehurricane resources. Although resources may have reduced trauma exposure, they did not appear to have buffered individuals from the mental health effects, and to a lesser extent physical health, of trauma and loss.

Discussion

Rates of mental and physical illness rose sharply among participants in this study and remained elevated for at least 1 year following Hurricane Katrina. Fully 13.8% of the sample had probable SMI, up from 6.9% before the hurricane. Moreover, nearly half (47.7%) had probable PTSD, which is higher than rates reported in previous studies of Hurricane Katrina survivors (Galea et al., 2007, 2008; Kessler et al., 2008) and speaks to the particular vulnerabilities of the mostly young, low-income, African American mothers in our study. Indeed, recent studies have revealed higher rates of mental illness among Hurricane Katrina survivors who were single, African American, low-income, hurricane-exposed, female, or between the ages of 18 and 34 (Galea et al., 2007; Kessler et al., 2008). When combined with the additional stressor of having small children, these risk factors conspire to create a high prevalence of PTSD. More generally, these findings are consistent with previous research, which has highlighted the particular burden of disasters that is carried by women of color and the poor (Adeola, 2009; Norris et al., 2002).

There were also significant increases in reported fair or poor health, the presence of at least one diagnosed medical condition, and the proportion of our sample that was overweight. Although most previous disaster research has focused on the mental health consequences, these findings suggest that survivors also bear a significant toll to their physical health. Moreover, most earlier studies of both mental and physical health have relied solely on post-Katrina samples or compared separate samples drawn from before and after the hurricane. By taking into account prehurricane assessments of both mental and physical health, our findings provide more definitive evidence that mental and physical health declines were coincident with the hurricane.

There were strong adverse effects of hurricane-associated stressors and loss on mental health outcomes: Individuals who experienced more stressors and property damage were more likely to experience symptoms of mental illness, PTSD, and marginally higher levels of perceived stress. This is consistent with a previous study in which severe housing damage predicted psychological distress among Hurricane Katrina survivors 1 year after the storm (Sastry & VanLandingham, 2009). The effects of loss and stressors on physical health were more muted, although more stressors predicted more diagnosed medical conditions.

Although research indicates that individuals with higher resources experience less loss and fewer stressors as the result of disaster (Adeola, 2009; Sattler et al., 2002), we found only mixed support for this pattern. Higher personal income, more perceived social support, and ownership of a car predicted fewer hurricane-related stressors, but other resources, such as receipt of public benefits and mental and physical health, did not. In the case of Hurricane Katrina, the degree of loss was geographically widespread and devastating, producing relatively egalitarian storm damage. These findings are consistent with those of a study of Thai survivors of the 2004 tsunami, which showed that those who were displaced by the tsunami had similar pretsunami levels of income and education as those who were not displaced (Frankenberg et al., 2008; van Griensven et al., 2006).

We found very little evidence that baseline economic, social and health resources buffered the adverse effects of hurricane-related stressors and loss on health. The lack of buffering effect is surprising, particularly since the resource variables include a measure of social support, which has a well-documented, positive association with disaster recovery (Kaniasty & Norris, 1993). Weems et al. (2007) found a relatively low association between post-Katrina social support and PTSD symptoms, suggesting that social support systems were overwhelmed and had not sufficiently mobilized to mitigate distress. Indeed, in contrast to more circumscribed events, the “collective trauma” of Katrina disrupted some of the very resources that might have been marshaled, with potential support providers either scattered around the country or too burdened themselves to provide ample help to network members (Fussell, *in press*; Galea et al., 2007; Weisler et al., 2006). Moreover, even in intact networks, an initial mobilization of help is often followed by a deterioration of perceived social support (Arata, Picou, Johnson, & McNally, 2000; Erickson, 1976; Kaniasty & Norris, 1993; Norris & Kaniasty, 1996).

Limitations

In interpreting the results of this study, several limitations should be kept in mind. First, this study relied largely on self-report measures, which are susceptible to subjective biases. Our reliance on a screening tool of nonspecific distress further limits the scope of the study. An analysis of the effects of resources on specific psychiatric problems commonly observed in the aftermath of a disaster (e.g., PTSD, depression, grief) could reveal differential associations informative to the planning of therapeutic interventions for disaster survivors. Moreover, clinical interviews would have been preferable to screening scales of mental

disorders, as the latter provide less precise and more conservative estimates (Kessler et al., 2008).

Additionally, our index of social support did not distinguish among types of perceived social support (e.g., emotional, informational, tangible), limiting our ability to discern whether specific forms of support led to fewer hurricane-related stressors. It would have also been helpful to obtain additional descriptive information about the composition of the participants’ social networks, a factor that was shown to influence depressive symptomatology among Hurricane Andrew survivors (Haines, Beggs, & Hurlbert, 2002). Data on the support provided by participants to others in the aftermath of disaster would also be beneficial in future research, as social demands, particularly on women, can increase stress and influence psychological outcomes (Jones-DeWeever, 2008).

Although we were fortunate to locate over 80% of our pre-Katrina sample, those who were not located may have been more marginalized and have suffered even higher levels of psychopathology, potentially rendering our prevalence estimates conservative. Finally, participants in this study are not representative of the entire population affected by the hurricanes, reducing the generalizability of the findings. Nonetheless, by highlighting the experience of poor, predominately African American, single mothers—a population that is faced with multiple stressors and of higher risk of adverse outcomes—our findings shed light on to a particularly vulnerable, underserved, understudied group.

Implications for Research

In earlier research on Hurricane Katrina, Galea et al. (2007) pointed out that the absence of baseline information limits the ability to draw causal inferences about the effects of hurricane-related stressors on mental health. More generally, baseline information is often lacking in studies on the health and mental health effects of disasters. Our results indicate that controlling for baseline sociodemographic measures, mental health, and physical health results in a modest reduction in estimates of the effects of stressors and loss. Although our broad conclusion is consistent with previous research demonstrating that disaster-related stressors and loss produce significant adverse health and mental health effects, our results suggest that estimates of the mental and physical health consequences of disasters are likely to be upwardly biased, but not so much as to eliminate the effect of the disaster.

Future research should consider the longer term trajectories of recovery and symptoms. Our findings document increases in mental and physical health problems associated with the hurricanes, which raises questions about the persistence of mental illness over time. Comparisons with other surveys are informative. Galea et al. (2007) found that 5–7 months after the hurricane, the rates of moderate to severe mental illness (MMI to SMI) and severe mental illness (SMI) in their metropolitan New Orleans sample were 32.0% and 17.0%, which are comparable to our rates of 37.2% and 13.8%, respectively, approximately 1-year post-Katrina. Yet Kessler et al. (2008) reported significant increases in rates of PTSD and SMI from the time period of 5–8 months after the hurricane to approximately a year later. It may be the case that, left untreated, PTSD and severe mental

illness become more entrenched over time, while more moderate symptoms attenuate. Indeed, in models estimating the population distribution of untreated mental health problems resulting from Hurricanes Katrina and Rita, Schoenbaum et al. (2009) determined that the prevalence of moderate symptoms peaked at between 7- and 12-month post-Katrina, while severe symptoms continued to climb over the 1st year, persisting for 25–30 months after the storm. Future research should employ additional waves of postdisaster data to determine the longer term trajectories and mediators of functioning. Growth curve modeling of change would permit researchers to explore whether the associations between prehurricane resources and symptoms persist over time.

Implications for Intervention

The findings also have important implications for the planning of postdisaster psychological care services. Efforts to identify and provide timely, evidence-based services to those with preexisting psychological vulnerabilities could potentially prevent or attenuate adverse postdisaster outcomes and the progression into more SMI (Schoenbaum et al., 2009). The persistence of negative mental and physical health symptoms 1 year after the disaster indicates that long-term treatment is needed. Regrettably, however, many of those in need of care in the months after the hurricane do not receive it (Chan, Lowe, Zwiebach, & Rhodes, 2008; Schoenbaum et al., 2009; Wang et al., 2008). This is not unusual—even under normal circumstances the majority of low-income adults in the United States with health problems and SMI do not receive adequate care (Wang, Demler, & Kessler, 2002; Young, Klap, Sherbourne, & Wells, 2001). Nonetheless, because survivors of disasters are known to have a higher risk of health and mental health problems, there is compelling reason to target services to members of this group. Most of the participants were single mothers, suggesting that timely intervention could offset problems in younger generations as well. Furthermore, since many survivors of disasters come into contact with service agencies after a disaster, there may be unique opportunities to offer or refer to treatment. The high rates of health and mental health problems among low-income survivors of Hurricane Katrina, coupled with the low rates of care, indicate that this was not successfully accomplished in the case of this natural disaster.

Policy Implications

In addition to health and mental health services, women of color, particularly those with young children, should be provided with additional economic and educational resources throughout the difficult recovery process. Affordable housing would help to promote the immediate safety as well as the long-term stability of fragile young families that are represented in this study. Likewise, the inclusion of women in the post-Katrina work force, both through the skills training and enforcement of antidiscrimination laws, will help the survivors benefit from the influx of economic resources into the region (Jones-DeWeever, 2008). Finally, educational resources and assistance are vitally needed to ensure that survivors can return to their educational goals with a renewed sense of hope and strength.

Keywords: African Americans; women; single parents; Hurricane Katrina; New Orleans; natural disasters; posttraumatic stress disorder; health outcomes

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