

Health Problems Among Low-Income Parents in the Aftermath of Hurricane Katrina

Sarah R. Lowe
Columbia University

Margaret Willis
Boston College

Jean E. Rhodes
University of Massachusetts Boston

Objective: Although the mental health consequences of disasters have been well documented, relatively less is known about their effects on survivors' physical health. Disaster studies have also generally lacked predisaster data, limiting researchers' ability to determine whether postdisaster physical health problems were influenced by disaster exposure, or whether they would have emerged even if the disaster had not occurred. The current study aimed to fill this gap. **Method:** Participants were low-income, primarily non-Hispanic Black mothers ($N = 334$) who survived Hurricane Katrina and completed 4 survey assessments, 2 predisaster and 2 postdisaster. In each assessment, participants reported on whether they had experienced 3 common health problems (frequent headaches or migraines, back problems, and digestive problems) and completed 2 mental health measure (the K6 scale, the Perceived Stress Scale). **Results:** The descriptive results suggested that the hurricane led to at least short-term increases in the 3 health outcomes. Fixed effects modeling was conducted to explore how changes in various predictor variables related to changes in each health condition over the study. Bereavement and increases in psychological distress were significant predictors of increases in health problems. **Conclusions:** Based on these results, further research that explores the processes through which disasters lead to both physical and mental health problems, postdisaster screenings for common health conditions and psychological distress, and interventions that boost survivors' stress management skills are suggested.

Keywords: natural disasters, Hurricane Katrina, health problems, psychological distress, bereavement

Hurricane Katrina made landfall in New Orleans on August 29, 2005, and led to disproportionate damage in low-income, non-Hispanic Black communities (e.g., Logan, 2006), due in part to housing that was less able to withstand disaster and greater proximity to levees that were in disrepair and that breached in the days following the storm (Ruscher, 2006). Moreover, the existing evacuation policies relied on private means of transportation that were less available to low-income, non-Hispanic Blacks than to their counterparts (Lavelle & Feagin, 2006). Consequently, low-income, non-Hispanic Blacks were more likely to stay in New Orleans, increasing their risk of exposure to deprivation, violence,

and other hardships during the storm and its aftermath (Elliot & Pais, 2006).

The psychological consequences of the hurricane have been well documented. Studies have shown elevated rates of general psychological distress, depression, and posttraumatic stress in the aftermath of Hurricane Katrina (e.g., Galea et al., 2007), and especially high levels among female, non-Hispanic Black, and low-income survivors (e.g., Elliot & Pais, 2006; Rhodes, Chan, Paxson, Waters, & Fussell, 2010). Less is known, however, about how the hurricane affected survivors' physical health, including rates of common stress-related symptoms, such as frequent headaches or migraines, back pain, and digestive problems.

Although most disaster research has focused on their psychological consequences, there is some evidence that disasters may also compromise physical health. A large study from the Netherlands, for example, found that survivors of a fireworks disaster reported higher levels of a variety of general health problems than the general Dutch population (van Kamp et al., 2006). By tracking survivors and nonexposed participants over multiple data points, studies have found that the declines in health go beyond what would be expected over time (e.g., Deeg, Huizink, Comij, & Smid, 2005).

One factor that appears to account for variation in postdisaster health is exposure severity. In general, survivors who endure more severe exposure (e.g., greater property damage, bereavement, injuries) have been found to have worse postdisaster health (e.g.,

This article was published Online First December 2, 2013.

Sarah R. Lowe, Department of Epidemiology, Columbia University, Mailman School of Public Health; Margaret Willis, Department of Sociology, Boston College; and Jean E. Rhodes, Department of Psychology, University of Massachusetts Boston.

The study was funded by NIH grants R01 HD057599 and T32 MH013043, the National Science Foundation, the MacArthur Foundation, and the Center for Economic Policy Studies at Princeton University. We thank Thomas Brock, MDRC, Christina Paxson, Elizabeth Fussell, and Mary Waters.

Correspondence concerning this article should be addressed to Sarah R. Lowe, Department of Epidemiology, Columbia University, Mailman School of Public Health, 722 West 168th Street, New York, NY 10032. E-mail: srl2143@columbia.edu

Dirkzwager, Grievink, Van Der Valden, & Yzermans, 2006). Persistent postdisaster stressors, such as disruptions in employment and relocation, have also been investigated, although the limited findings to date have been inconsistent (Uscher-Pines, 2009). The role of exposure in determining the health outcomes of Hurricane Katrina survivors specifically remains unclear. One study of 303 residents of FEMA trailers in the aftermath of Hurricane Katrina found that poorer health was associated with postdisaster loss of employment and residential instability (Lu, 2011). In contrast, a smaller study of Hurricane Katrina survivors ($N = 128$) found that property damage and level of employment were not significant predictors of physical health (Vu & VanLandingham, 2012).

It is also likely that psychological functioning contributes to postdisaster health outcomes. A long history of research has focused on the interplay of physical and mental health in nondisaster contexts (World Health Organization, 2004). For example, in a large-scale study of New Yorkers across 33 communities ($N = 10,000$), researchers found that those who reported significant levels of emotional distress were three times more likely to suffer from poor health than other participants (McVeigh, Mostashari, & Wunsch-Hitzig, 2003). Other research has highlighted the role of psychological distress and specific health conditions, including migraine headaches, back pain, and digestive problems (e.g., Currie & Wang, 2005; Modgill, Jette, Wang, Becker, & Patten, 2012; Mussell et al., 2008). In studies of disaster survivors specifically, higher psychological distress, depression, and posttraumatic stress have been significantly associated with poorer physical health, controlling for disaster exposure (e.g., Polusny et al., 2008; Ruggiero et al., 2009).

Predisaster mental health appears to be especially important in shaping postdisaster physical health outcomes. Drawing on data from electronic medical records, researchers in the Netherlands documented significant associations between predisaster mental health problems and increases in general health problems, unexplained physical symptoms (e.g., tiredness, headaches, abdominal pain), and chronic diseases (den Ouden, Dirkzwager, & Yzermans, 2005; Dirkzwager et al., 2006). A related study found that, 2 1/2 years after the disaster, predisaster mental health problems to be a stronger predictor of physical health symptoms than disaster exposure, suggesting that predisaster psychological functioning may be of particular importance in predicting the longer-term adjustment to disasters (Soeteman et al., 2006).

Given the associations between predisaster mental health and postdisaster physical health, it is unfortunate that few studies include predisaster data. A 2002 review of the literature found that fewer than 5% of extant studies included predisaster assessments (Norris et al., 2002). A number of studies since this review have included predisaster data, including the medical record studies from the Netherlands mentioned above as well as a handful of investigations with predisaster self-report data. For example, in a sample of adolescents exposed to the 2010 Nashville floods, Felton, Cole, and Martin (2013) found that predisaster depressive symptoms and rumination were significant predictors of postdisaster depressive symptoms. In a study of male veterans who survived Hurricane Katrina, Tharp et al. (2011) found that those who were exposed to predisaster violence had increased odds of experiencing violence exposure during the hurricane, as well as posttraumatic stress disorder, panic, and generalized anxiety disorder 2 years

thereafter. Finally, in a study of adolescents exposed to Hurricane Katrina, Weems et al. (2007) found that predisaster trait anxiety and negative affect were associated with postdisaster posttraumatic stress. Despite these and other notable exceptions, a lack of predisaster data remains the norm, and no studies to our knowledge have included predisaster self-report data on physical health conditions.

The lack of predisaster is understandable given logistical and practical considerations. The period between which a hurricane is identified and when it makes landfall is brief, making it difficult, if not impossible, for researchers to mobilize predisaster data collection. Other forms of natural disasters, including tornados and hurricanes, offer even less time to prepare, further decreasing the feasibility of collecting data prior to their occurrence. Researchers could follow participants from studies in progress prior to disasters, yet such studies might not have measures relevant to postdisaster responses. Even if ongoing studies do have relevant measures, participants might not have been asked for consent to be contacted for further studies and researchers therefore might not collect postdisaster data for ethical reasons.

Although the lack of predisaster data is understandable, in the absence of such data, it is difficult to discern the extent to which postdisaster elevations in health problems are due to preexisting health or mental health conditions or to the impact of the disaster and its aftermath. Moreover, as noted above, the few studies that do include predisaster data generally have not measured physical health when exploring the impact of disaster exposure on later adjustment. One cross-sectional study had Hurricane Katrina survivors ($n = 222$) retrospectively report on whether they had been diagnosed with a variety of health conditions prior to the hurricane, and found that recollections of predisaster arthritis, asthma, and hypertension were significantly associated with poorer postdisaster health (only predisaster arthritis was significant in a multivariate model; Kim, Plumb, Gredig, Rankin, & Taylor, 2008). Postdisaster physical and psychological functioning could have biased participants' retrospective reports, however, and the study did not look at changes in specific health conditions.

Likewise, in the absence of multiple waves of postdisaster data, it is difficult to decipher whether survivors' initial health difficulties linger or return to predisaster levels in the years following the event. Previous studies in the aftermath of other disasters have produced mixed findings about whether postdisaster declines in health persist over time. One study (Dorn, Yzermans, Spreeuwenberg, Schilder, & van der Zee, 2008) found that adolescent survivors of a mass burn incident had larger increases in respiratory and musculoskeletal problems than nonexposed participants in the first year postdisaster, but not 2, 3, or 4 years postdisaster study. In contrast, a study of older adults in the Netherlands found that disaster exposure was associated with declines in self-reported functional ability 4 years postdisaster (Deeg et al., 2005). These studies highlight both the importance of following disaster survivors beyond the short-term aftermath and the importance of participant age in determining health outcomes.

The Current Study

The current study explored the influence of disaster exposure and mental health in shaping three common physical health problems (frequent headaches or migraines, back problems, and diges-

tive problems) using data from a four-wave study of low-income women who survived Hurricane Katrina. The study builds upon the previous research in several ways. First, a focus on postdisaster physical health is in contrast to the majority of disaster research, which has largely focused on the psychological consequences of disasters. Second, two waves of predisaster data were included, which allowed us to explore whether the hurricane led to increases in health problems beyond what might be expected over time. Third, two waves of postdisaster data permitted exploration of whether postdisaster increases in health problems were temporary or persistent. Lastly, the unique study design also allowed for fixed effects modeling to investigate whether aspects of disaster exposure and changes in mental health indices predicted changes in health problems over the course of the study.

Method

Institutional Review Boards from MDRC and the Principal Investigators' universities (Harvard University, Princeton University, and University of Massachusetts Boston) approved the study. Participants were initially part of a multisite study of low-income parents who had enrolled in community colleges. The purpose of this initial study was to examine whether performance-based scholarships affected the academic achievement, health, and well being of low-income parents (Richburg-Hayes et al., 2009). Participants were sought from three community colleges in the city of New Orleans in 2004–2005. To be eligible for the study, students had to be between the ages of 18 and 34; be parents of at least one dependent child under 19; have a household income under 200% of the federal poverty level; and have a high school diploma or equivalent. Students were recruited through a general marketing and outreach campaign, which included flyers, newspaper and radio announcements, and oral presentations in mandatory orientation and testing sessions for incoming freshman. At baseline (i.e., upon enrollment in the study and prior to random assignment) 1,019 participants provided demographic information (e.g., age, race, number of children) and completed measures of physical health, psychological distress, and perceived stress.

By the time Hurricanes Katrina and Rita made landfall, on August 29, 2005 and September 24, 2005, respectively, 492 participants had been enrolled in the program long enough to complete a 12-month, predisaster follow-up survey (Wave 1). Trained interviewers conducted the survey, which included the same measure as the baseline survey, over the phone and compensated participants with \$20 gift cards. After Hurricanes Katrina and Rita, between May, 2006 and March 2007, 711 of the original 1,019 participants (69.8%) were successfully located and surveyed. Trained interviewers administered the postdisaster survey (Wave 2), which included the same measures as previous surveys, as well as a module of hurricane experiences, and sent participants \$50 gift cards. Approximately 4 years after the hurricanes, between March 2009 and June 2010, trained researchers administered an additional follow-up survey over the phone to 720 respondents (70.7% of 1019) and compensated participants with \$50 gift cards for their participation (Wave 3). All participants provided written consent to be part of the original study, and verbal consent to participate in the postdisaster survey.

As noted above, multiple time points are needed to determine whether exposure interrupts normal trajectories of physical health.

Thus, in order to analyze the maximum number of observations per respondent in the current study, only respondents who participated in all four waves of data collection were included ($n = 348$). Most participants were female ($n = 334$) and, because any analyses would be underpowered to fully examine gender differences, the 14 men were excluded, leaving a final sample of 334 mothers. There were no significant differences between the sample of 334 participants and the 608 excluded participants in the original sample on any of the variables included in the study. At the time of the baseline survey, the 334 participants had a mean age of 25.5 ($SD = 4.5$). Most of the participants (84.8%) identified as non-Hispanic Black, 10.5% as non-Hispanic White, 3.1% Hispanic, and 1.6% other race or ethnicity. All of the participants had at least one child, and the mean number of children was 1.8 ($SD = .9$).

Measures

Health outcomes. Three health outcomes were assessed at each wave of the survey. At baseline, participants indicated whether they had any of the following: (a) frequent headaches or migraines; (b) digestive problems (e.g., stomach ulcers, frequent indigestion/stomach upset); and (c) back problems (e.g., pain in lower or upper back, curvature of the spine). In each subsequent wave, participants were asked if they experienced these three health conditions over the past 12 months.

Exposure to Hurricane Katrina. Three indices of exposure to Hurricane Katrina were included. First, at Wave 2, participants were asked, "Did any members of your family, neighbors, or close friends die as a result of the storm or its aftermath?" (*Bereavement*). The value of the variable was set to zero for all respondents for baseline, Wave 1, and Wave 3.¹ The second exposure variable was the *Hurricane-Related Stressors* scale that assessed stressors experienced during the hurricane and the week that followed (Brodie, Weltzien, Altman, Blendon, & Benson, 2006). Participants indicated whether they had experienced the following as a result of the hurricane: (a) lacked enough fresh water to drink, (b) lacked enough 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 children, and (h) lacked knowledge of safety of other family members. The total scale score is the count of affirmative responses, ranging from 0 to 8. As with bereavement, the value of the variable was set to zero for all participants for baseline, Wave 1, and Wave 3. The final exposure measure was relocation, which has been previously linked to postdisaster health outcomes (Lu, 2011; Dirkzwager et al., 2006). Participants' zip codes were recorded at Wave 1, 2, and 3, and relocation was coded as 1 when the zip code for the given wave differs from the zip code from the previous wave. For the pre-Katrina waves, baseline and Wave 1, relocation due to Katrina is set to zero.

Psychological functioning. Two measures of psychological functioning, measured at each time point, were included. The first was the K6 scale, a 6-item screening measure of nonspecific psychological distress (Kessler et al., 2003). This scale has been

¹ The results of the analysis did not change when all post-Katrina waves—Waves 2 and 3—were coded based on the women's hurricane bereavement.

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). Participants rated items (e.g., “During the past 30 days, about how often did you feel so depressed that nothing could cheer you up?”) on a 5-point Likert-type scale ranging from 0 (*none of the time*) to 4 (*all the time*). Scale scores were the sum of all item responses (range: 0–24). In the current study, reliability (measured with Cronbach’s alpha) ranged from .72 to .81.

The Perceived Stress Scale (PSS; Cohen, Kamarck, & Mermelstein, 1983), which has been linked to postdisaster health outcomes in a previous study (Tremblay, Blandchard, Pelletier, & Vallerand, 2006), was also included. Participants were asked four questions at each wave about the frequency of stressful feelings “in the last 30 days” (e.g., “How often have you felt that you were unable to control the important things in your life?”). Response options ranged from 0 (*none of the time*) to 4 (*all of the time*), and scale scores were the sum of the four items (range: 0–16). Reliability of the PSS in this study ranged from Cronbach’s alpha of .57 to .76.

Household and economic characteristics. Four household and economic characteristics that previous studies have found to be associated with health behaviors and outcomes were included (e.g., Dooley, Fielding, & Levi, 1996; Hadley, 2003; Nomaguchi & Bianchi, 2004). First, hours of employment at each wave was included. If participants were unemployed at the time, hours of employment was coded as zero. Second, a dummy variable indicating whether the respondent is living with a spouse was included. Third, the number of children that the participant had at each wave was included. Lastly, dummy codes for whether the participant did not have health insurance at each wave were included. To assess health insurance status, participants were asked, “Are you currently covered by any kind of health insurance (including health insurance obtained through employment or purchased directly, as well as government programs like Medicaid that provide medical care or help pay medical bills)?”

Health characteristics. Three health characteristics that could impact the experience of frequent headaches or migraines, back problems, or digestive problems (e.g., Bick & MacArthur, 1995; Winter, Berger, Buring, & Kurth, 2009; Zvolensky, McMillan, Gonzalez, & Asmundson, 2009) were measured at each time point. First, an indicator variable was included to denote whether participants were currently smoking at each survey wave. A second indicator variable indicated whether participants were pregnant at the time of the survey for each wave. Pregnancy at baseline was inferred by comparing the date of the baseline survey with the year of the participant’s youngest child’s birth at Wave 1. At Waves 1, 2, and 3, respondents were asked directly if they were currently pregnant. Body mass index (BMI) at each time point was also included. BMI was calculated using height and weight reports collected at each wave. If respondents were pregnant at the time of the Wave 1, 2, or 3 assessment, they were asked for their prepregnancy weight.

Time. Finally, the effect of time was modeled by including a set of indicator variables for the waves of data collection, with the baseline serving as the reference group.

Analytic Approach

All data analyses were completed using Stata/SE 12.1. A notable number of cases were missing some amount of data. Only 44 cases had complete data across variables and all waves of data collection, though 243 of the 290 cases with missing data (83.8%) were missing four or fewer variables. Participants with at least some missing data were significantly more likely to have some form of health insurance, had a lower mean monthly income, and had lower mean hours of employment. Because missingness was related to measured characteristics, Multiple Imputation by Chained Equations (MICE) was used to impute missing data (Allison, 2002). Missing data for a given variable were imputed using both within-wave covariates and values of the given variable in proximal waves. In the Results section, a sensitivity analysis is included to examine and ways in which results change across models computed with multiply imputed data and models computed on a listwise deleted sample. Health outcomes were included in the imputation process. With imputed health outcome data, however, the number of cases that experienced changes in health outcomes across waves fluctuated based on the imputed values. Because fixed effects modeling requires stable number of individuals that are included in the model across all imputations, cases with imputed dependent variables ($n = 10$) were excluded from the fixed effects models.

Fixed effects (FE) logistic models were used to focus on the factors that contribute to changes in health outcomes within an individual over time while accounting for the large variation between individuals (Allison, 2009). In FE models, between-individual variation is accounted for by allowing each individual to have her own intercept. This includes between-individual variation that has not been explicitly measured in the surveys (such as family history and genetic predisposition) that may be important predictors of health outcomes. The coefficients estimated in the model therefore reflect the relationship between intraindividual changes over time in the covariates and intraindividual changes in health outcomes between each wave. These effects are assumed to be the same across individuals. Cases in which an individual does not experience change in the outcome variable (e.g., the individual reported migraines or headaches at all time points, or never reported migraines or headaches) are not included in the fixed effects models because they do not add anything to the modeling of change in the outcome. Therefore, the total number of participants in each model varies and is less than the total number of women in the sample ($N = 334$). In the model building process, tests for potential mediation or moderation between psychological factors and exposure for each model were conducted, and no significant results were detected. Dummy variables for each wave were included in the analyses, creating two-way fixed effects models, in order to account for any underlying trend in health changes over time.

Results

Table 1 displays descriptive data for the time-varying variables included in the fixed effect models, as well as the percentage of women in the sample that experienced each of the health issues at each of the survey waves. The number of participants experiencing each health problem was lowest at the baseline. The frequency of each health problems increased from baseline to Wave 1, and from

Table 1
Descriptive Data for all Variables Included in Fixed Effects Models (N = 334)

	Baseline	Wave 1	Wave 2	Wave 3
Health outcomes				
Frequent headaches or migraines	15.6%	46.4%	59.0%	53.9%
Digestive problems	3.9%	14.7%	22.5%	24.0%
Back problems	20.1%	37.4%	46.1%	44.0%
Hurricane exposure				
Bereavement	—	—	31.7%	—
Exposure scale	—	—	2.8 (2.2)	—
Relocation	—	—	69.2%	51.4%
Psychological characteristics				
Psychological distress	5.0 (4.4)	5.5 (4.2)	6.6 (5.1)	5.6 (4.9)
Perceived stress	5.5 (3.2)	4.2 (3.3)	5.4 (3.4)	4.9 (3.4)
Household characteristics				
Hours employed	33.1 (10.9)	35.1 (11.6)	35.3 (11.5)	39.1 (11.8)
Living with partner	27.2%	35.0%	51.8%	47.0%
Number of children	1.8 (0.9)	2.0 (1.1)	2.1 (1.1)	1.9 (1.0)
No insurance	—	—	—	—
Health characteristics				
Smoking	40.7%	37.4%	44.3%	32.0%
Pregnancy	10.8%	12.9%	15.0%	14.1%
BMI	32.3%	6.0%	7.5%	3.6%
	29.1 (7.4)	28.5 (6.6)	29.4 (6.9)	30.3 (7.3)

Note. Percentages based on one imputed dataset. Standard deviations of continuous variables are listed in parentheses.

Wave 1 to Wave 2. Digestive problems continued to increase from Wave 2 to Wave 3, whereas frequent headaches or migraines and back pains declined.

The number and percentage of individuals who experienced a health transition between each set of time points, either developing a health problem or experiencing the resolution of a health problem, was also computed (see Table 2). The highest frequency of participants developing each health problem was between baseline and Wave 1, and the lowest frequency was between Wave 2 and Wave 3. In contrast, the highest frequency of resolved health problem occurred between Wave 2 and Wave 3, and the lowest frequency occurred between baseline and Wave 1.

The results of the FE models are presented in Table 3. A total of 215 women had some change in their experience of frequent

headaches or migraines during the study period. Women who experienced bereavement due to the hurricane and its aftermath had 3.23 times higher odds of developing frequent headaches or migraines than those who did not. Additionally, increases in psychological distress and perceived stress were associated with greater risk of developing frequent headaches or migraines. A total of 125 women experienced a change in their digestive health. Those who experienced bereavement had 2.99 times greater odds of developing digestive problems than those who did not. Increases in psychological distress over time were also associated with developing digestive problems, whereas increases in perceived stress were not. These patterns were similar for the 198 women who developed or resolved back problems. Participants experiencing bereavement were 2.50 times as likely to develop back problems, and increases in psychological distress, but not perceived stress, were associated with developing back problems.²

Table 2
Percentage of Participants Experiencing the Appearance or the Resolution of Health Problems Between Each Wave (N = 334)

	Health problem appears					
	B to W1		W1 to W2		W2 to W3	
	n	%	n	%	n	%
Frequent headaches or migraines	112	33.5%	82	24.6%	39	11.7%
Digestive problems	43	12.9%	52	15.6%	40	12.0%
Back problems	77	23.1%	66	19.8%	48	14.4%
	Health problem resolves					
	n	%	n	%	n	%
Frequent headaches or migraines	9	2.7%	40	12.0%	56	16.8%
Digestive problems	7	2.1%	26	7.8%	35	10.5%
Back problems	19	5.7%	37	11.1%	55	16.5%

Note. Percentages are based on one imputed dataset. B = Baseline; W1 = Wave 1; W2 = Wave 2; and W3 = Wave 3.

Discussion

The primary purpose of the current study was to examine health outcomes in a sample of participants who survived Hurricane Katrina. Participants in the current study were low-income, mostly non-Hispanic Black, young mothers, a group that is at particularly high risk for stress exposure and posttraumatic adjustment difficulties (Rhodes et al., 2010). Four waves of data, including two predisaster and two postdisaster time points, enabled us to document changes in common physical health problems—frequent

² Notably, the results were somewhat different when using only cases with no missing data (migraines: $n = 97$; digestive problems: $n = 54$; back problems: $n = 83$). Bereavement did not reach statistical significance in each model. Additionally, psychological distress was no longer a significant predictor of changes in back problems. Although the trends were consistent, the reduction in sample size across the three models limited the power available to detect significant results.

Table 3
Results of Fixed Effects Logistic Regression Models (N = 334)

	Frequent headaches or migraines			Digestive problems			Back problems		
	Coef. (SE)	OR	p	Coef. (SE)	OR	p	Coef. (SE)	OR	p
Hurricane exposure									
Bereavement	1.17 (.44)	3.23	.01	1.09 (.50)	2.99	.03	.92 (.42)	2.50	.03
Exposure scale	.08 (.10)	1.09	.37	.05 (.10)	1.05	.64	-.01 (.09)	.99	.90
Relocation	-.30 (.29)	.74	.30	-.48 (.37)	.62	.19	.64 (.28)	1.90	.02
Psychological characteristics									
Psychological distress	.15 (.04)	1.16	<.01	.10 (.04)	1.10	.02	.14 (.03)	1.15	<.01
Perceived stress	.11 (.05)	1.11	.03	.09 (.05)	1.09	.12	.02 (.04)	1.03	.54
Household characteristics									
Hours employed	.02 (.01)	1.02	.27	<.01 (.02)	1.0	.79	.02 (.01)	1.02	.10
Living with partner	-.23 (.27)	.80	.40	.35 (.32)	1.43	.27	-.11 (.23)	.90	.64
Number of children	.49 (.29)	1.63	.10	.97 (.42)	2.63	.02	.19 (.28)	1.21	.51
No insurance	.06 (.25)	1.06	.82	.77 (.30)	.46	.01	.07 (.22)	1.07	.75
Health characteristics									
Smoking	-.59 (.61)	.55	.34	-.37 (.62)	.69	.56	-.34 (.46)	.71	.46
Pregnancy	-.62 (.40)	.54	.12	-.18 (.51)	.83	.72	.46 (.35)	1.58	.19
BMI	-.04 (.04)	.96	.31	.04 (.05)	1.04	.46	.01 (.04)	1.01	.79
Time (reference: Baseline)									
Wave 1	-2.71 (.36)	.07	<.01	-1.78 (.41)	.17	<.01	-1.28 (.25)	.28	<.01
Wave 2	.34 (.40)	1.41	.39	.30 (.48)	1.35	.53	-.26 (.36)	.77	.47
Wave 3	.68 (.29)	1.97	.02	1.12 (.36)	3.07	<.01	.18 (.27)	1.20	.50

Note. Results represent the average of analyses of 10 imputed datasets.

headaches or migraines, digestive problems, and back problems—over time, and to explore how the hurricane might have altered their course.

The descriptive results showed that health problems increased between the second predisaster and first postdisaster waves, suggesting that the hurricane had a negative health impact on the sample. Whereas digestive problems continued to increase between the two postdisaster waves, frequent headaches or migraines and back problems declined, indicating that some of the problems that emerged after Hurricane Katrina had been resolved.

When the percentages of participants who had a health problem appear or resolve were examined, however, a different pattern of results emerged. Each health condition was most likely to emerge between the two predisaster periods, suggesting that the incidence of these problems was increasing even prior to the hurricane. By contrast, health problems were the least likely to occur between the two postdisaster periods. It could be that participants were aging out of the period for new onset of these problems, or that any effects of the hurricane on health had attenuated. Supporting the latter interpretation, the highest proportions of resolved cases for each condition were between the two postdisaster periods. The proportion of resolved cases between the second predisaster and first postdisaster assessment was also greater than the proportion between the two predisaster assessments. One possible interpretation of this finding is that the hurricane brought some participants in contact with health providers who were able to treat preexisting conditions.

To understand what factors might account for changes in health problems over the study, fixed effects models were conducted. The advantage of fixed effects modeling was an ability to explore factors underlying intraindividual change in health conditions over the course of the study, while essentially controlling for stable between-individual characteristics, and show how changes in predictor variables relate to changes in health. The results of these

analyses showed that bereavement and increases in psychological distress increased the odds of developing each health problem. Increases in perceived stress predicted the development of frequent headaches or migraines, but not digestive or back problems.

Taken together, the results suggest bereavement as a key disaster-related experience in shaping the course of common health problems. Although prior research has not explored the association between bereavement and health in the aftermath of disaster, the results are consistent with prior findings showing bereavement to be significantly predictive of postdisaster mental health problems (e.g., Norris et al., 2002), and with a large body of research documenting the negative health impact of bereavement in nondisaster contexts (e.g., Stroebe, Schut, & Stroebe, 2007). Further studies are needed to better understand the pathways through which bereavement leads to health problems in the aftermath of disasters. For example, it could be that grief reactions inhibit health behaviors, including regular exercise and healthy eating, which might protect against common health problems.

Another potential pathway between bereavement and health conditions is through increases in psychological distress, the other consistently significant predictor in the fixed effects models. These findings coincide with many others showing significant associations between mental health problems and negative health outcomes (e.g., World Health Organization, 2004). Notably, the health outcomes included in the current study were all stress-related. It is therefore possible that the stress of the hurricane experience contributed to both physical and mental health outcomes, or that psychological distress is representative of the stress processes that trigger frequent headaches or migraines, digestive problems, and back problems. Interestingly, the increases in perceived stress were only predictive of frequent headaches or migraines, suggesting that stress is most likely to exert a direct influence on this condition, potentially through the effects of elevated cortisol levels (Peterlin, Nijjar, & Tietjen, 2011). Psycho-

logical distress could also be associated with negative health behaviors, such as overeating, disrupted sleep, and decreases in physical activity, which could account for health outcomes. Further research is needed to better understand the complex relationships among hurricane-related experiences, psychological distress, and health in the aftermath of disasters.

Importantly, bereavement and psychological distress were more strongly associated with the development of health problems than factors that are commonly assumed to influence health, such as household characteristics (e.g., number of children, health insurance), smoking, pregnancy, and BMI. Other aspects of hurricane exposure, including an index of hurricane-related stressors and whether participants had relocated, were also not significant in multivariate models. This was somewhat surprising given that some of the stressors, including difficulties accessing necessary medications and medical care, were health-related and that relocation could lead to disruptions in care. Of course, replication is needed, but at least in the current study, bereavement and psychological distress were more important factors in determining the onset of common health conditions.

Overall, the results of this study suggest that disasters take at least a short-term toll on survivors' physical health. As such, crisis and postdisaster medical units should screen for common health problems alongside psychological distress, especially among survivors who have experienced bereavement. Disaster survivors, in particular those from ethnic minority groups, might also be more likely to present with common physical health problems than psychological distress (e.g., Noël & Whaley, 2012). Therefore, by assessing health problems, practitioners could perhaps identify survivors at risk for psychological symptoms and in need of mental health services. Furthermore, because many survivors of disasters come into contact with service agencies (e.g., FEMA, nonprofit organizations) after a disaster, the events might provide unique opportunities to detect latent health problems and to offer or refer to treatment. Strong connections among services agencies and health providers are needed to facilitate appropriate referrals.

Once survivors are connected to services, practitioners could use empirically supported stress management techniques (e.g., Stahl & Goldstein, 2010) to simultaneously target physical and mental health problems, decreasing the likelihood of their persistence and escalation in the long-term aftermath of disasters. Practitioners could help survivors develop health behaviors that have long-term benefits for both physical and mental health. At the same time, providers should be attentive to life constraints that might impede survivors' ability to maintain health behaviors, such as difficulties accessing adequate housing, healthy food, and employment. Unfortunately, many of those in need of care in the months after the hurricane do not receive it (e.g., Wang et al., 2007) and, even under normal circumstances, the majority of low-income adults in the United States with health problems and serious mental illness do not receive adequate care (e.g., Young, Klap, Sherbourne, & Wells, 2001). Redressing the structural barriers that impede service use among this group is especially important (Miranda & Green, 1999). One potential means of doing so in the postdisaster context could be Internet-based interventions, such as the *Disaster Recovery Web* project, a mental health intervention that is currently being evaluated with a population-based sample of hurricane survivors (Ruggiero et al., 2012). A recent investigation found no significant differences between non-Hispanic Black,

Hispanic, and non-Hispanic White participants, nor by income or education, in nonuse and dropout attrition, suggesting the promise of Internet-based interventions for reducing inequality in access to care (Price, Davidson, Andrews, & Ruggiero, 2013).

Despite the potential of this study to inform research and practice, there are several limitations worth noting. Although a strength of the study was its inclusion of four waves of data, those who were missing a complete wave of data at any given time point may have been more marginalized and have suffered even higher levels of psychopathology, potentially rendering the prevalence estimates conservative. Similarly, participants in this study are not representative of the entire population affected by the hurricanes, nor of all low-income mothers from the New Orleans area, reducing the generalizability of the findings. Nonetheless, by highlighting the experience of low-income, predominately non-Hispanic Black single mothers—a population that is faced with multiple stressors and is of higher-risk of adverse outcomes—the findings shed light on to a particularly vulnerable, underserved, and understudied group. An additional limitation is that rates of pregnancy and smoking were low throughout the study, and it is possible that in a larger sample with greater proportions of pregnant women and smokers, these factors would play a more important role in shaping health outcomes.

The study was also limited to the health measures that were included in the ongoing predisaster study. As such, it was impossible to explore whether rates of other conditions (e.g., heart disease, diabetes, asthma) increased after the disaster, or the associations between hurricane-related experiences and changes in distress and these outcomes. Likewise, a reliance on a screening tool of nonspecific psychological distress limits the scope of the study. An analysis of the effects of specific psychiatric problems commonly observed in the aftermath of a disaster (e.g., PTSD, depression, grief) on health outcomes could reveal differential associations informative to the planning of therapeutic and health interventions for disaster survivors. Additionally, the index of hurricane-related stressor was based solely on self-report, was confined to the week Hurricane Katrina occurred, and did not assess information on other traumatic experiences or more persistent stressors (e.g., injuries, property damage, residential instability, long-term separation from family and friends) that could potentially impact physical health. It is also worth noting that the first postdisaster assessment did not occur until roughly 12 months after Hurricane Katrina. As such, the results do not capture survivors' psychological and physical symptoms in the immediate aftermath of the disaster.

Despite these limitations, the study provides evidence that natural disasters are associated with an increased incidence of common health problems beyond what might be expected over time. Bereavement due to disaster and increases in psychological distress seem to be key factors underlying the increased incidence of these problems. These findings provide support for postdisaster practices that connect survivors with comprehensive medical care that addresses both physical and mental health symptoms.

References

- Allison, P. D. (2002). *Missing data*. Thousand Oaks, CA: Sage.
 Allison, P. D. (2009). *Fixed effects regression models*. Thousand Oaks, CA: Sage.

- Bick, D., & MacArthur, C. (1995). The extent, severity and effect of health problems after childbirth. *British Journal of Midwifery*, 3, 27–31. Retrieved from www.britishtjournalofmidwifery.com/
- Brodie, M., Weltzien, E., Altman, D., Blendon, R. J., & Benson, J. M. (2006). Experiences of Hurricane Katrina evacuees in Houston Shelters: Implications for future planning. *American Journal of Public Health*, 96, 1402–1408. doi:10.2105/AJPH.2005.084475
- Cohen, S., Kamarck, T., & Mermelstein, R. (1983). A global measure of perceived stress. *Journal of Health and Social Behavior*, 24, 385–396. doi:10.2307/2136404
- Currie, S. R., & Wang, J. (2005). More data on major depression as an antecedent risk factor for first onset of chronic back pain. *Psychological Medicine*, 35, 1275–1282. doi:10.1017/S0033291705004952
- Deeg, D. J. H., Huizink, A. C., Comij, H. C., & Smid, T. (2005). Disaster and associated changes in physical and mental health in older residents. *European Journal of Public Health*, 15, 170–174. doi:10.1093/eurpub/cki126
- den Ouden, D., Dirkzwager, A. J., & Yzermans, C. J. (2005). Health problems presented in general practice by survivors before and after a fireworks disaster: Associations with mental health care. *Scandinavian Journal of Primary Health Care*, 23, 137–141. doi:10.1080/02813430500202454
- Dirkzwager, A. J. E., Grievink, L., Van der Velden, P. G., & Yzermans, C. J. (2006). Risk factors for psychological and physical health problems after a man-made disaster. *The British Journal of Psychiatry*, 189, 144–149. doi:10.1192/bjp.bp.105.017855
- Dooley, D., Fielding, J., & Levi, L. (1996). Health and unemployment. *Annual Review of Public Health*, 17, 449–465. doi:10.1146/annurev.pu.17.050196.002313
- Dorn, T., Yzermans, J. C., Spreuwenberg, P. M. M., Schilder, A., & van der Zee, J. (2008). A cohort study of the long-term impact of a fire disaster on the physical and mental health of adolescents. *Journal of Traumatic Stress*, 21, 239–242. doi:10.1002/jts.20328
- Elliott, J. R., & Pais, J. (2006). Race, class, and Hurricane Katrina: Social differences in human response to disaster. *Social Science Research*, 35, 295–321. doi:10.1016/j.ssresearch.2006.02.003
- Felton, J. W., Cole, D. A., & Martin, N. C. (2013). Effects of rumination on child and adolescent depressive reactions to a natural disaster: The 2010 Nashville flood. *Journal of Abnormal Psychology*, 122, 64–73. doi:10.1037/a0029303
- Furukawa, T. A., Kessler, R. C., Slade, T., & Andrews, G. (2003). The performance of the K6 and K10 screening scales for psychological distress in the Australian. *Psychological Medicine*, 33, 357–362. doi:10.1017/S0033291702006700
- Galea, S., Brewin, C. R., Gruber, M., Jones, R. T., King, D. W., King, L. A., . . . Kessler, R. C. (2007). Exposure to hurricane-related stressors and mental illness after Hurricane Katrina. *Archives of General Psychiatry*, 64, 1427–1434. doi:10.1001/archpsyc.64.12.1427
- Hadley, J. (2003). Sicker and poorer—The consequences of being uninsured: A review of the research on the relationship between health insurance, medical care use, health, work, and income. *Medical Care Research and Review*, 60, 3S–75S. doi:10.1177/1077558703254101
- Kessler, R. C., Barker, P. R., Colpe, L. J., Epstein, J. F., Groer, J. C., Hiripi, E., . . . Zaslavsky, A. M. (2003). Screening for serious mental illness in the general population. *Archives of General Psychiatry*, 60, 184–189. doi:10.1001/archpsyc.60.2.184
- Kim, S. C., Plumb, R., Gredig, Q., Rankin, L., & Taylor, B. (2008). Medium-term post-Katrina health sequelae among New Orleans residences: Predictors of poor physical and mental health. *Journal of Clinical Nursing*, 17, 2335–2342. doi:10.1111/j.1365-2702.2008.02317.x
- Lavelle, K., & Feagin, J. R. (2006). Hurricane Katrina: The race and class debate. *Monthly Review*. Retrieved from <http://www.monthlyreview.org/0706lavelle.htm>
- Logan, J. R. (2006). *The impact of Katrina: Race and class in storm-damaged neighborhoods. S4, Spatial Structures in the Social Sciences Initiative, Hurricane Katrina Project*. Providence, RI: Brown University. Retrieved from <http://www.s4.brown.edu/katrina/report.pdf>
- Lu, A. (2011). Stress and physical health deterioration in the aftermath of Hurricanes Katrina and Rita. *Sociological Perspectives*, 54, 229–250. doi:10.1525/sop.2011.54.2.229
- McVeigh, K. H., Mostashari, F., & Wunsch-Hitzig, R. A. (2003). There is no health without mental health. *NYC Vital Signs*, 2(3), 1–4. Retrieved from www.nyc.gov/health/survey
- Miranda, J., & Green, B. L. (1999). The need for mental health services research focusing on poor young women. *Journal of Mental Health Policy and Economics*, 2, 73–80. doi:10.1002/(SICI)1099-176X(199906)2:2<73::AID-MHP40>3.0.CO;2-3
- Modgill, G., Jette, N., Wang, J. L., Becker, W. J., & Patten, S. B. (2012). A population-based longitudinal cohort study of major depression and migraine. *Headache*, 52, 422–432. doi:10.1111/j.1526-4610.2011.02036.x
- Mussell, M., Kroenke, K., Spitzer, R. L., Williams, J. B., Herzog, W., & Löwe, B. (2008). Gastrointestinal symptoms in primary care: Prevalence and association with depression and anxiety. *Journal of Psychosomatic Research*, 64, 605–612. doi:10.1016/j.jpsychores.2008.02.019
- Noël, L. T., & Whaley, A. (2012). Ethnic/racial differences in depression among U.S. primary care patients: Cultural considerations in screening and detection. *Journal of Ethnic & Cultural Diversity in Social Work*, 21, 314–330. doi:10.1111/j.1741-3737.2004.00029.x
- Nomaguchi, K. M., & Bianchi, S. M. (2004). Exercise time: Gender differences in the effects of marriage, parenthood, and employment. *Journal of Marriage and Family*, 66, 413–430. doi:10.1111/j.1741-3737.2004.00029.x
- Norris, F., Friedman, M., Watson, P., Byrne, C., Diaz, E., & Kaniasty, K. (2002). 60,000 disaster victims speak. Part I: An empirical review of the empirical literature, 1981–2001. *Psychiatry*, 65, 207–239. doi:10.1521/psyc.65.3.207.20173
- Peterlin, B. L., Nijjar, S. S., & Tietjen, G. E. (2011). Post-traumatic stress disorder and migraine: Epidemiology, sex differences, and potential mechanisms. *Headache*, 51, 860–868. doi:10.1111/j.1526-4610.2011.01907.x
- Polusny, M. A., Ries, B. J., Schultz, J. R., Calhoun, P., Clemensen, L., & Johnson, I. R. (2008). PTSD symptom clusters associated with physical health and health care utilization in rural primary care patients exposed to natural disaster. *Journal of Traumatic Stress*, 21, 75–82. doi:10.1002/jts.20281
- Price, M., Davidson, T. M., Andrews, J. O., & Ruggiero, K. J. (2013). Access, use and completion of a brief disaster mental health intervention among Hispanics, African-Americans, and Whites affected by Hurricane Ike. *Journal of Telemedicine and Telecare*, 19, 70–74. doi:10.1177/1357633X13476230
- Rhodes, J., Chan, C., Paxson, C., Rouse, C. E., Waters, M., & Fussell, E. (2010). The impact of Hurricane Katrina on the mental and physical health of low-income parents in New Orleans. *American Journal of Orthopsychiatry*, 80, 237–247. doi:10.1111/j.1939-0025.2010.01027.x
- Richburg-Hayes, L., Brock, T., LeBlanc, A., Paxson, C., Rouse, C. E., & Barrow, L. (2009). *Rewarding persistence: Effects of a performance-based scholarship program for low-income parents*. New York, NY: MDRC. Retrieved from <http://www.mdrc.org/publication/rewarding-persistence>
- Ruggiero, K. J., Amstadter, A. B., Acierno, R., Kilpatrick, D. G., Resnick, H. S., Tracy, M., & Galea, S. (2009). Social and psychological resources associated with health status in a representative sample of adults affected by the 2004 Florida hurricanes. *Psychiatry*, 72, 195–210. doi:10.1521/psyc.2009.72.2.195

- Ruggiero, K. J., Resnick, H. S., Paul, L. A., Gros, K., McCauley, J. L., Acierno, R., . . . Galea, S. (2012). Randomized controlled trial of an internet-based intervention using random-digit-dial recruitment: The Disaster Recovery Web project. *Contemporary Clinical Trials, 33*, 237–246. doi:10.1016/j.cct.2011.10.001
- Ruscher, J. B. (2006). Stranded by Katrina: Past and present. *Analyses of Social Issues and Public Policy, 6*, 33–38. doi:10.1111/j.1530-2415.2006.00114.x
- Soeteman, R. J. H., Yzermans, C. J., Kerssens, J. J., Dirkzwager, A. J. E., Donker, G. A., van den Bosch, W. J. H. M., & van der Zee, J. (2006). The course of post-disaster health problems of victims with pre-disaster psychological problems as presented in general practice. *Family Practice, 23*, 378–384. doi:10.1093/fampra/cml009
- Stahl, B., & Goldstein, E. (2010). *A mindfulness based stress reduction workbook*. Oakland, CA: New Harbinger.
- Stroebe, M., Schut, H., & Stroebe, W. (2007). Health outcomes of bereavement. *The Lancet, 370*, 1960–1973. doi:10.1016/S0140-6736(07)61816-9
- Tharp, A. T., Vasterling, J. J., Sullivan, G., Han, X., Davis, T., Deitch, E. A., & Constans, J. (2011). Effects of pre- and post-Katrina nonviolent and violent experiences on male veterans' psychological functioning. *Disaster Medicine and Public Health Preparedness, 5*, S227–S234. doi:10.1001/dmp.2011.47
- Tremblay, M. A., Blanchard, C. M., Pelletier, L. G., & Vallerand, R. J. (2006). A dual route in explaining health outcomes in natural disaster. *Journal of Applied Social Psychology, 36*, 1502–1522. doi:10.1111/j.0021-9029.2006.00069.x
- Uscher-Pines, L. (2009). Health effects of relocation following disaster: A systematic review of the literature. *Disasters, 33*, 1–22. doi:10.1111/j.1467-7717.2008.01059.x
- van Kamp, I., van der Velden, P. G., Stellato, R. K., Roorda, J., van Loon, J., Kleber, R. J., . . . Lebert, E. (2006). Physical and mental health shortly after disaster: First results from the Enschede firework disaster study. *European Journal of Public Health, 16*, 252–258. doi:10.1093/eurpub/cki188
- Vu, L., & VanLandingham, M. J. (2012). Physical and mental health consequences of Katrina on Vietnamese immigrants in New Orleans: A pre- and post-disaster assessment. *Journal of Immigrant and Minority Health, 14*, 386–394. doi:10.1007/s10903-011-9504-3
- Wang, P. S., Gruber, M. J., Powers, R. E., Schoenbaum, M., Speier, A. H., Wells, K. B., & Kessler, R. C. (2007). Mental health service use among Hurricane Katrina survivors in the eight months after the disaster. *Psychiatric Services, 58*, 1403–1411. doi:10.1176/appi.ps.58.11.1403
- Weems, C. F., Pina, A. A., Costa, N. M., Watts, S. E., Taylor, L. K., & Cannon, M. F. (2007). Predisaster trait anxiety and negative affect predict posttraumatic stress in youths after Hurricane Katrina. *Journal of Consulting and Clinical Psychology, 75*, 154–159. doi:10.1037/0022-006X.75.1.154
- Winter, A. C., Berger, K., Buring, J. E., & Kurth, T. (2009). Body mass index, migraine, migraine frequency and migraine features in women. *Cephalalgia, 29*, 269–278. doi:10.1111/j.1468-2982.2008.01716.x
- World Health Organization. (2004). *Promoting mental health: Concepts, emerging evidence, practice*. Geneva, Switzerland: World Health Organization, Department of Mental Health and Substance Abuse in collaboration with the Victorian Health Promotion Foundation and the University of Melbourne.
- Young, A. S., Klap, R., Sherbourne, C. D., & Wells, K. B. (2001). The quality of care for depressive and anxiety disorders in the United States. *Archives of General Psychiatry, 58*, 55–61. doi:10.1001/archpsyc.58.1.55
- Zvolensky, M. J., McMillan, K., Gonzalez, A., & Admundson, G. J. G. (2009). Chronic pain and cigarette smoking and nicotine dependence among a representative sample of adults. *Nicotine & Tobacco Research, 11*, 1407–1414. doi:10.1093/ntr/ntp153

Received March 14, 2013
 Revision received July 3, 2013
 Accepted July 12, 2013 ■

E-Mail Notification of Your Latest Issue Online!

Would you like to know when the next issue of your favorite APA journal will be available online? This service is now available to you. Sign up at <http://notify.apa.org/> and you will be notified by e-mail when issues of interest to you become available!