SLEEP QUALITY OF LOW INCOME YOUNG WOMEN PREDICTS PERCEIVED STRESS

Sleep Quality Among Low-Income Young Women in Southeast Texas Predicts Changes in Perceived Stress Through Hurricane Ike

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Study Objectives: To document the time course of perceived stress among women through the period of a natural disaster, to determine the effect of sleep quality on this time course, and to identify risk factors that predict higher levels of perceived stress.

Design: Longitudinal study from 2006–2012.

Setting: Community-based family planning clinics in southeast Texas.

Participants: There were 296 women aged 18–31 y who experienced Hurricane Ike, September 2008.

Measurements and Results: Cohen Perceived Stress Scale (PSS) was administered every 2 mo from 6 mo before to 12 mo after Hurricane Ike. Sleep quality was assessed 1 mo after Hurricane Ike using the Pittsburg Sleep Quality Index (PSQI). Good sleep was defined as a PSQI summary score < 5, and poor sleep as a score ≥ 5. Hurricane Ike stressors (e.g., property damage, subjective stressors) and pre-Ike lifetime major life events and emotional health (e.g., emotional dysregulation, self-control) were also assessed.

Results: Over the entire period of 18 mo (6 mo before and 12 mo after the hurricane), perceived stress was significantly higher among poor sleepers compared to good sleepers, and only good sleepers showed a significant decrease in perceived stress after Hurricane Ike. In addition, a higher level of perceived stress was positively associated with greater Ike damage among poor sleepers, whereas this correlation was not observed among good sleepers. In the final multivariate longitudinal model, Ike-related subjective stressors as well as baseline major life events and emotional dysregulation among poor sleepers predicted higher levels of perceived stress over time; among good sleepers, additional factors such as lower levels of self-control and having a history of a psychiatric disorder also predicted higher levels of perceived stress.

Conclusions: Sleep quality after Hurricane Ike, an intense natural disaster producing substantial damage, impacted changes in perceived stress over time. Our findings suggest the possibility that providing victims of disasters with effective interventions to improve sleep quality could help to reduce their perceived stress over time.

Keywords: natural disaster, sleep quality, stress, women

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INTRODUCTION

Poor sleep is one of the most prevalent, yet underaddressed, health concerns in the modern world.[1,2] Perceived stress is also an important aspect of coping that has received increasing interest as a potential health threat.[3–5] Sleep quality and perceived stress are undoubtedly related,[6,7] but it is unclear whether poor sleep causes stress or *vice versa*. Data suggest that sleep problems correlate with past traumatic life event experiences.[8] A recent review reported that sleep problems commonly occur among people exposed to trauma, particularly those who develop posttraumatic stress disorders (PTSD).[9] However, cross-sectional data supporting this conclusion provides only limited information regarding the secondary versus central nature of sleep in the genesis of PTSD. Predisaster information can help determine whether sleep problems are caused by such traumatic experiences. Thus, we aimed to examine whether predisaster major life events and emotional health, as well as disaster-related factors like the degree of damage experienced, would predict sleep quality immediately post disaster.

The extent to which poor sleep increases stress versus stress compromising sleep quality is not clear. When challenged by untoward events, such as natural disasters, people's reactions differ.[10–12] Natural disasters are often followed by emotional distress, as well as injuries and illnesses, in affected populations.[10,11] However, the typical absence of data collected before disasters has rarely permitted prospective study of the course of stress symptoms through a disaster period.[10,11]

The eye of Hurricane Ike made landfall at Galveston, Texas on September 13, 2008 as a strong, 600-mile-wide Category 2 storm. This storm was one of the most destructive in Texas state history, with a 20-foot storm surge pushing a wall of water across a wide area and flooding that extended far inland. As many as 4 million people in the region were without power for several weeks.

Reported consequences of Hurricane Ike included short-term and long-term mental and physical health problems,[13–15] but as in previous disaster research, these reports did not obtain in-depth data before and after the storm. We examined the effect of sleep quality on the time course of perceived stress from 6 mo before through 1 y after Hurricane Ike among 296 low-income women living in the Galveston area.

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Table 1—Study timeline and calendar months for a study of young, low-income women in the southeast Texas (n = 296).

Study Timeline	Calendar Months	N[a]
Before Ike		
5–6 mo	Mar 13–May 12, 2008	166
3–4 mo	May 13–July 12, 2008	201
1–2 mo	July 13–Sept 12, 2008	244
Hurricane Ike Sept 13, 2008		
After Ike		
1–2 mo	Sept 14–Nov 13, 2008	257
3–4 mo	Nov 14–Jan 13, 2009	264
5–6 mo	Jan 14–Mar 13, 2009	271
7–8 mo	Mar 14– May 13, 2009	276
9–10 mo	May 14–July 13, 2009	274
11–12 mo	July 14–Sept 13, 2009	257

[a]Missing cases were compared with baseline demographics including age, education, marital status, and employment at each time point. No significant differences were found among the groups at $P < 0.05$.

METHODS

Study Design and Sampling

The data for the current analysis originated from a larger longitudinal study of stress and substance use in young women conducted from November 2006 through January 2012 in southeast Texas. Participants were patients attending one of six University of Texas Medical Branch (UTMB) community-based family planning clinics serving primarily low-income women with an average annual income of $7,000. Inclusion criteria were: (1) female; (2) not-pregnant; (3) aged 18 y or older; (4) non-Hispanic white, non-Hispanic black, or Hispanic; (5) able to speak English or Spanish; and (6) able to consent. This study was approved by the UTMB Institutional Review Board.

Formal written consent was obtained in English or Spanish and was renewed annually throughout the study. Participants completed face-to-face interviews at the baseline, as well as 12 mo and 24 mo post-Ike. In addition, four bimonthly telephone interviews were conducted between the annual interviews. Participants were reimbursed for their time and travel costs. Of 1,363 women invited to participate, 886 accepted and provided consent. Hurricane Ike struck the geographical study area at approximately the midpoint of the original longitudinal study.

For the purposes of this investigation, the original 24-mo study data were restructured according to the Hurricane Ike timeline. Because participant availability was limited at this point in the study, a subgroup of 403 women from the study was subsequently requested to answer additional Ike-related questions. These women were interviewed starting 1 mo after Hurricane Ike. Participants in the post-Ike subgroup did not differ from the larger sample in age, education, employment status, or race. However, more women in the post-Ike subgroup had a steady boyfriend (36%) or were married (23%) as compared with the total study population (33% and 19%, respectively); whereas fewer women in the post-Ike subgroup were cohabitating (19%) or did not have a steady partner (23%) compared to the total study population (20% and 28%, respectively) ($P < 0.05$). Of these post-Ike study participants, 88 were recruited after September 2008 and were excluded due to lack of data collected before Hurricane Ike. An additional 19 participants were excluded because of missing sleep information. A total of 296 women with complete sleep measures and pre-Ike and post-Ike stress measures were retained. In comparing subject participating in the analysis (n = 296) with those who were excluded from analysis (n = 107), no significant differences were found in age, race, education, marital status, employment status, or psychiatric diagnosis.

Measures and Instruments

Timeline of Hurricane Ike

Each of the 296 women's interview dates were assigned to a timeline according to the time period in which they were conducted. Time periods included 3–4 mo and 1–2 mo prior to Hurricane Ike and six additional time periods after Ike (see Table 1).

Cohen Perceived Stress Scale (PSS)

This 10-item scale measures the degree to which life situations are appraised as stressful during the last 30 days using a five-point Likert scale.[16] Summary score ranges from 0 (no stress) to 40 (high stress), and the mean for women in the United States in the normative samples was about 16.1.[3] For this study, the PSS was administered at baseline and every 2 mo for the duration of the study. Cronbach α at baseline was 0.84.

Sleep Quality

The quality of sleep was assessed using the Pittsburgh Sleep Quality Index (PSQI), which measures the quality and patterns of sleep in seven domains during the past month (e.g., subjective sleep quality, use of sleep medication) on a 0 to 3 scale.[17] An overall score of 5 or greater indicates poor sleep. In the current study, the PSQI was administered 30 days after Hurricane Ike.

Hurricane Ike Stressors

Selected items from the Disaster Supplement Questionnaire[18] were administered to the post-Ike subgroup. Two sets of questions were selected for analysis. The first set of questions involved tangible stressors including six categories of damage (i.e., property/houses, external structure, furniture, appliances, motor vehicles and sentimental possessions [e.g., pets, family photo albums or family videos]) that were rated on a five-point scale of "none," "slight damage," "moderate damage," "severe damage," and "total destruction. For analysis, responses were combined to indicate either "none to minimum damage" (= 0) or "more severe damage" (= 1). The second set of questions were related to subjective stressors that included family arguments, embarrassment or humiliation, feeling isolated, and fear of crime. Summary indicators of both stressors were created separately by summing corresponding items with higher scores indicative of more stressful exposures.

Hurricane Ike Assistance Applied for

The Disaster Supplement Questionnaire[18] asked participants to indicate the agencies to which they had applied for

assistance after Hurricane Ike. The agencies listed included the Federal Emergency Management Agency, state local police, other parts of state and local government, the National Guard and armed forces, other parts of the federal government, the Red Cross, other relief agencies, insurance companies, and the American public. A summary index was created representing any Ike assistance applied for, which served as a proxy for any assistance needed.

Other Covariates

At baseline, demographic information was obtained including age, race, marital status, employment, and education. Lifetime psychiatric disorders of major depression, generalized anxiety disorder, substance use disorder, and posttraumatic stress disorder were assessed at baseline using the Composite International Diagnostic Interview—World Health Organization version (WHO CIDI 2.1).[19] In addition, standard instruments assessing major life events,[20] emotional dysregulation,[21] and self-control [22] were completed at baseline.

Statistical Analyses

Descriptive statistics were used to compare demographic characteristics of the study sample as stratified according to sleep quality. Cross-tabulation was performed for categorical variables and *t* tests were used for continuous variables. When baseline life events, emotional health, and Ike stressor variables were used to predict sleep quality, the SAS logistic procedure (SAS version 9.4, SAS Institute, Cary, NC)[23] was used. Perceived stress over time as the outcome variable was analyzed using a repeated measures generalized linear mixed model (SAS MIXED procedure, SAS version 9.4, SAS Institute),[23] and an autoregressive process AR(1) was used to model the covariance structure. These models produce unbiased marginal estimates of effect when missing observations can be assumed to be missing at random.[24] We tested the main effect of sleep status after Ike against perceived stress over time, as well as the main effect of stress over the period of time from 6 mo before to 12 mo after Hurricane Ike. Then, using the grouping factor "sleep quality," we investigated whether there was a group × time interaction to determine whether the relationship between sleep quality and perceived stress changed over time. We tested differences in the mean stress level at each post-Ike time point and compared this to the 2 mo immediately before the disaster. We also tested the interaction between sleep quality and the primary exposure (i.e., Ike stressors) on perceived stress over time. A significant interaction would indicate that the relationship between sleep quality and perceived stress differed depending on the extent of Ike stressors. If a significant interaction was detected, the final multivariate model was analyzed separately according to sleep quality. These models use Ike stressor summary variables and risk factors assessed at baseline interviews to predict the time course of stress.

RESULTS

Overall, the mean score of the PSQI was 4.2 (standard deviation [SD] = 3.3), with 39% having a total summary score of PSQI ≥ 5, and thus classified as poor sleepers shortly after Hurricane Ike (Table 2). As expected, a significant association was

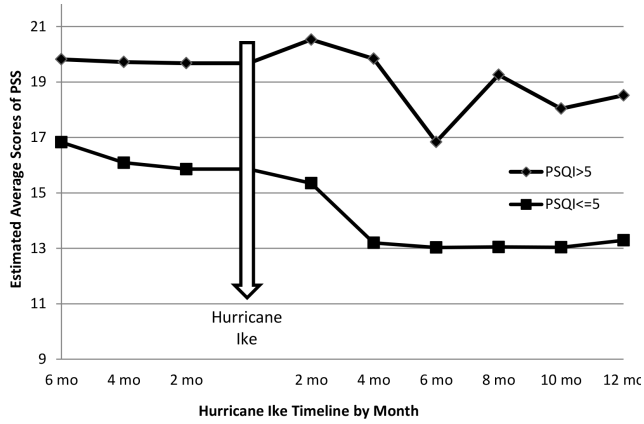

Figure 1—Estimated average scores of Perceived Stress Scale (PSS) by the Pittsburgh Sleep Quality Index (PSQI).

detected between the post-Ike PSQI and overall sleep quality from the baseline pre-Ike questionnaire ($P < 0.01$). However, there were no significant differences in sleep quality between any of the baseline demographic variables.

Figure 1 depicts a significant interaction between sleep quality and time period, indicating that the difference in perceived stress between good and poor sleepers followed a different pattern after Hurricane Ike than before (Den DF = 1824, $F = 2.33$, $P = 0.018$). Over the 18-mo study period, average perceived stress scores among good sleepers, as determined shortly after Ike, ranged from 16.9 (SD = 9.3) 6 mo before Ike to 12.8 (SD = 8.0) 1 y after Ike; and the scores began to decline after Ike, being significantly lower from 3–4 mo (average 2.56 points lower, $P < 0.001$) through 12 mo (average 2.68 points lower, $P < 0.003$) after Ike. In contrast, the range of perceived stress scores for poor sleepers was 20.2 (SD = 8.4) before Ike to 16.7 (SD = 9.3) after Ike. The scores for poor sleepers remained high after Ike compared to before ($P > 0.05$), with the single exception of 5–6 mo post-Ike (average 2.3 points lower, $P = 0.005$). In addition, the main effect of sleep quality on stress was significant (estimate = 1.89, $P < 0.05$), indicating that poor sleepers were almost twice as likely to experience higher levels of perceived stress as good sleepers.

Table 3 shows the bivariate distribution of sleep quality with baseline (pre-Ike) measurements of major life events, emotional dysregulation, and self-control, and Ike-related experiences including stressors (tangible and subjective) and assistance applied for. All these factors were significantly associated with sleep quality ($P < 0.05$).

Table 4 shows adjusted odds ratios (ORs) for the effects of both pre-Ike and post-Ike stressors and emotional health on sleep quality in three models, all of which control for the demographic variables. Model I included baseline life experiences, Model II included Ike stressors, and Model III included both. In Model III, baseline reports of lifetime major life events (OR = 1.19, 95% confidence interval [CI]: 1.02, 1.39) and emotional dysregulation (OR = 1.02, 95% CI: 1.01, 1.04) were both significant predictors of poor sleep after Hurricane Ike, as were the post-Ike tangible stressors (OR = 1.19, 95% CI: 1.01, 1.40) and subjective stressors (OR = 1.81, 95% CI: 1.40, 2.37).

Table 2—Baseline background characteristics and Hurricane Ike sleep quality description of low-income women from the southeast Texas (n = 296).

			Sleep Quality				
	Total (n = 296)[a]		Good (n = 169)		Poor (n = 127)		
	n	%	n	%	n	%	P
Overall sleep quality at Ike							< 0.01
Very good	70	24.2	66	42.0	4	3.0	
Fairly good	142	49.1	86	54.8	56	42.4	
Fairly bad	41	14.2	3	1.9	38	28.8	
Very bad	36	12.5	2	1.3	34	25.8	
Race							
Black	142	48.0	82	18.5	60	14.2	0.91
Hispanic	60	20.3	35	20.7	25	19.7	
White	94	21.8	52	30.8	42	33.1	
Age (y)							
18 – 21	84	28.5	49	29.0	35	27.8	0.81
22 – 25	111	37.6	61	36.1	50	39.7	
26 – 30	100	33.9	59	34.9	41	32.5	
Education							
Less than 12th grade	85	29.3	44	26.7	41	32.8	0.38
High school graduate	119	41.0	73	44.2	46	36.8	
Some college	86	29.7	48	29.1	38	30.4	
Marital status							
Married	67	22.7	38	22.5	29	23.0	0.89
Cohabitation	55	18.6	34	20.1	21	16.7	
Not married w. boyfriend	106	35.9	60	35.5	46	36.5	
Not married w/o boyfriend	67	22.7	37	21.9	37	23.8	
Employment status							
Full time	93	32.1	50	29.8	43	35.3	0.64
Part time	42	14.5	23	13.7	19	15.6	
Homemaker	52	17.9	31	18.5	21	17.2	
Unemployed	103	35.5	64	38.1	39	32.0	
Annual Income, mean (SD)	8,183 (11,131)		7,655 (9,615)		8,880 (12,891)		0.45

[a]May not total 296 due to missing values. SD, standard deviation.

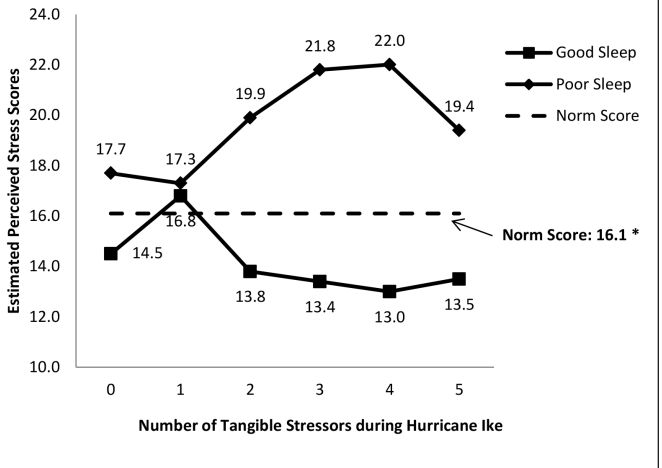

Figure 2—Estimated perceived stress scores by number of Hurricane Ike tangible stressors and sleep status. *The norm score from Cohen S, Janicki-Deverts D. Who's stressed? Distribution of psychological stress in the United States in probability samples from 1983, 2006, and 2009. *J Appl Soc Psychol* 2012;42:1320–34.

We then assessed the interaction of sleep quality and Ike tangible stressors on perceived stress over time. After controlling for main effects as well as the interaction of sleep quality and the Ike time period (Figure 1), the interaction was statistically significant ($P < 0.05$), as indicated in Figure 2. Among poor sleepers, levels of perceived stress increased as the number of Ike tangible stressors increased. In contrast, among the good sleepers, levels of perceived stress did not show significant changes associated with number of Ike tangible stressors, except for a slight increase correlated with reported experience of one Ike stressor.

Because of the interactions between sleep quality and Ike stressors, we analyzed the effect of these stressors on perceived stress separately for good sleepers and poor sleepers (Table 5). Among both good sleepers and poor sleepers, baseline emotional dysregulation and more major life events before Ike were associated with higher levels of perceived post-Ike stress. For example, among poor sleepers, a one-unit increase in subjective stress increased the perceived stress score by 1.48 ($P < 0.05$). Among the good sleepers, lower self-control and diagnosis of any psychiatric disorder at baseline were both

Table 3—Bivariate statistical estimates to describe the relationship[a] between sleep quality and baseline experiences and Hurricane Ike stressors.

	Sleep Quality		Unadjusted OR (95% CI)
	Good	Poor	Poor versus Good
Had moderate or severe damages to, mean (SD)	0.9 (1.7)	1.9 (2.3)	1.25 (1.10, 1.43)
Property, n (%)	70 (48.0)	89 (70.1)	
Furniture, n (%)	30 (20.6)	52 (40.9)	
Appliances, n (%)	23 (15.9)	52 (40.9)	
External structure of property, n (%)	20 (13.7)	43 (33.9)	
Motor vehicles, n (%)	59 (40.4)	68 (53.5)	
Sentimental possession (e.g., pets, family albums, family videos), n (%)	15 (10.3)	31 (24.6)	
Ike subjective stressors, mean (SD)	0.6 (1.0)	1.7 (1.4)	2.12 (1.67, 2.68)
Family argument, n (%)	34 (23.3)	65 (52.0)	
Embarrassment or humiliation, n (%)	14 (9.6)	40 (32.0)	
Feeling isolated, n (%)	23 (15.8)	58 (46.8)	
Fear of crime, n (%)	20 (13.7)	45 (36.0)	
Ike assistance applied for			1.73 (1.06, 2.81)
Yes, n (%)	82 (64.6)	75 (51.4)	
No, n (%)	45 (35.4)	71 (48.6)	
Baseline experiences			
Major life events, mean (SD)	2.8 (1.9)	3.9 (2.2)	1.32 (1.17, 1.49)
Emotional dysregulation, mean (SD)	74.1 (22.3)	91.2 (24.3)	1.03 (1.02, 1.04)
Self-control scale, mean (SD)	44.7 (43.3)	41.0 (9.7)	0.96 (0.94, 0.98)
Had DSM-IV psychiatric disorders, n (%)	82 (49.1)	81 (65.9)	2.00 (1.24, 3.23)

[a]All the indicators were significantly associated with sleep quality ($P < 0.05$). CI, confidence interval; DSM-IV, Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition; OR, odds ratio; SD, standard deviation.

Table 4—Adjusted odds ratios to predict poor sleep after Hurricane Ike by baseline life experiences and Ike stressors.

	Model I	Model II	Model III
Ike stressors			
Tangible stressors	1.21 (1.06, 1.39)		1.19 (1.01, 1.40)
Subjective stressors	1.89 (1.49, 2.40)		1.81 (1.40, 2.37)
Ike assistance applied for (yes versus no)	1.25 (1.10, 1.43)		1.19 (1.01, 1.40)
Baseline life experiences			
Major life events		1.23 (1.07,1.42)	1.19 (1.02,1.39)
Emotional dysregulation		1.03 (1.01,1.04)	1.02 (1.01,1.04)
Self-control		1.00 (0.97,1.04)	0.99 (0.95,1.02)
DSM-IV psychiatric disorders (yes vs no)		1.06 (0.60, 2.13)	0.80 (0.42,1.52)

Values presented as adjusted OR (95% CIs). CI, confidence interval; DSM-IV, Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition; OR, odds ratio.

associated with greater perceived stress over time. For example, a one-unit increase in self-control reduced the score of perceived stress by 0.09 ($P < 0.05$).

DISCUSSION

In a sample of young, low-income women in southeast Texas who experienced Hurricane Ike in 2008, sleep quality was assessed once after Ike using the PSQI. About 39% of women were classified as poor sleepers. In a cross-sectional study of low-income young women from the same family planning program, Kachikis and Breitkopf[7] found that 44% of participants reported their sleep quality as less than "good," and sleep quality, assessed with a single question, was inversely associated with perceived stress. Sleep quality, including short sleep, varies among women according to demographic characteristics such as age, education level, employment status, and number of children. Mindell et al.[25] examined sleep quality among a large sample of mothers of young children in 14 countries and correlated poor sleep with lower educational level, lower income, and having a younger child. They reported that 59% of subjects in the United States were poor sleepers. In addition, Patel et al.[26] found that poor sleep (also using one question) was associated with poverty, and that African-American and Latino residents in greater Philadelphia were more likely to

Table 5—Multivariate stratified longitudinal models[a] to predict perceived stress over time by baseline life experiences and Ike stressors.

	Sleep Status	
	Poor Sleep[b]	Good Sleep[c]
Ike stressors		
Number of tangible stressors		
1 versus 0	−1.31	1.22
2+ versus 0	0.03	0.45
Subjective stressors	1.48[e]	1.15[e]
Ike assistances applied for (yes versus no)	−0.63	0.41
Baseline life experiences		
Major life events	0.33[d]	0.32[d]
Emotional dysregulation	0.07[e]	0.15[e]
Self-control	−0.02	−0.09[e]
DSM-IV psychiatric disorders (yes vs no)	0.11	1.28[d]
AR(1) residual	61.9	56.7
AIC	6123.6	7031.6

[a]Stratified by sleep status and controlled for the time period from 6 mo prior to and 12 mo post to Hurricane Ike. [b]$P > 0.05$ (not significant) for the time variable in the poor sleep model. [c]$P < 0.05$ for the time variable in the good sleep model. [d]$P < 0.01$. [e]$P < 0.05$. AR(1), autoregressive process; DSM-IV, Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition; AIC, Akaike's information criterion.

report poor sleep than Whites. Our results are consistent with those previously reported in women.

We found that both baseline experiences (lifetime major life events, emotional dysregulation) and subjective Ike stressors predicted sleep quality in both unadjusted bivariate analyses (Table 3) and adjusted multivariate analyses (Table 4). Thus, obtaining such predisaster information in this population may be valuable for disaster preparedness. It also indicates that the effect of the disaster itself on sleep quality may be independent of predisaster factors. Incorporating both predisaster and disaster-related experiences may benefit recovery efforts.

In our study, sleep quality was related to the time course of perceived stress as measured at many time points beginning before Ike through 1 y after. Good sleepers fared considerably better than poor sleepers. Prather et al.[27] used the PSQI to categorize 289 women as "good" or "poor" sleepers and found that sleep quality was inversely associated with perceived stress level. In another cross-sectional study of African American women, poorer sleep quality on the PSQI was correlated with higher perceived stress.[28] However, these studies lacked longitudinal data to determine changes in stress and sleep quality over time. A substantial body of literature has examined stressful experiences and sleep quality in relation to traumatic events, including natural disasters.[10,11,29] Disasters generate a wide range of stressors on individuals and their communities over time. In addition, adverse outcomes may accrue or become apparent over time.[10,11,30] However, after examining 225 samples of ≥ 85,000 individuals who experienced 132 distinct disasters between 1981 and 2004, Norris and associates[10,11] noted that only 10 samples (4.4%) included data obtained before the disaster. They concluded that "studies using pre-post design were much less likely to find severe (or very severe) effects than were studies using after-only designs."[11] To our knowledge, our study is one of the few with a reasonable sample size that describes a longitudinal time course over the period of a natural disaster with measures collected before the disaster.

It is interesting to note that perceived stress decreased after Hurricane Ike among good sleepers. McMillen et al.[31] explored the concept of "perceived benefit" after a disaster, in which people who believe they have somehow benefitted from the disaster show greater recovery after the event than those who perceived no benefit. The perceived benefits included "community became closer," "enhanced closeness," and "personal growth." The effect is greater with more severe disaster exposure. Perceived benefit may also interact with sleep quality. Hamilton et al.[32] found that higher quality sleep buffers the relationship between stress and negative affect and the relationship between pain and both positive and negative affect. These investigators suggested that high-quality sleep acts as a biobehavioral resource that reduces allostatic load. This buffering may exert its effect by modulating negative affect in response to stressful encounters, or by maximizing the use of effective coping strategies.

Our study also identified multiple risk factors to predict higher levels of perceived stress for both poor and good sleepers. First, subjective stressors experienced during Hurricane Ike (e.g., family arguments, embarrassment or humiliation, feeling isolated, fear of crime) were associated with higher levels of stress. Second, major life events and emotional dysregulation assessed at baseline were also associated with higher perceived stress. Awareness of these factors may help disaster aid workers refine and focus psychosocial relief efforts for victims of natural disasters.

A primary limitation of this study was that sleep quality was assessed only once shortly after the hurricane, therefore poor sleep in some women may have simply been related to greater property damage and hardship. However, sleep quality was associated with perceived stress even after controlling for hurricane-related stressors and damages. In addition, both major life events and emotional dysregulation at baseline predicted poor sleep after Ike. This suggests that sleep quality was not simply an acute state reflecting the trauma of Ike. Sleep quality, even after the hurricane, seems to primarily reflect womens' long-term experiences. Because our sample included only women of lower socioeconomic status, generalizations to men and to more economically stable individuals must be approached with caution.

Although sleep quality was assessed only once after Hurricane Ike, it was clearly associated with perceived stress even before Ike. It is salient to consider whether sleep problems intensified perceived stress or whether stress caused the sleep problems. If it is the former, then measures to improve sleep quality in low-income women are warranted as stress prevention interventions. If it is the latter, however, efforts to cope more effectively with stressful experiences would be beneficial for mitigating disaster-related sleep problems. This distinction is important because although education about improving sleep quality is clear and often feasible (e.g., dark, quiet bedroom;

dim lights in the evening; early lights out), interventions to reduce stress among low-income women are more difficult and frequently involve factors beyond a woman's control (e.g., violence, food insecurity); however, interventions can help women develop improved skills to better cope with adversity.

In summary, our findings provide new insights that could be used to design multilevel, individualized, or targeted strategies for disaster preparedness and interventions, potentially including initial sleep quality screening. Conventional, traditional preparedness measures may be sufficient for low-income women with good sleep habits and without any predisaster emotional needs. However, additional targeted inventions could be useful for good sleepers who may have experienced more major life events and those with greater emotional needs (i.e., higher levels of emotional dysregulation and lower levels of self-control). For poor sleepers, a systematic, comprehensive preparedness and intervention is recommended.

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DISCLOSURE STATEMENT

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