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PSYCHOSOCIAL STRESS AND SLEEP

The Contribution of Psychosocial Stressors to Sleep among African Americans in the Jackson Heart Study

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Study Objectives: Studies have shown that psychosocial stressors are related to poor sleep. However, studies of African Americans, who may be more vulnerable to the impact of psychosocial stressors, are lacking. Using the Jackson Heart Study (JHS) baseline data, we examined associations of psychosocial stressors with sleep in 4,863 African Americans.

Methods: We examined cross-sectional associations between psychosocial stressors and sleep duration and quality in a large population sample of African Americans. Three measures of psychosocial stress were investigated: the Global Perceived Stress Scale (GPSS); Major Life Events (MLE); and the Weekly Stress Inventory (WSI). Sleep was assessed using self-reported hours of sleep and sleep quality rating (1 = poor; 5 = excellent). Multinomial logistic and linear regression models were used to examine the association of each stress measure (in quartiles) with continuous and categorical sleep duration (< 5 ("very short"), 5–6 h ("short") and ≥ 9 h ("long") versus 7 or 8 h ("normal"); and with sleep quality after adjustment for demographics and risk factors (body mass index, hypertension, diabetes, physical activity).

Results: Mean age of the sample was 54.6 years and 64% were female. Mean sleep duration was 6.4 ± 1.5 hours, 54% had a short sleep duration, 5% had a long sleep duration, and 34% reported a "poor" or "fair" sleep quality. Persons in the highest GPSS quartile had higher odds of very short sleep (odds ratio: 2.87, 95% confidence interval [CI]: 2.02, 4.08), higher odds of short sleep (1.72, 95% CI: 1.40, 2.12), shorter average sleep duration (Δ = −33.6 min (95% CI: −41.8, −25.4), and reported poorer sleep quality (Δ = −0.73 (95% CI: −0.83, −0.63) compared to those in the lowest quartile of GPSS after adjustment for covariates. Similar patterns were observed for WSI and MLE. Psychosocial stressors were not associated with long sleep. For WSI, effects of stress on sleep duration were stronger for younger (< 60 y) and college-educated African-Americans.

Conclusions: Psychosocial stressors are associated with higher odds of short sleep, lower average sleep duration, and lower sleep quality in African Americans. Psychosocial stressors may be a point of intervention among African Americans for the improvement of sleep and downstream health outcomes.

Keywords: sleep duration, sleep quality, psychosocial stress, African American, Jackson Heart Study

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Significance

African Americans report shorter sleep duration and a poorer sleep quality than non-Hispanic whites, however, few studies have investigated the determinants of poor sleep among African Americans. We investigated associations between chronic and acute stressors and sleep duration and quality in a large population of African Americans given African Americans have both a high prevalence of stress and may have a differential vulnerability to the impact of stressors on sleep relative to non-Hispanic whites. We observed clinically meaningful differences in sleep duration and quality comparing individuals with higher and lower reports of psychosocial stress. Future research should identify potential buffers that may mitigate the effects of psychosocial stressors in this population to improve sleep and subsequent health outcomes.

INTRODUCTION

Approximately 50 to 70 million adults in the United States have a sleep or wakefulness disorder.[1] Short (≤ 6 h) and long (≥ 9 h)[2] sleep duration and a poor quality of sleep can interrupt the health promoting functions that occur during sleep, leading to poor health outcomes.[1] Large scale observational and experimental studies have linked poor sleep to high blood pressure, heart disease, diabetes, stroke, obesity, and depression.[3–6]

Although most research on sleep has been conducted in white populations, studies that have included African-Americans have found that compared to non-Hispanic whites, African Americans have poorer sleep quality, lower mean sleep duration, and a higher prevalence of sleep-disordered breathing.[7–12] It is important to identify within African Americans the factors contributing to poor sleep in this population. Research in non-Hispanic white populations has linked poor sleep to psychosocial stressors including negative life events, work stress, and financial strain.[13–17] For example, in the British Whitehall II study, sleep problems were greater among participants who had higher scores of psychosocial adversity and vulnerability, and in those exposed to financial strain or neighborhood crime independent of covariates.[14] Other studies have also linked short sleep duration to high levels of stress, but many of these studies were in restricted populations or small samples.[18] Studies focused on African Americans are lacking.

It is important to investigate these associations among African Americans for two reasons: (1) this population has a high prevalence of stress[19]; and (2) this population may have a differential vulnerability to stressors relative to non-Hispanic whites.[20] African Americans have been shown to have more frequent exposures to certain stressors over the life course because of their social and economic circumstances.[20–27] For example, several studies have found that African Americans report experiencing greater cumulative exposures to stressors (chronic and acute) than non-Hispanic whites.[25–29] Additionally, stressful experiences, such as discrimination due to race, can produce psychosocial distress which can result in alterations in physiological processes that can impair sleep[21,28,30]; the effect

may also be independent of psychological distress.[31] Workplace stressors (discrimination or limited control over job demands) may also be more common in African Americans than in whites.[21] In addition to the higher prevalence of stressors, the consequences of these stressors for sleep may be different in African Americans than in whites. For example, African Americans may be less likely to have access to resources and support mechanisms that buffer the adverse health effects of stressors, or these stressors may interact with other exposures (such as adverse neighborhood environments) resulting in stronger effects of psychosocial stressors and poor sleep in African Americans. Additionally, a study conducted by Jackson and colleagues found African Americans in higher occupational roles had poorer sleep, whereas non-Hispanic whites in similar roles had better sleep.[21] The authors hypothesize this difference may be due stress. There is a clear need to identify the effect of stress on sleep within African Americans.

We used a large population-based cohort, the Jackson Health Study (JHS), to examine the cross-sectional associations of psychosocial stress (global, major life events, weekly) with sleep duration and quality in African Americans. We hypothesized that higher chronic and acute stress are associated with poor sleep quality and short sleep duration.

METHODS

The JHS is a large population-based, prospective cohort designed to examine the etiology of cardiovascular disease in African Americans. A total of 5,301 participants aged 21–95 y were recruited from three counties, Hinds, Madison, and Rankin in the Jackson, Mississippi (MS), metropolitan statistical area (MSA) between September 2000 and March 2004 using four approaches.[32] First, all the Jackson, MS living participants in the Atherosclerosis Risk in Community (ARIC) study within the eligible age range were invited to participate in JHS. In total, 31% of the JHS participants were recruited from the ARIC study. Second, participants were recruited through random sampling (17% of the total JHS sample) from a commercially available list (AccuData Intergrated Marketing, Fort Myers, FL) of all community residents aged 35–84 y in the tri-county area.[24] The third approach recruited volunteers (30% of the total JHS sample) aged 35–84 y through targeted advertisements: radio, newspaper, local churches, and civic/social organizations.[24] Volunteers were approximately representative of the Jackson MSA African American population in terms of age, sex, and socioeconomic characteristics.[33] Fourth, family members of other JHS participants (22% of the total JHS sample) were recruited from enumerated households to permit future genetic studies.[34] Family members were included even if they were younger than 35 y or older than 84 y of age. The final study sample has been shown to be geographically representative of the age-eligible African American population in Jackson, MS MSA.[35] The JHS was approved by the institutional review boards of Jackson State University, Tougaloo College, and University of Mississippi Medical Center. All participants provided written informed consent.

Psychosocial Stressors (Exposures)

Three measures of psychosocial stress were included: the Global Perceived Stress Scale (GPSS) was administered as part of the baseline examination; Major Life Events (MLE) were assessed by telephone interview during the first annual follow-up; and the Weekly Stress Inventory (WSI) was given to study participants at the conclusion of the baseline clinical examination with instruction to complete at home and mail back to the JHS Coordinating Center.[24]

The GPSS is an eight-item questionnaire that measured the perception of the severity of chronic stress experienced over a prior period of 12 mo in eight domains including employment, relationships, related to one's neighborhood, caring for others, legal problems, medical problems, racism and discrimination, and meeting basic needs.[36] Participants rated stress severity for each domain on a four-point scale ranging from "not stressful" to "very stressful" (0–3). The GPSS was created for the JHS,[36] and adapted from the following scales, Survey of Recent Life Experiences,[37] Perceived Stress Scale,[38] and Life Events Scale.[39] Of 5,301 JHS participants, 5,279 completed the GPSS survey. Of these participants, 99.55% (n = 5,255) had complete GPSS data; 0.38% (n = 20) had missing responses for 1 out of the 8 questionnaire items. Cronbach alpha for these participants on the GPSS was 0.72.

The MLE survey (adapted from the Life Changes Scale) measured 11 items based on participant reports of major life events (chronic stress) that had occurred in the past 12 mo by answering "yes" or "no."[40] The items included: (1) experiencing serious personal illness; (2) being a victim of physical assault; (3) being a victim of a robbery or home burglary; (4) losing a loved one due to violence; (5) experiencing gunfire at home/neighborhood; (6) having a close friend/relative die; (7) having a close friend/relative experience major illness/injury; (8) moving to a worse residence/neighborhood; (9) losing a job; (10) being forced to retire when didn't want to; (11) experiencing divorce/separation from spouse. Yes responses were coded as 1 and no responses as 0. Of the JHS participants, 5,085 completed the MLE survey. Of these participants 81.07% (n = 4,867) had responses on all items; 1.28% (n = 65) had missing responses in 1 out of the 11 items. The MLE is an index and not a true scale, therefore no Cronbach alpha was calculated.

The WSI developed by Brantley and Jones (1989) consisted of an 87-item questionnaire that assessed minor discrete experiences of stress (acute stress) across a broad range of life domains (over the past week) including work tasks, relationships, finances, transportation, household tasks and responsibilities, leisure time activities, and others.[41] Participants were asked to assess the severity of the daily irritants during the past week on a 7-point scale with levels defined as follows: 0 = did not happen; 1 = not stressful; 2 = slightly stressful; 3 = mildly stressful; 4 = moderately stressful; 5 = stressful; 6 = very stressful; 7 = extremely stressful. Of the JHS participants, 3,602 returned the WSI survey. Of these participants, 81.07% (n = 2,920) had all responses on all items; 13.24% (n = 477) had missing responses in less than or equal to 9 of 87 questionnaire items.

For statistical analyses, we used an average score for the GPSS, MLE, and WSI. If the number of missing item responses was 1 for GPSS or MLE or less than or equal to 9 for WSI, the missing item response(s) were imputed as the average of the other complete responses to the scales for the participant.

The average score was then calculated as the average of all responses after imputation. If the number of missing items was more than 1 for the GPSS or MLE or more than 9 for the WSI then the overall score was set to missing. Higher average scores indicate more stress on all scales.

Sleep Measures (Outcomes)

Self-reported sleep duration and sleep quality were collected at baseline between 2000 and 2004. To assess sleep duration, participants responded to the following: "During the past month, excluding naps, how many hours of actual sleep did you get at night (or day, if you work at night) on average?" Responses were given in hours and transformed into minutes for analysis. For our primary analysis sleep duration was also categorized into very short (< 5 h), short (5–6 h), normal (7 or 8 h), and long (≥ 9 h) sleep.[42,43] The analyses included both continuous (in minutes) and categorized (very short, short, normal, and long) measures of sleep duration. Participants also indicated their level of sleep quality by responding to the following question, "During the past month, how would you rate your sleep quality overall?" Responses were reported on a Likert scale, with 1 = excellent, 2 = very good, 3 = good, 4 = fair, 5 = poor; coding was reversed for analysis and further categorized as high (excellent, very good, good) and low (fair, poor).

Covariates

Participants self-reported age, sex, education, and income, which may confound the association of psychosocial stressors and sleep. Education was assessed as years of schooling completed (range = 0–16+ years) and categorized into four groups: less than high school, high school, higher than high school but less than a college degree, and higher than a college degree. Annual family income was self-reported for 11 categories ranging from under $5,000 to $100,000 or more and further classified into four categories: low, lower-middle, upper-middle, and affluent that were based on income, family size, number of children younger than 18 y of age, and the United States Census designated poverty level for the year in which the income information was obtained.[24] Low income was defined as income below the poverty level. Lower-middle income was defined as income at or above the poverty level but below 2.5 times the poverty level. Upper-middle income was defined as income at or above 2.5 times the poverty level, but below four times the poverty level. High income was defined as income of four times the poverty level or more.[44] A continuous family income was also calculated by taking the interval midpoint of each family income bracket (e.g. the midpoint for $5,000-$7,999 is $6,500).[24] Those who reported total family income of < $5,000 were assigned a value of $2,500 and those with > $100,000 were assigned $112,500 based on the US income distribution. Participants who did not know their income or refused to respond were classified as "Unknown."

Risk factors, such as body mass index (BMI), hypertension, diabetes, physical activity, and depressive symptoms may confound the associations between psychosocial stress measures and sleep. However, some of these risk factors may also operate as mediators as psychosocial stress can affect the occurrence of these factors. For this reason results are shown before and after adjustment for these covariates. Trained study staff measured each of these four risk factors. BMI was calculated in kg/m^2 using measurements of weight and height while participants wore light clothing and no shoes. Seated blood pressure measurements were obtained after 5 minutes of rest. Two resting blood pressure readings were taken 1 min apart in the seated position and averaged. Hypertension was defined according to Seventh Report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure (JNC VII) criteria as a systolic blood pressure ≥ 140 mmHg or a diastolic blood pressure ≥ 90 mmHg, use of antihypertensive medications (self- report and actual) within 2 w prior to data collection, or self-reported history of hypertension.[45] Diabetes was defined according to American Diabetes Association, 2004 criteria as fasting glucose ≥ 126 mg/dL, use of antidiabetic medication (self-report and actual), or self-reported diabetes diagnosis.[46] Physical activity was measured using the JHS Physical Activity Measurement instrument, a modified version of the Baecke physical activity survey.[47,48] A total physical activity score was calculated based on a summary score of the intensity, frequency, and duration of activities associated with various aspects of life (active living, home life, sport, and work),[24] and has been validated against accelerometers and pedometers.[49]

Depressive symptoms were assessed as part of a follow-up questionnaire and were only available in a subset of participants we therefore included depressive symptoms in secondary analyses in this subset only. Depressive symptoms were measured according to the Centers for Epidemiologic Studies Depression Scale (CES-D). The CES-D is a standardized, 20-item, self-reported instrument that measures the frequency of recently experienced depressive symptoms.[50] Participants were asked about their mood over the past week, responding to each item (e.g., "I was bothered by things that usually don't bother me," "I felt hopeful about the future," etc.) as to how often they felt "this way." Item ratings ranged from 0 or "rarely or none of the time," 1 "some or a little of the time," 2 "occasionally or a moderate amount of the time," and 3 "most or all of the time." Scores range from 0 to 60 with higher scores reflecting greater levels of depressive symptoms while lower scores reflect lower levels of depressive symptoms. The Cronbach alpha was 0.82.

Statistical Analysis

Only participants with complete data on the psychosocial stress measures and sleep measures were included in the analyses. After excluding missing data for sleep and psychosocial stress measures, we performed analyses on two analytic datasets: the first included participants with complete data on the GPSS and MLE measures, n = 4,863 (2,555 for subset with depressive symptoms); and the second included a subset of participants who had complete data on the WSI measure, n = 3,177 (2,734 for subset with depressive symptoms). Each of the psychosocial stressors was investigated in a separate model.

Descriptive statistics for demographics and risk factors were calculated for the two analytic datasets and stratified by sex due to differences in sleep characteristics and psychosocial stressors by sex and prior literature showing differences in the association of stress with sleep by sex.[41] Pearson correlations

Table 1—Sample characteristics by sex and analytic sample, the Jackson Heart Study, 2000–2004.

	Women		Men		P value comparing Women to Men	
Characteristics	**GPSS/MLE**	**WSI**	**GPSS/MLE**	**WSI**	**GPSS/MLE**	**WSI**
N (% of sample)	3,106 (63.9)	2,071 (65.2)	1,757 (36.1)	1,106 (34.8)	–	–
Age (y), mean (SE)	55.2 (12.6)	54.1 (12.4)	53.6 ± 12.9	52.4 (12.6)	< 0.01	< 0.01
Education (%)					0.56	0.61
< HS	17.3	12.6	17.7	13.1	–	–
HS/GED	20.4	19.4	19.0	18.1	–	–
> HS but Bachelor degree	28.6	30.9	30.0	29.8	–	–
College degree+	33.6	37.1	33.3	39.0	–	–
Income (dollars), mean (SE)	38,560 (29,345)	40,880 (29,749)	51,670 (32,663)	53,984 (32,876)	< 0.01	< 0.01
Income (%)					< 0.01	< 0.01
Low	17.8	15.5	9.7	9.3	–	–
Lower-middle	27.0	25.4	21.5	18.3	–	–
Upper-middle	29.6	30.6	30.8	31.8	–	–
Affluent	25.7	28.4	38.0	40.6	–	–
BMI	32.8 (7.5)	32.8 (7.5)	29.8 (6.1)	29.9 (6.1)	< 0.01	< 0.01
Physical activity, mean (SE)	8.2 (2.6)	8.4 (2.5)	8.7 (2.6)	8.9 (2.5)	< 0.01	< 0.01
Depressive symptoms, mean (SE)	11.3 (8.2)	11.3 (8.3)	9.6 (9.1)	9.6 (7.3)	< 0.01	< 0.01
Hypertension (%)	64.7	62.4	59.3	56.0	< 0.01	< 0.01
Diabetes (%)	19.4	18.0	16.8	14.7	0.03	0.02
Stress measures						
GPSS, mean (range)	0.69 (0–3.0)	–	0.56 (0–2.6)	–	< 0.01	–
MLE, mean (range)	0.13 (0–0.7)	–	0.11 (0–0.5)	–	< 0.01	–
WSI, mean (range)	–	1.0 (0–5.5)	–	0.94 (0–6.2)	–	0.06
Sleep duration, mean (SE)	6.5 (1.5)	6.5 (1.5)	6.3 (1.5)	6.3 (1.4)	< 0.01	< 0.01
Sleep quality, mean (SE)	2.9 (1.1)	2.9 (1.1)	3.0 (1.1)	3.0 (1.1)	< 0.01	< 0.01

Sample size GPSS/MLE = 4,863 except: education = 4,852, income (dollars) = 4,134, income (categorical) = 4,114, BMI = 4,856, physical activity = 4,597, depressive symptoms = 2,956, hypertension = 4,829, diabetes = 4,756; Sample size WSI = 3,177 except: education = 3,174, income (dollars) = 2,736, income (categorical) = 2,723, BMI = 3,173, physical activity = 3,008, depressive symptoms = 2,871, hypertension = 3,157, diabetes = 3,107. BMI, body mass index; GPSS, Global Perceived Stress Scale; HS, high school; MLE, Major Life Events; SE, standard error; WSI, Weekly Stress Inventory.

were calculated to examine the correlation between psychosocial stress measures and between sleep outcome variables (sleep duration and sleep quality).

Multinomial logistic regression was used to examine the association of each psychosocial stress measure (modeled as indicator variables based on quartiles of the distribution with the lowest quartile as the referent) with categories of sleep duration (very short versus normal, short versus normal, long versus normal). Linear regression was used to examine the association of each psychosocial stress measure with continuous sleep outcomes (sleep duration and sleep quality). Psychosocial stress measures were modeled in separate sequential models as follows: unadjusted, followed by adjustment for age, sex, education, and income, and further adjusted for BMI, diabetes, hypertension, and physical activity. We also tested for linear trends across quartiles of psychosocial stress measures.

We investigated whether associations of psychosocial stress measures with the sleep outcomes were modified by sex, age, and education. Interaction terms between each psychosocial stress measure and potential effect modifiers (sex, age, education) were included in the fully adjusted models; $P < 0.05$ for interaction terms were considered evidence of effect modification. All analyses were conducted using SAS software version 9.3 (SAS Institute, Cary, NC).

In secondary analyses we used the same sequential modeling approach and added an additional model that further adjusted for depressive symptoms.

RESULTS

Comparisons of characteristics in the GPSS/MLE sample and the WSI sample showed some differences: the WSI sample was younger, more likely to be female, more likely to be of higher education and higher income, had a higher mean physical activity score, and a lower prevalence of hypertension and diabetes than the GPSS/MLE sample. The GPSS was weakly correlated with the MLE ($r = 0.25$) and WSI ($r = 0.37$); MLE and WSI were also weakly correlated ($r = 0.16$). Sleep duration and sleep quality were moderately correlated ($r = 0.46$).

In the GPSS/MLE sample, women were older, had a lower family income, a lower physical activity score, a higher BMI, and a higher prevalence of hypertension and diabetes compared to men (Table 1). Similar patterns were observed for the WSI sample. Women had higher stress scores (GPSS, MLE, and WSI) than men (Table 1). Mean sleep duration was higher for women than men, but men had a higher sleep quality score than women in both analytic samples (Table 1).

Age-adjusted sleep duration and sleep quality by quartiles of psychosocial stress measures by sex are reported in Table 2. For both women and men, lower chronic and acute stressors

Table 2—Age-adjusted sleep duration and sleep quality by stress quartiles among women and men, the Jackson Heart Study, 2000–2004.

	Women[a]		Men[a]	
	Sleep Duration (range 1–16 h)	Sleep Quality (range: 1 poor–5 excellent)	Sleep Duration (range 1–16 hours)	Sleep Quality (range: 1 poor–5 excellent)
GPSS				
Q1	6.78 (0.06)	3.25 (0.04)	6.58 (0.06)	3.31 (0.05)
Q2	6.59 (0.05)	3.09 (0.04)	6.44 (0.06)	3.11 (0.05)
Q3	6.45 (0.06)	2.92 (004)	6.29 (0.08)	2.95 (0.06)
Q4	6.20 (0.05)	2.54 (0.04)	5.96 (0.07)	2.68 (0.05)
P for trend	< 0.01	< 0.01	< 0.01	< 0.01
MLE				
Q1	6.68 (0.05)	3.08 (0.04)	6.50 (0.06)	3.16 (0.04)
Q2	6.44 (0.05)	2.96 (0.04)	6.36 (0.06)	3.11 (0.05)
Q3	6.49 (0.05)	2.91 (0.04)	6.28 (0.07)	2.96 (0.05)
Q4	6.24 (0.06)	2.63 (0.05)	6.11 (0.09)	2.80 (0.07)
P for trend	< 0.01	< 0.01	< 0.01	< 0.01
WSI				
Q1	6.69 (0.07)	3.21 (0.05)	6.61 (0.08)	3.27 (0.06)
Q2	6.67 (0.06)	3.10 (0.05)	6.27 (0.08)	3.15 (0.06)
Q3	6.38 (0.06)	2.91 (0.05)	6.31 (0.09)	2.95 (0.07)
Q4	6.26 (0.06)	2.58 (0.05)	6.08 (0.09)	2.83 (0.07)
P for trend	< 0.01	< 0.01	< 0.01	< 0.01

Adjusted to the mean age. Values are presented as mean (standard error). [a]n = GPSS/MLE: women: 3,106, men: 1,757; WSI: women: 2,071, men: 1,106. The n values for GPSS and MLE and for WSI are given separately because of the variations in sample size. GPSS, Global Perceived Stress Scale; MLE, Major Life Events; WSI, Weekly Stress Inventory.

were associated with longer sleep duration and better sleep quality, P for trend < 0.01.

Overall, persons who reported higher scores on the GPSS, MLE, and WSI had higher odds of very short sleep and short sleep relative to those in the lowest quartile of GPSS, MLE and WSI after age, sex, education and income adjustment (Table 3, P for trend < 0.01 for all). The associations remained after further adjustment for risk factors (Table 3). In general, psychosocial stress measures were not associated with long sleep (Table 3). There was a graded association such that mean minutes of sleep duration was lower with each higher quartile of the GPSS, MLE and WSI after adjustment for age, sex, education and income (P for trend < 0.01). The associations remained after further adjustment for risk factors (Table 3).

Persons who reported higher scores on the GPSS, MLE, and WSI reported a worse sleep quality relative to those in the lowest quartile of GPSS, MLE, and WSI after adjusting for age, sex, education, and income (Table 4). All psychosocial stress measures showed significant trends (all P for trend < 0.05), such that higher categories of the psychosocial stress measures were associated with lower sleep quality scores, P < 0.01 for all. The associations remained after further adjustment for risk factors (Table 4).

Tests of effect modification according to sex revealed no statistically significant differences in associations of psychosocial stress measures with sleep duration or sleep quality. However, age and education modified the association of WSI (continuous) and sleep duration, such that younger individuals (age 60 y and younger) and more educated individuals (college degree or higher) were more vulnerable to the effect of stress on sleep duration than older and less educated individuals, P < 0.05 for interaction. There was no effect modification by age and education for the other psychosocial stress measures.

Secondary Analysis

Consistent with the results of the primary analysis, associations between psychosocial stressors and sleep duration and quality remained after adjustment for demographics and risk factors in the subset of JHS participants with CES-D data. After further adjustment for depressive symptoms, the associations were slightly attenuated but remained statistically significant (Tables S1 and S2 in the supplemental material).

DISCUSSION

Sleep problems are frequent among African Americans, but the factors associated with poor sleep in this population are understudied. We investigated psychosocial stressors as predictors of poor sleep outcomes among African Americans. Higher levels of reported chronic and major life stressors were associated with higher odds of very short sleep, short sleep, shorter sleep duration on average (or fewer mean hours/minutes of sleep), and a lower sleep quality score after adjustment for demographics, socioeconomic status, and risk factors. We found graded associations such that higher levels of stress were associated with shorter sleep durations and poorer sleep quality. The association of WSI with sleep duration was stronger among younger and college educated persons than older and less educated persons. These findings indicate that

Table 3—Odds ratios (95% confidence interval) of very short, short and long sleep duration (versus normal) and mean differences (95% confidence interval) in sleep duration associated with psychosocial stress, the Jackson Heart Study, 2000–2004.

	Model 1				Model 2			
	OR of Very Short Sleep	OR of Short Sleep	OR of Long Sleep	Mean Difference in Minutes of Sleep	OR of Very Short Sleep	OR of Short Sleep	OR of Long Sleep	Mean Difference in Minutes of Sleep
GPSS								
Q1	REF	REF	REF	REF	REF	REF	REF	REF
Q2	1.23 (0.86, 1.74)	1.21 (1.01, 1.46)[b]	0.84 (0.58, 1.22)	−9.9 (−17.6, −2.3)[a]	1.14 (0.78, 1.65)	1.20 (0.99, 1.46)[c]	0.94 (0.63, 1.39)	−7.2 (−15.2, 0.6)[c]
Q3	1.53 (1.06, 2.22)[b]	1.47 (1.20, 1.80)[a]	0.90 (0.60, 1.36)	−19.7 (−27.9, −11.5)[a]	1.56 (1.06, 2.29)[b]	1.49 (1.20, 1.83)[a]	0.93 (0.60, 1.46)	−20.0 (−28.5, −11.5)[a]
Q4	2.95 (2.11, 4.11)[a]	1.74 (1.43, 2.12)[a]	0.83 (0.54, 1.25)	−35.4 (−43.3, −27.5)[a]	2.87 (2.02, 4.08)[a]	1.72 (1.40, 2.12)[a]	0.85 (0.54, 1.34)	−33.6 (−41.8, −25.4)
P for trend	< 0.01	< 0.01	0.43	< 0.01	< 0.01	< 0.01	0.49	< 0.01
MLE								
Q1	REF	REF	REF	REF	REF	REF	REF	REF
Q2	1.20 (0.88, 1.63)	1.21 (1.02, 1.43)[b]	0.56 (0.39, 0.82)[a]	−13.2 (−20.2, −6.1)[a]	1.30 (0.93, 1.80)	1.17 (0.98, 1.40)[c]	0.53 (0.35, 0.78)[a]	−13.9 (−21.2, −6.6)[a]
Q3	1.28 (0.93, 1.78)	1.23 (1.02, 1.47)[b]	0.68 (0.46, 0.99)[b]	−12.9 (−20.3, −5.5)[a]	1.27 (0.90, 1.80)	1.20 (1.00, 1.45)[b]	0.64 (0.43, 0.96)[b]	−12.3 (−19.9, −4.6)[a]
Q4	2.52 (1.80, 3.51)[a]	1.52 (1.23, 1.88)[a]	0.95 (0.62, 1.44)	−26.6 (−35.0, −18.1)[a]	2.63 (1.85, 3.73)[a]	1.44 (1.16, 1.80)[a]	0.94 (0.60, 1.46)	−27.2 (−35.9, −18.4)[a]
P for trend	< 0.01	< 0.01	0.46	< 0.01	< 0.01	< 0.01	0.40	< 0.01
WSI								
Q1	REF	REF	REF	REF	REF	REF	REF	REF
Q2	1.24 (0.78, 1.96)	1.26 (1.00, 1.58)[b]	1.04 (0.64, 1.68)	−8.4 (−17.6, 0.8)[c]	1.17 (0.72, 1.92)	1.24 (0.98, 1.57)[c]	1.19 (0.71, 2.00)	−6.4 (−16.0, 3.1)
Q3	2.00 (1.29, 3.10)[a]	1.55 (1.23, 1.95)[a]	1.01 (0.61, 1.68)	−21.2 (−30.5, −11.8)[a]	2.05 (1.30, 3.24)[a]	1.54 (1.21, 1.96)[a]	1.10 (0.63, 1.89)	−20.2 (−29.9, −10.6)[a]
Q4	3.34 (2.19, 5.10)[a]	1.78 (1.40, 2.27)[a]	1.36 (0.83, 2.23)	−30.2 (−39.8, −20.7)[a]	3.57 (2.30, 5.56)[a]	1.71 (1.33, 2.21)[a]	1.67 (0.99, 2.81)[c]	−28.5 (−38.4, −18.6)[a]
P for trend	< 0.01	< 0.01	0.28	< 0.01	< 0.01	< 0.01	0.09	< 0.01

Model 1 adjusted for age, sex, education, income; sample size GPSS/MLE = 4,125; WSI = 2,734. Model 2 adjusted for age, sex, education, income, physical activity, body mass index, diabetes, and hypertension; sample size GPSS/MLE = 3,799; WSI = 2,531. [a] $P \leq 0.01$, [b] $P \leq 0.05$, [c] $P \leq 0.10$. GPSS, Global Perceived Stress Scale; MLE, Major Life Events; OR, odds ratio; WSI, Weekly Stress Inventory.

Table 4—Adjusted mean differences in sleep quality scores associated with psychosocial stress, the Jackson Heart Study, 2000–2004.

	Model 1	Model 2
GPSS		
Q1	REF	REF
Q2	−0.24 (−0.34, −0.15)[a]	−0.24 (−0.33, −0.14)[a]
Q3	−0.41 (−0.51, −0.31)[a]	−0.43 (−0.53, −0.32)[a]
Q4	−0.72 (−0.82, −0.62)[a]	−0.73 (−0.83, −0.63)[a]
P for trend	< 0.01	< 0.01
MLE		
Q1	REF	REF
Q2	−0.09 (−0.18, −0.00)[b]	−0.10 (−0.19, −0.01)[b]
Q3	−0.18 (−0.27, −0.09)[a]	−0.20 (−0.29, −0.10)[a]
Q4	−0.37 (−0.48, −0.27)[a]	−0.38 (−0.49, −0.27)[a]
P for trend	< 0.01	< 0.01
WSI		
Q1	REF	REF
Q2	−0.12 (−0.23, −0.00)[b]	−0.11 (−0.23, 0.01)[c]
Q3	−0.32 (−0.43, −0.20)[a]	−0.32 (−0.44, −0.19)[a]
Q4	−0.52 (−0.64, −0.40)[a]	−0.52 (−0.65, −0.40)[a]
P for trend	< 0.01	< 0.01

Values presented as mean difference (95% confidence interval). Model 1 adjusted for age, sex, education, income; sample size GPSS/MLE = 4,125; WSI = 2,734. Model 2 adjusted for age, sex, education, income, physical activity, body mass index, diabetes, and hypertension; sample size GPSS/MLE = 3,799; WSI = 2,531. [a] $P \leq 0.01$, [b] $P \leq 0.05$, [c] $P \leq 0.05$. CI, confidence interval; GPSS, Global Perceived Stress Scale; MLE, Major Life Events; WSI, Weekly Stress Inventory.

psychosocial stressors may contribute to adverse sleep outcomes among African Americans, with possible implications for a range of health outcomes linked to poor sleep.[52,53]

Our study extends the current literature by examining multiple psychosocial stressors as predictors of sleep outcomes within a large population of African Americans. Existing studies have measured stress within one time frame, included a narrow range of life domains or limited the assessment of stress to daily stressors.[18,54,55] We expanded the assessments of stress across various life domains. To our knowledge, only one other study examined associations of multiple psychosocial stressor domains with sleep duration. In this study, conducted in a population of 2,983 black, Hispanic, and white adults aged 18 y and older, acute life events, financial stress, community stress, employment stressors, childhood adversity, and relationship stress were all associated with short sleep duration.[56] Although we examined a smaller range of stressors, our findings are consistent with these results and confirm the relation between psychosocial stressors and sleep in a large population sample of African Americans. In addition, we documented associations of psychosocial stressors not only with sleep duration but also with sleep quality, a known factor for increased cardiovascular risk.[4]

Researchers have hypothesized that inadequate sleep among racial minorities may be due to an abundance of life stressors[7,21]; our results support this hypothesis. We found that both chronic and major life stressors were associated with the sleep outcomes, with similar effect sizes. There are several plausible mechanisms by which psychosocial stressors may contribute to poor sleep. The psychological experience of stress triggers

the stress response system.[57,58] Arousal of the stress response system activates both the sympathetic nervous system (triggers fight-or-flight response) and the hypothalamo-pituitary-adrenal (HPA) axis.[59] The result of this activation can delay sleep onset and lead to longer sleep, potentially contributing to poor sleep quality and disrupting sleep duration.[57,60,61] Furthermore, psychosocial stressors may affect sleep indirectly through unhealthy behaviors such as poor diet, lack of physical activity, increased sedentary behaviors, or other risk factors such as diabetes, hypertension, or depressive symptoms.[62,63] We adjusted for these risk factors but associations were not substantially changed, suggesting that these factors are not important mediators or confounders, at least in our sample.

Women in our study had higher mean psychosocial stressor scores compared to men, which was consistent with previous reports,[64] but we did not find that sex modified the associations between psychosocial stress measures and sleep duration or quality in our population.[18] A prior study on the associations of perceived stress with sleep duration and sleep quality among police officers found strong associations among men but not women.[18] It is possible that there is something unique regarding being a police officer that may result in differences by sex that we would not observe in a general population. Other studies examining the association between psychosocial stress (depression) and sleep found sex to be an effect modifier; specifically, depression was a significant predictor of sleepiness in men.[65] Similarly, Burgard and colleagues[55] found an association between being bothered/upset at work and poor sleep quality to be stronger in men than women. These prior studies used different measures of psychosocial stressors and were predominately non-Hispanic white cohorts. Our psychosocial stress measures were broad and included a wide array of experiences that were not sex specific. However, more specific measures of psychosocial stressors (as measured in these previous studies) may be more relevant to capturing the different experiences of men and women.

In general, we found no association between psychosocial stress and odds of long sleep duration. This lack of association is consistent with the research of Slopen and colleagues, who found that psychosocial stressors (not including discrimination) were not associated with odds of long sleep.[56] Positive associations between psychosocial stress as measured by the WSI and odds of long sleep were observed but did not reach significance; the associations between GPSS and MLE and long sleep, however, were in the opposite direction. It is possible that individuals with higher stress may have more work demands or responsibilities that do not allow for a long sleep duration.

Tests for effect modification according to age and education revealed statistically significant differences in the association between WSI and sleep duration. WSI was associated with shorter sleep duration in younger (60 y or younger) individuals but not in older individuals. This may be a measurement issue as the experiences measured in the WSI may be more relevant to younger than older populations. The education by WSI interaction revealed that those with a college education or higher were more vulnerable to the effects of the WSI on sleep duration compared to those of lower education. This is consistent with prior work that demonstrates African Americans of higher SES may be more vulnerable to the effects of stress on health.[21,22,66–68] Differential validity of the psychosocial measures by SES could also explain these findings.

Our study has several important limitations. We used self-reported sleep outcomes that may correlate poorly with objective measures of sleep.[69] Research has shown that sleep duration is often underreported, especially among African Americans, possibly leading to bias.[70] Measurement error in psychosocial stress measures is also a possibility. The fact that both measures are self-reported raises the possibility of same-source bias if there is some underlying trait that causes individuals to report both adverse sleep and high stress. Also, anxiety and psychotropic medications may confound the associations of interest, but were not available for this analysis. The cross-sectional design of our study limits the ability to infer causation. We cannot determine whether experiences of psychosocial stress occurred prior to the sleep problems or the reverse. As with many epidemiologic studies, residual confounding is a limitation if there were unmeasured or poorly measured covariates that were not accounted for in the analyses. Last, our study consisted of African Americans in Jackson MS; therefore, our results may not generalize to other populations or regions, with different risk profiles than those in our study. An important strength of the study is the availability of a rich set of stress measures and multiple measures of sleep.

In conclusion, we found that higher stress was associated with poor sleep duration and sleep quality. Psychosocial stressors may be a point of intervention among African Americans for the improvement of sleep and downstream health outcomes.

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