

## Socioeconomic Adversity and Women's Sleep: Stress and Chaos as Mediators

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We examined income-to-needs ratio, perceived economic well-being, and education and their relations with European and African American women's sleep ( $n = 219$ ). Sleep was examined through actigraphy and self-reports. Income-to-needs ratio was related to sleep minutes. Perceived economic well-being and education were associated with subjective sleep problems. Perceived stress mediated relations between both income-to-needs ratio and economic well-being and subjective sleep problems. Chaos emerged as a mediator linking income-to-needs ratio and subjective sleep problems. African American women had fewer sleep minutes and lower sleep efficiency than European Americans, and more robust relations between economic well-being and stress was observed for European Americans. Findings highlight the importance of economic adversity for women's sleep and explicate some pathways of risk.

In addition to a good diet and exercise, getting adequate, high-quality sleep is an essential health-promoting behavior. Sleep plays critical roles in emotion processing and regulation (Yoo, Gujar, Hu, Jolesz, & Walker, 2007), mental health (Buysse, Angst et al., 2008), cognitive functioning (Lim & Dinges, 2010), and physical health (Buxton & Marcelli, 2010; Leproult & Van Cauter, 2010). Epidemiological evidence in the United States has shown significant differences in sleep duration and quality based on socioeconomic status (SES; Krueger & Friedman, 2009). Given the importance of sleep for overall well-being and the existence of sleep disparities along socioeconomic levels, identification of pathways of risk connecting SES and sleep problems is warranted.

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Socioeconomic status is a multidimensional construct (Chen & Paterson, 2006; Hout, 2008) and various objective and subjective measures of monetary resources, education, and economic hardship have been used to index SES. However, not all SES indicators are interchangeable and assessment of multiple parameters is recommended (Braveman et al., 2005). Income-to-needs ratio is a standard measure of a family's economic situation (U.S. Census Bureau, 2013) that accounts for the number of individuals supported by the family income. Examining SES through income or income-to-needs ratio is a very common approach to assessing SES, reflects the accessibility of material resources, and is associated frequently with health outcomes (Adler & Ostrove, 1999). In relation to sleep, having monetary resources could translate into larger, less dense, and higher-quality housing (e.g., away from trains or other noise, better windows to block noise, allergen control) as well as better-quality health care (e.g., treatment for asthma), which would yield better sleep.

Another conceptualization of SES reflects one's standing in society, which includes the highest level of achieved education (Krieger, Williams, & Moss, 1997). Education is an index of human capital (McLoyd & Ceballo, 1998) and incorporates noneconomic social resources such as health literacy and possibly knowledge about the importance of sleep. In addition to the objective SES indicators of income and education, an individual's sense of economic well-being/hardship is an important subjective indicator of SES (Braveman et al., 2005), which could also influence sleep. Perceived economic hardship reflects the individual's appraisal of the family's financial situation and is likely to increase family stress (Conger, Conger, & Martin, 2010). Greater perceptions of economic hardship, including the inability to make ends meet and the need to make financial cutbacks, are associated with worse physical and mental health (Wickrama, Hwa Kwag, Lorenz, Conger, & Surjadi, 2010). Toward reducing health disparities, explication of SES parameters associated with health is essential for effective prevention and intervention (Chen & Paterson, 2006).

Several large-scale studies have documented associations between low SES and poorer sleep using a variety of indicators of SES and sleep, most commonly income and education for SES and self-reported duration for sleep. For example, in large-scale population studies, both income and education have been associated with self-reported sleep duration (Krueger & Friedman, 2009; Stamatakis, Kaplan, & Roberts, 2007). Similarly, income and education have been related to poor sleep quality (Grandner et al., 2010) and daytime sleepiness (Baker, Wolfson, & Lee, 2009).

However, investigations specific to the links between subjective assessments of economic well-being and sleep are limited in the literature. Hall, Bromberger, and Matthews (1999) found that difficulty making ends meet mediated the relations between lower income and self-reported poor sleep quality. Scholars have posited that perceived economic well-being is a different indicator of economic difficulties compared to objective measures because it directly taps into pressures experienced by families regardless of their income (Chen & Paterson, 2006). Thus, consideration of the effects of perceptions of economic well-being on sleep may be informative.

## ETHNICITY AS A MODERATOR

Ethnic differences in sleep have been shown across many studies. A recent meta-analysis found consistent evidence of shorter and worse-quality sleep in African Americans in comparison

to European Americans across 14 studies, representing more than 4,000 participants (Ruiter, DeCoster, Jacobs, & Lichstein, 2011). However, less is known about how SES may differentially predict sleep depending on an individual's ethnicity. For example, indicators of SES may not have the same functional meaning across groups (Williams, Mohammed, Leavell, & Collins, 2010). Further, by way of possessing two risk factors (in the context of contemporary American society), low SES African Americans may be at greater risk for insufficient and low-quality sleep. Examining the role of SES in relation to ethnicity is warranted (Braveman & Barclay, 2009) and allows for assessment of aggregation of risk affecting sleep.

In one of the few studies that have explicitly examined the possibility that SES and ethnicity may have an interactive influence on sleep, Mezick and colleagues (2008) found evidence that, compared to European Americans, African Americans had shorter and worse-quality sleep assessed objectively via actigraphy and polysomnography. In the same vein, SES, measured with a composite of education and income, was also associated with lower objective sleep quality; however, no interaction between ethnicity and SES was observed. Likewise, Hall and colleagues (2009) did not find a significant interaction between markers of SES (education and financial strain) and ethnicity, but noted their sample was restricted in that there were few women included from low SES backgrounds. Conversely, Goodin, McGuire, and Smith (2010) reported that ethnicity moderated relations between perceived social status and subjective sleep quality. For African Americans but not for European Americans, lower perceived social status was associated with worse sleep quality. Thus, African Americans from lower SES backgrounds may be under greater burden of stress by being poor and belonging to a minority group. Inconsistent findings regarding moderating effects of ethnicity may be a result of differences in the samples but also may be a result of the methodologies used to assess the multidimensional constructs of SES and sleep.

## INTERVENING PROCESSES

In the context of the literature linking SES and sleep, there are fewer studies that have examined processes and pathways of risk. Investigations that seek to answer the question of how or why low SES is associated with poorer sleep may be instrumental to inform interventions because mediators of effects may be more open to change than an individual's SES. Perceived stress is a key process that underlies relations between SES and health (Matthews & Gallo, 2011). Given the higher likelihood of experiencing stressful life events among low SES individuals (Hatch & Dohrenwend, 2007), and having fewer resources with which to deal with those stressors (Matthews, Raikkonen, Gallo, & Kuller, 2008), it is not surprising that living under conditions of economic adversity is related to perceived stress (Gallo, Bogart, Vranceanu, & Matthews, 2005). The association between chronic stress and disturbed sleep is well established (De Lange et al., 2009; Kim & Dimsdale, 2007). However, to our knowledge, the role of perceived stress as a mediator of relations between SES and sleep has not been documented; nevertheless, stress has been found to mediate relations between other predictors (e.g., loneliness; McHugh & Lawlor, 2013) and sleep. In a related study, Mezick and colleagues (2008) did not find evidence that reports of stressful life events mediated relations between SES and sleep. However, *perceptions* of stress were examined in the present study and encompass reports of individuals appraising their lives as uncontrollable and overwhelming and thus

indirectly take into account an individual's ability to cope with stressors (Cohen, Kamarck, & Mermelstein, 1983).

Chaos within the home environment, including disorganization, noise, and irregularity in routines, has been considered an important family-level factor that negatively affects the development of children, particularly those from low SES homes (Evans, Gonnella, Marcynyszyn, Gentile, & Salpekar, 2005). Chaotic home environments are related to children's sleep problems (Brown & Low, 2008; Gregory, Eley, O'Connor, Rijdsdijk, & Plomin, 2005), although not much is known about the extent to which home chaos affects adult sleep. Given that greater home chaos has been negatively related to family income and education (Dumas, LaFreniere, & Serketich, 1995), and that chaos has been shown to have negative effects on the sleep of children, it stands to reason that home chaos may serve as a mediator of effects in relations between SES and sleep for adults.

The current study examined relations between multiple indicators of SES and sleep and the role of perceived stress and chaos as mediators of effects. Ethnicity was assessed as a moderator of effects. Consistent with practice and recommendations to assess sleep through multimodal methods (Mezick et al., 2008; Sadeh, 2011a), sleep parameters were examined through actigraphy and self-reports. Our sample of middle-aged women allows us to focus on the sociodemographic constructs of SES and ethnicity, while minimizing the influences of gender and age on sleep. Further, studying the research questions with rural and semirural African American and European American middle-aged women across a wide range of SES is underrepresented in the literature. Perceived stress and chaos were expected to mediate the associations between lower SES and women's shorter sleep duration and worse objectively and subjectively assessed sleep quality. There were no hypotheses regarding whether the mediation effects would vary based on ethnicity. Similarly, no specific propositions were advanced regarding differential effects associated with either the various SES indices or sleep parameters.

## METHODS

### Participants

Participants were enlisted in a larger study assessing biopsychosocial influences on children's health, and data were collected in 2010 and 2011 in rural and semirural towns in the Southeastern United States (Auburn University Sleep Study—Wave 2; no actigraphic data for women's sleep were available at T1). Based on inclusion criteria of the larger study, all women ( $n = 219$ ) had at least one school-aged child. Based on self-report, women who had a diagnosed sleep disorder ( $n = 5$ ) or were shift workers ( $n = 3$ ) were excluded. The final analytic sample was composed of 211 women ( $M$  age = 37.08 years,  $SD = 6.84$ ). Most women reported cohabitating with a romantic partner or spouse (91.6%). Representative of the community, 74.4% of women were European American (EA) and 25.6% were African American (AA).

### Procedures and Measures

For the larger study, families were recruited from letters sent home from schools with children (for more detail about recruitment, which occurred at T1, see El-Sheikh et al., 2013). The study

was approved by the university's institutional review board, and women gave their consent and received monetary compensation for their participation. Actigraphs were delivered to the family home, and women were instructed to place the actigraph on their nondominant wrist just prior to bedtime and to remove it upon waking for seven consecutive nights. Questionnaires were completed using an online format in the lab in the days following completion of actigraphy.

*Income-to-needs ratio.* The family income-to-needs ratio (INR), a standard measure of a family's economic situation (U.S. Census Bureau, 2013), accounts for the number of individuals supported by the family income. Women reported annual familial income according to the following categories: (a) \$10,000 to \$20,000; (b) \$20,000 to \$35,000; (c) \$35,000 to \$50,000; (d) \$50,000 to \$75,000; or (e) more than \$75,000. Means of the familial income range and household size were used in deriving this variable, which was computed by dividing family income by the federal poverty threshold for that family size (e.g., in 2010, a family of four with an annual income  $\leq$  \$22,025 was considered to be living in poverty). Families who had an INR of  $\leq 1.0$  were considered to be living in poverty (28.6% of the sample); those with an INR of  $> 1$  but  $\leq 2$  were considered to be living near the poverty line (33.3%); those with INR  $> 2$  but  $< 3$  were considered to be of lower middle class (30.5%); and those with a score = 3 were considered to be of middle-class standing (7.7%).

*Perceived economic well-being.* Women provided information about their family's economic hardship using three well-established scales (Conger et al., 1992): "can't make ends meet," "material needs," and "financial cutbacks." For "can't make ends meet," women rated how much they agreed with three statements assessing the amount of difficulty the family had in paying their bills each month over the last year. Two of the three questions are on a 5-point Likert-type scale; the third is on a 4-point scale. Standardized scores were generated and higher scores represent *less* economic pressure;  $\alpha = .85$ . "Material needs" comprises seven questions assessing how women felt about their family's economic situation. Using a 5-point scale, women rated how much they agreed with each statement; higher scores represent better economic well-being ( $\alpha = .90$ ). "Financial cutbacks" comprises 22 statements describing adjustments the family had to make over the last year due to financial need (e.g., using savings to meet living expenses). Higher scores indicate a better economic situation;  $\alpha = .86$ .

*Education.* Women indicated their education level using the following categories: (a)  $< 7$ th grade (1% of the sample); (b) completion of 8th grade (2%); (c) 9th to 11th grade (3%); (d) high school graduate (27%); (e) partial college or specialized training (44%); (f) bachelor's degree (16%); or (g) graduate degree (7%). Education was examined as a continuous variable (1 through 7).

*Sleep.* Actigraphy was used to record sleep between bedtime and wake time; measures were cross-validated using daily sleep logs. Actigraphy is considered a reliable tool for objectively measuring sleep in a naturalistic setting (Rupp & Balkin, 2011). The actigraphs were Octagonal Basic Motionloggers (Ambulatory Monitoring Inc., Ardsley, NY) that measured motion in 1-min epochs using zero crossing mode. The analysis software package (AW2,

2002 Ambulatory Monitoring, Inc., Ardsley, NY) utilized the established Cole-Kripke scoring algorithm (Cole & Kripke, 1989; Cole, Kripke, Gruen, Mullaney, & Gillin, 1992) to derive sleep variables.

Using data from all available nights, two well-established actigraphy-based sleep parameters were derived. To assess sleep duration, we examined Sleep Minutes, the number of minutes scored as sleep between sleep onset and wake time. To examine sleep quality, we derived Sleep Efficiency, the percent of time spent asleep compared with the total time spent in bed. Women had an average of 5.86 nights ( $SD = 1.27$ ) of valid actigraphy data. Reasons for missing data included forgetting to wear the actigraph, mechanical problems and occasional medicine use (e.g., for a headache), and exclusion of these nights from analyses. Intraclass correlations indicated good night-to-night stability over the week of assessment: Sleep Minutes ( $\alpha = .82$ ) and Sleep Efficiency ( $\alpha = .92$ ).

Women reported sleep problems experienced within the past month via the 19-item Pittsburgh Sleep Quality Index (PSQI; Buysse, Reynolds, Monk, Berman, & Kupfer, 1989), which has established psychometric properties for the assessment of sleep problems within the normative range (Buysse et al., 1989). The overall global sleep composite (range 0 to 21) was calculated based on various indicators of sleep including quality, latency, duration, and habitual sleep efficiency; a higher score reflects poorer sleep quality. A global scale score  $> 5$  suggests significant sleep problems (Buysse et al., 1989); 54% of women reported a score  $> 5$ .

**Stress.** Women completed the Perceived Stress Scale (PSS; Cohen et al., 1983), which has established psychometric properties (Cohen & Williamson, 1988). The PSS consists of 10 questions, and assesses how often in the past month women felt or thought a certain way using a 5-point rating scale (e.g., “could not cope with all the things that you had to do”; “difficulties were piling up so high that you could not overcome them”; “you were unable to control the important things in your life”);  $\alpha = .86$ .

**Chaos.** Women completed the Confusion, Hubbub, and Order Scale (CHAOS; Matheny, Wachs, Ludwig, & Phillips, 1995). The measure consists of 15 true/false items that assess the disorder and instability of the household (e.g., “It’s a real zoo in our home”; “There is often a fuss going on at our home”; “You can’t hear yourself think in our home”). High internal consistency was observed in this study;  $\alpha = .80$ .

### Plan of Analysis

Established procedures for conducted structural equation models (SEM) were followed (Bollen & Long, 1992). First, SEMs were fit to examine the direct effects of three SES indices on the three sleep outcomes. The SES variables were: (a) the observed variable of family income-to-needs ratio; (b) the observed variable of education, and (c) a latent variable composed of the three Conger and colleagues scales (Conger et al., 1992; Conger & Conger, 2002) of “can’t make ends meet,” “material needs,” and “financial cutbacks,” which we term *perceived economic well-being*. The three Conger scales are typically aggregated to derive the latent construct of economic well-being and thus we followed this established procedure. The latent

construct of perceived economic well-being was fit in Mplus and showed excellent measurement properties; the three observed measures loaded well on the latent variable ( $r_s = .75$  to  $.86$ ) and higher levels indicate a better economic situation. Because the various indices of socioeconomic adversity (i.e., income-to-needs, education, and perceived economic well-being) reflect somewhat different constructs, and for a better explication of study questions, we examined the three SES parameters independently.

The following were the actigraphy-derived sleep measures: sleep minutes and sleep efficiency. The third sleep variable reflected women's subjective sleep problems and was based on the PSQI. The three sleep measures were examined independently, allowing for finer analyses involving sleep. Further, the use of manifest variables facilitates the comparison of study findings to those based on the extant literature and future research from other data sets. In all SEM models, to reduce the effects of potential confounds, age, regular medication use, cohabitation, and season of sleep assessment were controlled. Many women used medication on regular bases (31%). This was deciphered through one question that asked women, "What medications if any do you take regularly?" We defined this variable as any medication taken daily on three or more nights during the week of actigraphy. Inspection of the data indicated that many women ( $n = 52$ ) took medicine for hypertension; 33 for depression/anxiety; 19 for diabetes; 16 for thyroid problems; 10 for high cholesterol; 6 for various sleep problems including insomnia. Small percentages of women were on other medications and many women took more than one medicine. To reduce outlier effects, data points in each variable that exceeded 4 SDs were set to be missing.

The direct relations between each of the three socioeconomic indicators and each of the three sleep variables were examined separately. Next, ethnicity was examined as a moderator of these direct effects by fitting multiple group models across the two ethnic groups (European American or EA and African American or AA). Subsequently,  $\Delta\chi^2$  invariance tests determined whether moderation by ethnicity existed for each direct parameter estimate (Muthen & Muthen, 2007). The residual variances of the sleep variables were also tested for invariance across ethnicity; that is, testing determined whether the effect size,  $R^2$ , for women in one ethnic group is greater than the other.

If a direct effect did exist between a socioeconomic indicator and a sleep variable, we examined if that effect was mediated by stress or chaos. In a mediation model, the independent variable (SES) shares a significant relation with the process variable (stress, chaos), which in turn is significantly associated with the outcome (sleep parameter) (MacKinnon, Lockwood, Hoffman, West, & Sheets, 2002), while the original significant direct effect of the independent variable on the outcome is reduced either in magnitude or to nonsignificance. Moderation by ethnicity was tested for these mediating effects models by fitting multiple group models across EA and AA groups. As indicated above, if the  $\Delta\chi^2$  invariance tests indicated invariance for any set of parameters, they were held invariant as the other parameters were tested. Analyses were conducted with Mplus (Version 6; Muthen & Muthen, 2007). Missing data were not imputed; available data from all 181 participants were used in analyses by using full information maximum likelihood (FIML) estimation with robust standard errors, which has many advantages for handling missing data (Acock, 2005). Supportive of using FIML, the proportion of data present to estimate each relation ranged from 70% to 100%. Model fit was assessed by a  $\chi^2/df < 5$  and a RMSEA  $< .10$  (Wheaton, Muthen, Alwin, & Summers, 1977).

## RESULTS

## Preliminary Analyses

Descriptive statistics and correlations among study variables are presented in Table 1. Ethnicity and some control variables were related to primary model variables (not depicted in table). African American ethnicity was associated with lower income-to-needs ratio ( $r = -.30, p < .01$ ), less home chaos ( $r = -.16, p < .05$ ), fewer sleep minutes ( $r = -.29, p < .01$ ), and lower sleep efficiency ( $r = -.17, p < .05$ ).

Age was negatively associated with income-to-needs ( $r = .24, p < .01$ ). Regular medication use was related to more sleep minutes ( $r = .21, p < .05$ ), lower subjective sleep quality ( $r = .19, p < .05$ ) and greater stress ( $r = .27, p < .01$ ). Cohabitation was associated with fewer financial problems indicated by material needs and making ends meet ( $r = .28-.30, p < .05$ ). Age, regular medication use, cohabitation, and season of sleep assessment (fall/spring) were controlled in subsequent analyses.

## Socioeconomic Indices as Predictors of Sleep

Below, we report SES indices as predictors of sleep. Income-to-needs ratio (Model fit:  $\chi^2/df = 0.0$ ; RMSEA = .00) is associated with sleep minutes (SM) ( $\beta_{\text{INR} \rightarrow \text{SM}} = .22, r = .19, p < .05, R^2 = 15.5\%$ ), and approaches conventional levels of significance for subjective sleep problems (PSQI) (Model fit:  $\chi^2/df = 0.0$ ; RMSEA = .00;  $\beta_{\text{INR} \rightarrow \text{PSQI}} = -.54, r = -.14, p < .10, R^2 = 11.1$ ); the link is not significant for sleep efficiency.

Perceived economic well-being (EWB; Model fit:  $\chi^2/df = 0.0$ ; RMSEA = .00) predicts subjective sleep problems ( $\beta_{\text{EWB} \rightarrow \text{PSQI}} = -.17, r = -.22, p < .01, R^2 = 14.2\%$ ) in expected directions; no such associations are observed for sleep minutes or efficiency.

Education (WE) (Model fit:  $\chi^2/df = 0.0$ ; RMSEA = .00) predicts subjective sleep problems ( $\beta_{\text{WE} \rightarrow \text{PSQI}} = -.74, r = -.24, p < .001, R^2 = 14.1\%$ ); no such effects are observed for sleep minutes or efficiency. Ethnicity does not moderate any of the aforementioned associations between SES and sleep parameters.

## Stress and Chaos as Mediating Variables Between Socioeconomic Indices and Sleep Stress

Central to this investigation, stress (STR) functioned as a mediating variable between income-to-needs ratio and subjective sleep problems (Model fit:  $\chi^2/df = 3.9$ ; RMSEA = .10); findings supportive of mediation are graphically depicted in Figure 1. The direct path from income-to-needs ratio to sleep problems that approached statistical significance prior to the introduction of stress in the model is not significant ( $\beta_{\text{INR} \rightarrow \text{PSQI}} = -.028, r = -.07$ ). Income-to-needs predicts stress ( $\beta_{\text{INR} \rightarrow \text{STR}} = -1.24, r = -.18, p < .05, R^2_{\text{STR}} = 3.1\%$ ), which then predicts sleep problems ( $\beta_{\text{STR} \rightarrow \text{PSQI}} = .19, r = .35, p < .001$ ). Of note is that 19.1% of the variance in sleep problems was predicted by the model.

Stress was also a mediator linking perceived economic well-being (EWB) with subjective sleep problems and a moderation effect for ethnicity exists for the size of the effect of economic well-being on stress ( $R^2$ ) (Model fit:  $\chi^2/df = 1.3$ ; RMSEA = .03) ( $\beta_{\text{EWB} \rightarrow \text{STR}} = -.78, r = -.60, p < .001, \text{EA } R^2_{\text{STR}} = 35.6\%, \text{AA } R^2_{\text{STR}} = 22.1\%; \beta_{\text{STR} \rightarrow \text{PSQI}} = .18, r = .31, p < .001$ );



TABLE 1  
Correlations and Descriptive Statistics Among Study Variables

Variable	1	2	3	4	5	6	7	8	9	10
1. Income-to-poverty ratio	—									
2. Material needs	.45***	—								
3. Ends meet	.29***	.65***	—							
4. Financial cuts	.24**	.59***	.68***	—						
5. Education	.52***	.31***	.10	.09	—					
6. Stress	-.15~	-.46***	-.45***	-.44***	.07	—				
7. Chaos	-.17*	-.36***	-.43***	-.37***	-.07	.42***	—			
8. Sleep minutes	.25**	.13	.03	-.01	.08	.07	-.11	—		
9. Sleep efficiency	.25**	.16~	.09	.02	.13	-.03	.09	.45***	—	
10. Subjective sleep problems	-.13	-.23**	-.20**	-.25**	-.23**	.41***	.16*	-.16~	-.07	—
<i>M</i>	1.89	17.59	10.56	37.66	4.86	15.82	17.83	395.35	93.59	6.71
<i>SD</i>	.92	6.11	2.56	4.56	1.12	6.51	2.98	63.25	8.82	3.54

~ $p < .10$ ; \* $p < .05$ ; \*\* $p < .01$ ; \*\*\* $p < .001$ .

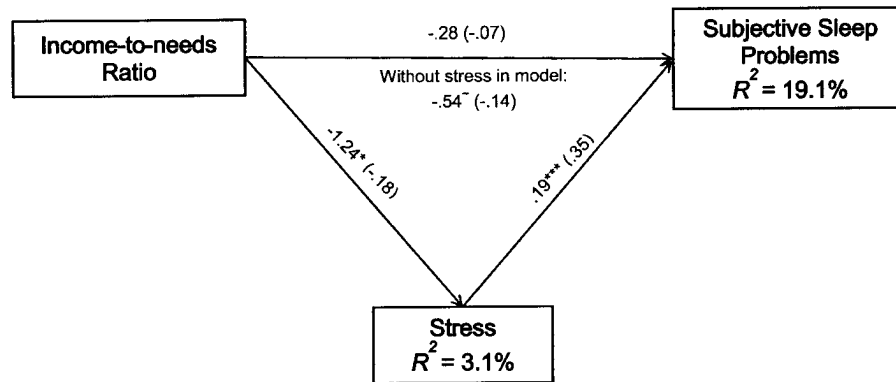


FIGURE 1 Perceived stress as a mediator of the relation between income-to-needs ratio and subjective sleep problems. Unstandardized and standardized (in parentheses) coefficients are provided. Note.  $\sim p < .10$ ;  $*p < .05$ .

mediation effects are depicted in Figure 2. The direct effect of EWB on self-reported sleep problems, controlling for the mediation effects of stress, is nonsignificant ( $\beta_{\text{EWB} \rightarrow \text{PSQI}} = -.04$ ,  $r = -.05$ ,  $p > .05$ ). The mediation of EWB through stress explains 21% of the variance of self-reported sleep problems for both EA and AA women. Stress did not function as a mediator of relations between the SES variables and the actigraphy-derived sleep parameters.

**Chaos.** Chaos (CHS) functioned as a mediating variable between income-to-needs ratio and subjective sleep problems (Model fit:  $\chi^2/df = 3.9$ ; RMSEA = .09) ( $\beta_{\text{INR} \rightarrow \text{CHS}} = -.55$ ,  $r = -.17$ ,  $p < .05$ ,  $R^2_{\text{CHS}} = 2.8\%$ ;  $\beta_{\text{CHS} \rightarrow \text{PSQI}} = .17$ ,  $r = .14$ ,  $p < .05$ ,  $R^2_{\text{SE}} = 13.3\%$ ); see Figure 3. The direct effect of income-to-needs ratio on self-reported sleep problems, controlling for the mediation effects of chaos, is nonsignificant ( $\beta_{\text{INR} \rightarrow \text{PSQI}} = -.41$ ,  $r = -.11$ ,  $p > .05$ ). No moderation of these effects was found across ethnicity. Chaos did not function as a mediator of relations between the SES variables and the actigraphy-derived sleep parameters.

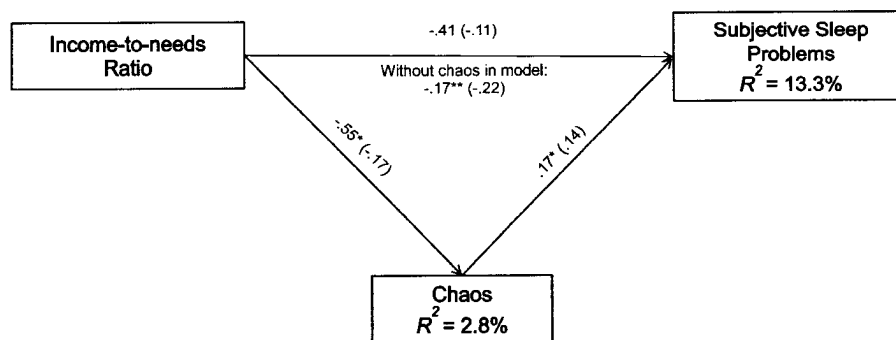


FIGURE 2 Chaos as a mediator of the relation between income-to-needs ratio and subjective sleep problems. Unstandardized and standardized (in parentheses) coefficients are provided. Note.  $*p < .05$ ;  $**p < .01$ .

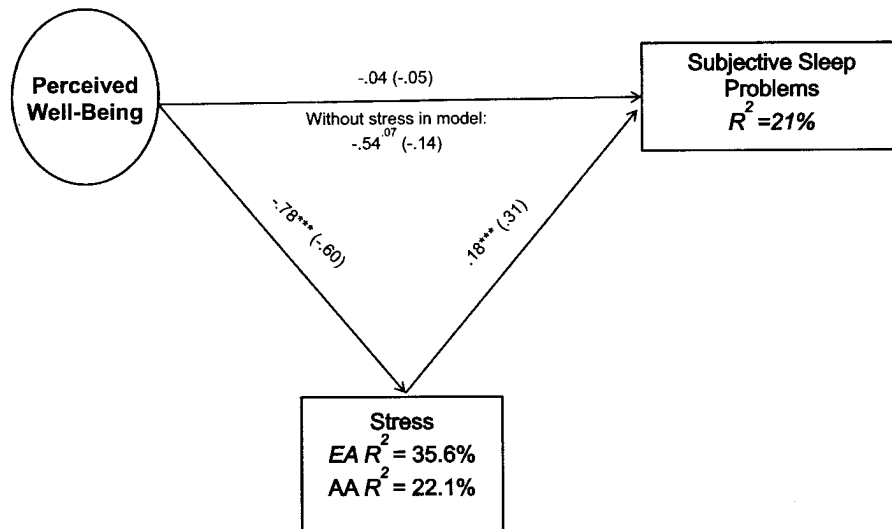


FIGURE 3 Perceived stress as a mediator of the relation between income-to-needs ratio and subjective sleep problems. Unstandardized and standardized (in parentheses) coefficients are provided. EA = European American, AA = African American. Ethnicity was a moderator of effects and more variance in stress was explained for European than African American women. Note. \* $p < .05$ ; \*\* $p < .01$ . \*\*\* $p < .001$ .

### Alternative Models

Because it is plausible that sleep may function as a mediator of relations between SES and either stress or chaos, we conducted post hoc analyses and tested if any of the sleep parameters mediate relations among the three SES indicators and stress and chaos. In three models, significant effects emerged and are detailed next. Perceived economic well-being originally predicts stress ( $\beta_{\text{EWB} \rightarrow \text{STR}} = -.74$ ,  $r = -.53$ ,  $p < .001$ ,  $R^2 = 37.2\%$ ) and when “subjective sleep problems” is entered as an intervening indicator, the path from well-being to stress is slightly reduced ( $\beta_{\text{EWB} \rightarrow \text{STR}} = -.66$ ,  $r = -.48$ ,  $p < .001$ ,  $R^2 = 41.4\%$ ). In this model, paths from well-being to subjective sleep ( $\beta_{\text{EWB} \rightarrow \text{PSQI}} = -.21$ ,  $r = -.28$ ,  $p < .001$ ) and from subjective sleep to stress ( $\beta_{\text{PSQI} \rightarrow \text{STR}} = .44$ ,  $r = .24$ ,  $p < .001$ ) are significant. Thus, subjective sleep problems functioned as a partial mediator of effects in this model linking economic well-being and perceived stress.

Income-to-needs ratio originally predicts stress ( $\beta_{\text{EWB} \rightarrow \text{STR}} = -1.52$ ,  $r = -.22$ ,  $p < .01$ ,  $R^2 = 13.7\%$ ) and when subjective sleep is entered as an intervening variable, the path from income-to-needs ratio to stress is reduced ( $\beta_{\text{INR} \rightarrow \text{STR}} = -1.19$ ,  $r = -.17$ ,  $p < .05$ ,  $R^2 = 21.2\%$ ). The paths from income-to-needs ratio to subjective sleep ( $\beta_{\text{INR} \rightarrow \text{PSQI}} = -.58$ ,  $r = -.15$ ,  $p < .05$ ) and from subjective sleep to stress ( $\beta_{\text{PSQI} \rightarrow \text{STR}} = .61$ ,  $r = .34$ ,  $p < .001$ ) are significant. Thus, subjective sleep problems functioned as a partial mediator linking income-to-needs ratio and perceived stress.

Lastly, education does not predict either stress or chaos, but when subjective sleep problems are entered as an intervening variable in each of these models, the paths from education to subjective sleep problems in both cases are always significant ( $\beta_{\text{ED} \rightarrow \text{PSQI}} = -.74$ ,  $r = -.23$ ,  $p < .01$ ) and subjective sleep problems significantly predict stress ( $\beta_{\text{PSQI} \rightarrow \text{STR}} = .66$ ,

$r = .37, p < .001; R^2 = 18.8\%$ ) or alternatively chaos ( $\beta_{\text{PSQI} \rightarrow \text{CHS}} = .15, r = .17, p < .05; R^2 = 7.9\%$ ). Thus, subjective sleep problems functioned as intervening variables in the associations between education and both perceived stress and chaos. In a mediation model but not an intervening variable model, the relation between the independent and dependent variable is significant prior to the inclusion of the process variable.

## DISCUSSION

The current study builds on prior knowledge regarding socioeconomic differences in women's sleep by examining the influence of multiple indicators of economic adversity on objectively and subjectively assessed sleep parameters and explicating pathways that link SES and sleep within the context of ethnicity. SES was associated with actigraphy-based and subjective sleep parameters. Novel findings suggest that several of the associations between SES and women's sleep are mediated by perceived stress and family chaos.

Consistent with prior research (Krueger & Friedman, 2009; Lauderdale, Knutson, Yan, Rathouz, Hulley, Sidney, Liu, 2006; Stamatakis et al., 2007), lower SES was directly associated with worse sleep. However, not all indicators of SES were equally predictive of different aspects of women's sleep. Income-to-needs ratio was the SES variable most robustly associated with multiple sleep parameters. In path models that included covariates, lower income-to-needs ratio was related to shorter sleep duration and more subjective sleep problems; in bivariate analyses, income-to-needs ratio was associated with actigraphy-based sleep minutes and efficiency. Greater monetary resources may allow for an improved sleeping environment (e.g., less violent neighborhoods, better housing conditions, lower density, temperature and noise control, higher-quality bedding) and access to high-quality health care (e.g., treatment for asthma and allergies) leading to longer and better-quality sleep. For example, environmental conditions including toxic waste, crowding, and poor working conditions, especially multiple risk factors, could explain links between SES and health outcomes (see Evans & Kantrowitz, 2002). Further, neighborhood adversity is associated with sleep (Hale et al., 2013) and home type and exposure to irritants was found to mediate relations between SES and physical health outcomes pertinent to sleep, including rhinitis and asthma (Trupin et al., 2013). Whether improvements in some aspects of the sleeping environment alone could reduce socioeconomic disparities in sleep is a question for future inquiries.

There were fewer relations between the other indices of SES and sleep. Consistent with investigations that reported relations between either education (Grandner et al., 2010; Krueger & Friedman, 2009) or perceived economic well-being (Hall et al., 1999) and sleep, these SES variables were associated with self-reported sleep problems but not actigraphy-based sleep parameters. The vast majority of women in the sample (77%) did not have a college education, which may have affected the benefit that education may have on actigraphy-derived sleep. Subjective measures of SES and perceived financial constraints are associated with numerous negative health outcomes (Adler, Epel, Castellazzo, & Ickovics, 2000; Chen & Paterson, 2006) and psychological distress (Quon & McGrath, 2014); the latter is also related to sleep problems including insomnia (Buysse et al., 2008). Further, different findings based on subjective sleep measures derived through the PSQI and objective measures have been reported (Buysse et al., 1989). Subjective sleep assessments in this study included parameters not indexed by the

objective measures, including perceived insomnia and sleepiness over a one-month period, and as such may not tap daily fluctuations in sleep (Buysse et al., 1989).

Central to this investigation, findings indicate that perceived stress functioned as a mediator of associations between both income-to-needs ratio and perceived economic well-being and subjective sleep problems. Supportive of the mediation effects, 19% and 21% of the variance of self-reported sleep problems is predicted by the models involving income-to-needs ratio and perceived economic well-being, respectively. Lower SES individuals are more likely to experience stressful life events (Hatch & Dohrenwend, 2007) and have fewer resources to handle such events (Matthews et al., 2008). Thus, consistent with the findings and other literature (Gallo et al., 2005), it follows that economic adversity would be associated with higher levels of perceived stress. Furthermore, given the established link between stress experiences and sleep disruptions (Charuvastra & Cloitre, 2009; Kim & Dimsdale, 2007; Van Reeth et al., 2000), it is not surprising that perceived stress functioned as a mediator linking lower SES and sleep problems. Establishing stress as a mediator of effects in this context is novel and builds on the extant literature. It is not clear why mediation effects were observed here, whereas in Mezick and colleagues' (2008) study, no such evidence was observed. It is plausible that design and sample characteristics contributed in part to these discrepant effects. For example, although *perceived stress* was examined in this study, "experiences of stressful life events" was assessed in Mezick et al.'s study.

Because it is plausible that sleep problems may function as intervening variables in associations between SES and perceived stress or chaos, we conducted post hoc analyses to test these alternative models. Subjective sleep problems functioned as a partial mediator of relations between both perceived economic well-being and income-to-needs ratio and perceived stress. Further, subjective sleep problems functioned as intervening variables in the associations between education and both perceived stress and chaos. These findings build on the literature and suggest that relations between economic adversity and either perceived stress or family chaos could be due at least in part to disruptions in women's sleep.

The current study provides new data showing that home chaos serves as a mediating process linking lower SES with subjective sleep problems for adults, and 13% of the variance of self-reported sleep problems is predicted by the model involving income-to-needs ratio. Similar to the mediating pathway through stress, lower perceptions of economic well-being predicted greater chaos within the home. Chaotic homes may be noisier at bedtime, more likely to experience midnight disruptions, or generally less conducive to establishing sleep routines. The finding that chaos was associated with sleep problems is consistent with the few studies conducted with children (Brown & Low, 2008; Gregory et al., 2005) and extends the findings to adults. Future observational and diary studies may help in understanding how chaotic home environments disrupt sleep and in providing a context for understanding the observed effects.

Most of the direct effects, and all of the mediation effects, between the SES indices and sleep were observed for subjective and not actigraphy-based sleep problems. Subjective and objective assessments tap different constructs and complement one another (Sadeh, 2011b). For example, actigraphy-based sleep duration and efficiency were examined, whereas subjective sleep was assessed with the PSQI, which examines subjective sleep duration and efficiency as well as other sleep parameters including latency, daytime sleepiness, and sleep disturbance. Although the PSQI is a well-validated measure of poor sleep quality, findings based on the PSQI and objective measures of sleep derived through actigraphy and polysomnography are not always

consistent (Buysse et al., 2008). Further, in some studies, the PSQI has been found to relate more robustly with psychosocial variables than actigraphy-based measures (Beaudreau et al., 2012; Buysse et al., 2008; Dorheim, Bondevik, Eberhard-Gran, & Bjorvatn, 2009). Further, subjective sleep problems take into account individual differences in sleep need that actigraphy does not address. For example, some women may need less sleep than others to function optimally, and this would be reflected in subjective satisfaction with one's sleep versus objective sleep measures. Relatedly, daytime sleepiness is a fundamental sleep-wake parameter that may reflect, at least in part, insufficient nighttime sleep and/or poor sleep quality. Again, this sleep parameter is encompassed within the current assessment of subjective but not objective sleep. It is also possible that more pronounced effects were observed for subjective sleep quality because of shared method variance with SES, perceived stress, and chaos. Differential effects highlight the importance of multimethod assessments of sleep.

Consistent with many studies (Ruiter et al., 2011), African American ethnicity was associated with fewer sleep minutes and lower sleep efficiency. Findings demonstrate these relations through actigraphic assessments in a relatively large sample of semirural middle-aged women across a wide range of SES. Moderation effects were also examined in the path models. Although mediation effects are observed for all women in relation to economic well-being and subjective sleep problems, one ethnic difference exists: lower perceptions of economic well-being are related to greater stress for *all* women but more robustly for AA women. Although there were no differences in either perceived economic well-being or in the level of stress experienced by EA and AA women, there may be important differences in the type and chronicity of stressors that AA and EA women face that may not be reflected in their report of stress in the past month as examined in this study; the stress scale used in analyses did not provide such information. Similarly, perceived economic well-being may have different meanings across ethnic groups. For example, although African American women had a lower income-to-needs ratio, they still reported similar levels of economic well-being. Of course, these explanations are speculative and direct testing of these propositions could clarify observed effects.

There may be several health-related variables that influence the findings of the current study. Despite the fact that participants were excluded from analyses if they had a diagnosed sleep disorder, it is possible that some participants may have undiagnosed sleep disorders that affect sleep. Many women in the sample took medication on regular bases and their health conditions and/or medication could affect their sleep. For example, many women were being treated for hypertension, depression, anxiety, diabetes, and thyroid problems, which could influence sleep. Obesity, which is known to be related to the amount and quality of sleep individuals achieve (Cappuccio et al., 2008), and to be inversely related to income in women (Ogden, Lamb, Carroll, & Flegal, 2010), may have influenced findings; however, some of the prior research on SES and ethnic differences in sleep did not find body mass index to have a significant effect on results (Mezick et al., 2008). We did not assess BMI and recognize that it is a study limitation. Further, there are a number of poor health behaviors, such as smoking and physical inactivity (Strine & Chapman, 2005) that are related to insufficient sleep and may have contributed to the observed SES differences in sleep. Integrating the assessment of other health behaviors and indicators into the study of links between SES and sleep could add substantially to the overall understanding of the causes and consequences of sleep disparities.

Findings should be interpreted within the study's boundaries. The sample consists of primarily middle-aged women residing in semirural locales across a wide range of SES at the

lower end of the SES spectrum; the percentage of middle- and upper-class families was relatively small. The extent to which the findings would generalize to older and younger women living in other settings is unknown. In addition, although actigraphy allows for the objective estimation of various aspects of sleep quantity and quality, it does not allow for the assessment of sleep architecture (e.g., sleep stages). Research employing polysomnography would shed light on how SES may influence the previously reported ethnic differences in sleep architecture (Ruiter et al., 2011). This study represents a step in understanding processes that link SES and sleep; however, there are many potential biological, psychological, lifestyle, and environmental factors that were not assessed that might help explain why economically disadvantaged individuals have worse sleep. Conclusions regarding causality cannot be made and longitudinal examination of mediating effects over time would enhance the meaning and contributions of any such process effects. Finally, mediation effects were only evident for certain SES and sleep parameters. Examination and explanation of why these differential associations were observed is an important direction for future research.

In summary, the findings add to a growing literature showing socioeconomic disparities in sleep and identify stress and chaos as two intervening processes linking lower SES to sleep among women. Policies or interventions that help improve the economic and/or educational circumstances of low SES families may also allow these families to sleep better. In the context of the stress- and chaos-related findings, interventions such as stress management or interventions that promote daily routines in family homes may improve sleep not only for the women but potentially for other family members. High-quality sleep is an important health behavior to promote, and hence it is important to understand the various pathways to better sleep among different ethnic groups.

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