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Low Socioeconomic Status Negatively Affects Sleep in Pregnant Women

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Abstract

Objective—To evaluate the effect of socioeconomic status on measures of sleep quality, continuity, and quantity in a large cohort of pregnant women.

Design—Prospective, longitudinal study.

Participants—One hundred seventy (170) pregnant women at 10-20 weeks gestation.

Methods—Sleep quality was assessed with the Pittsburgh Sleep Quality Index. Sleep duration and continuity (sleep fragmentation index [SFI]) were assessed with actigraphy at 10-12, 14-16, and 18-20 weeks gestation. Since sleep did not significantly differ across time, averages across all three time points were used in analyses. Socioeconomic status (SES) was defined by self-reported annual household income. Linear regression analyses were used to model the independent associations of SES on sleep after adjusting for age, race, parity, marital status, body mass index (BMI), perceived stress, depressive symptoms, and financial strain.

Results—On average, women reported modestly poor sleep quality ($M = 5.4$, $SD = 2.7$), short sleep duration (391 (55.6) min) and fragmented sleep (SFI $M = 33.9$, $SD = 10.4$). A household income $< \$50,000/\text{year}$ was associated with poorer sleep quality ($\beta = -.18$, $p < .05$) and greater sleep fragmentation ($\beta = -.18$, $p < .05$) following covariate adjustment.

Conclusions—Low SES was associated with poorer sleep quality and fragmented sleep, even after statistical adjustments. Perceived stress and financial strain attenuated SES-sleep associations indicating that psychosocial situations preceding pregnancy are also important to consider.

Keywords

sleep; pregnancy; actigraphy; stress; SES; income; education

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During pregnancy women are likely to experience substantial sleep disruption. The most commonly reported disruptions include poor sleep quality and decreased continuity (Okun, 2013). An abundance of data stem from women evaluated in later gestation, and approximately 75% of women in later gestation (28-40 weeks) have substantial sleep complaints (Okun, 2013). In contrast, less is known about sleep in early gestation. A few studies indicate that upwards of 25% of women report considerable sleep disturbance during this time (Facco, Kramer, Ho, Zee, & Grobman, 2010; Okun & Coussons-Read, 2007). Identifying women who experience sleep disturbance in early gestation may be clinically relevant given the recent empirical evidence that shows that sleep disturbances in early pregnancy are significantly associated with an increased risk of having an adverse pregnancy outcome, including glucose intolerance, gestational hypertension, preeclampsia, and preterm birth (Facco, Grobman, Kramer, Ho, & Zee, 2010; Okun, Schetter, & Glynn, 2011; Reutrakul et al., 2011; Williams et al., 2010). Identification and intervention for these sleep issues may mitigate the risk of adverse pregnancy outcomes (Okun, Roberts, Marsland, & Hall, 2009).

Researchers are beginning to evaluate the impact of sociodemographic characteristics on sleep in pregnancy. Low socioeconomic status (SES), for instance, has recently emerged as a putative contributor to poor sleep in a variety of populations, including community dwelling adults from across the United States and Sweden as well as pre- and post-menopausal women (Grandner et al., 2010; Hall et al., 2009; Jansson & Linton, 2006; Knutson, 2012; Nordin, Knutsson, Sundbom, & Stegmayr, 2005; Patel, Grandner, Xie, Branas, & Gooneratne, 2010). In two large studies of non-pregnant and postpartum women, researchers found that fewer years of education and lower family income were associated with poor sleep quality (Baker, Wolfson, & Lee, 2009; Soltani et al., 2012). Likewise, Hall and colleagues reported that among pre- and peri-menopausal women aged 40-55 years, difficulty in paying for basics was associated with decreased sleep quality and lower objectively-assessed sleep efficiency (Hall et al., 2009). Krueger and Friedman reported in a cohort of 110,000+ adults that women, adults with children < 18 years of age, and those with lower levels of education or income were more likely to have short sleep (Krueger & Friedman, 2009). While the evidence strongly supports an association between low SES and sleep in women, none of these researchers examined pregnant women.

Study results indicate that low SES is a predictor of overall health, (Delpisheh, Kelly, Rizwan, & Brabin, 2006; Hall, Bromberger, & Matthews, 1999; Moore, Adler, Williams, & Jackson, 2002; Morgen, Bjork, Andersen, Mortensen, & Nybo Andersen, 2008), including increased susceptibility to infectious disease, cognitive impairment, greater rates of mental illness, heart disease, and all-cause mortality. This relationship has also been demonstrated in pregnancy. Low SES is associated with preterm birth (PTB) (Chiavarini, Bartolucci, Gili, Pieroni, & Minelli, 2012; Morgen et al., 2008; Peacock, Bland, & Anderson, 1995) and infants who are small for gestational age (SGA) (Delpisheh et al., 2006; Lu & Halfon, 2003), even after accounting for other traditional risk factors. Notably, both PTB and SGA are associated with adverse health outcomes in the infant, including cognitive impairment, metabolic dysregulation and later-life cardiovascular disease (Callaghan, Macdorman, Rasmussen, Qin, & Lackritz, 2006; Greenough, 2007; Martin, Kirmeyer, Osterman, &

Shepherd, 2009; Tambyraja & Ratnam, 1982; Wen, Smith, Yang, & Walker, 2004). Hence, the consequences of low SES affect the mother and infant.

Given the importance of sleep in pregnancy to maternal and fetal health, it is important to understand the factors that influence sleep during pregnancy, some of which might be static factors that precede pregnancy. Socioeconomic status is one static factor likely to contribute to disturbed sleep in pregnancy. Thus, the overall aim of this study was to examine whether SES, characterized by household income, was associated with sleep quality, continuity, and duration in a cohort of pregnant women. We hypothesized that low SES status, defined as less than \$50,000/year annual household income, would be associated with poorer sleep quality, sleep continuity, and shorter sleep duration in early gestation (10-20 weeks') more than other factors that might contribute to poor sleep.

Methods

Participants assessed in this secondary analysis were drawn from the Sleep in Pregnancy (SLIP) study, a longitudinal, prospective study of sleep in early pregnancy. Pregnant women between the ages of 18-45 residing in the greater Pittsburgh area during October 2008 through December 2010 were recruited between 10 -14 weeks gestation. Recruitment was by self-referral, physician referral, local advertising, or via participation in University research registries. The breadth of advertising afforded a diverse and highly representative cohort. Interested women contacted the study coordinator for further information and initial screening. Eligible women were then invited to participate. Exclusion criteria included a self-reported diagnosis of any psychopathology, sleep disorder, or active prescription of an anti-depressant medication or treatment/therapy. We were unable to physiologically screen for obstructive sleep apnea/sleep disordered breathing or restless legs. Women with self-reported chronic disease such as diabetes, HIV, or uterine abnormalities were also excluded. Approval was obtained from the University of Pittsburgh Institutional Review Board. All women were compensated and provided written informed consent.

Procedures

The SLIP study protocol was conducted during weeks 10-20 of pregnancy. Demographic information was collected at enrollment. Participants completed the Pittsburgh sleep diary daily (Monk et al., 1994) and wore a wrist actigraph (Mini Mitter, Respironics/Phillips, OR) for 2-weeks during three assessment periods (10-12 weeks, 14-16 weeks, and 18-20 weeks gestation). At the conclusion of each 2-week assessment, participants completed a series of online questionnaires assessing psychosocial variables, such as perceived stress and depressive symptoms.

Socioeconomic Status—Socioeconomic status was determined by self-reported annual household income at the time of enrollment. We dichotomized women into two groups: less than or greater than/equal to \$50,000 / year. This cutoff represents the median split and is consistent with previously published reports which reflect the income distributions of pregnant women in Pittsburgh (Levine, Marcus, & Leon-Verdin, 2008).

Sleep Measures—*Subjective sleep quality* was derived from the total Pittsburgh Sleep Quality Index (PSQI) score. This 18-item questionnaire inquires about sleep complaints in the last month to determine habitual sleep quality. It is comprised of seven subscales assessing habitual duration of sleep, nocturnal sleep disturbances, sleep latency, sleep quality, daytime dysfunction, sleep medication usage, and sleep efficiency. Each subscale has a possible score of 0 through 3, with an overall global score of 0 through 21. The PSQI and its psychometric properties have been validated in various psychiatric populations (Buysse, Reynolds, Monk, Berman, & Kupfer, 1989) and recently in a study of pregnant women (Jomeen J & Martin C.R., 2007), indicating high internal consistency and a reliability coefficient (Cronbach's alpha) of .83. A score of > 5 indicates poor sleep quality (Buysse et al., 1989; Jomeen J & Martin C.R., 2007).

Sleep duration and *sleep continuity* were derived from actigraphy. Wrist actigraphy was measured with the Mini Mitter Actiwatch-64 device, which was worn concurrently with the collection of sleep diaries for 2-weeks at each time point to provide a behavioral assessment of participants' sleep duration and continuity in their usual sleeping environments. Actigraphy data were collected in 1-min epochs and analyzed with the Actiware Version 5.04 software program. Sleep diary data for bed time and rise time and event markers were used to calculate sleep-wake variables. *Sleep duration* was defined as total sleep time (TST) from lights out to out of bed. *Sleep continuity* was defined by the sleep fragmentation index (SFI). It is a composite of mobile and immobile values expressed as percentages. For example: The Fragmentation Index = % Mobile + % 1 min Immobile. The SFI is represented as a unitless number from 0-150 and is an indicator of restlessness during sleep (Kurina et al., 2011). Sleep data did not show significant variability across time so all sleep data were averaged.

Covariates—The following covariates were examined as potential confounders: *Age* at time of consent; *race* (Black or other), *marital status* (married or not married), *parity* (nulliparous or multiparous), *BMI*, *perceived stress* as assessed by the 10-item Perceived Stress Scale (PSS), (Cohen, Kamarck, & Mermelstein, 1983) and *depressive symptoms* as assessed by the 16-item Inventory for Depressive Symptoms (IDS) (Rush, Gullion, Basco, Jarrett, & Trivedi, 1996). The Perceived Stress Scale (PSS) 10-item (Cohen et al., 1983) was used to assess the degree to which situations in one's life are appraised as stressful during the last month. It is one of the most commonly administered subjective stress questionnaires with a Cronbach's α ranging from 0.78 to 0.91 in healthy, adult cohorts (Cohen et al., 2012). Scores range from 0 (no stress) to 40 (very stressed). The Inventory for Depressive Symptoms (IDS)-16 Item Inventory (Rush et al., 1996) rates the nine criterion symptom domains (0–27) needed to diagnose a major depressive episode by Diagnostic and Statistical Manual of Mental Disorders (DSM-IV). This commonly used questionnaire has a Cronbach's α ranging from .92–.94 in depressed and euthymic patients. The PSS and the IDS, minus sleep items, were calculated as continuous variables. *Financial strain* was derived from the question "How hard is it for you to pay for the basics like food, housing, medical care and heating?" For analyses, the 3-level response was dichotomized as "somewhat hard" to "very hard" versus "not hard at all". Body Mass Index and depressive

symptoms were not included in the final models since they were uncorrelated with either the predictor or outcome variables.

Statistical Analysis

Descriptive statistics were used to characterize the sample and evaluate distributions of the data. Skewed variables were transformed prior to analyses. Linear regression models, adjusting for race, marital status, parity and perceived stress, were conducted to evaluate the hypothesis that sleep quality, continuity and duration differed by SES (income). In separate analyses, we further adjusted for financial strain given the evidence that it has an independent association with sleep (Hall et al., 2008; Hall et al., 2009). Data were analyzed using IBM SPSS 20.0 and a $P < 0.05$ was considered significant.

Results

Participant characteristics are presented in Table 1. Women were 29 ± 4.7 years of age with a BMI of 26.6 ± 6.2 at gestational week 12. Approximately 83% were married or living with their partner, and for over half this was their first child. Twenty-two percent were African-American, about 40% had less than a college degree, and 57.9% reported a household income of $< \$50,000/\text{year}$. The sleep measures averaged across time are shown in Table 2.

Linear regression analyses were conducted to determine whether having an income $< \$50,000/\text{year}$ was associated with poor sleep quality, poor continuity or short sleep duration. Regression coefficients for SES and sleep outcomes, adjusting for age, race, marital status, parity and perceived stress, are displayed in Table 3. We found that women of lower SES were more likely to have poorer sleep quality as indicated by higher PSQI scores ($\beta = -.21$, $p = .005$) after adjustment for race, marital status, parity, and perceived stress. This significant association remained significant following further adjustment of financial strain ($\beta = -.19$, $p = .01$). In this model, only early (T1) perceived stress ($\beta = .44$, $p < .001$) was correlated with poor sleep quality. Women with lower SES, had more sleep fragmentation ($\beta = -.26$, $p = .006$), after adjusting for age, race, marital status, parity and perceived stress. This significant association remained after adjusting for financial strain ($\beta = -.19$, $p = .026$). No other covariates were associated with sleep fragmentation. Low SES, defined as having an income $< \$50,000/\text{year}$, was not associated with sleep duration ($P_s > .05$).

Discussion

We evaluated relationships between SES and subjective sleep quality and actigraphy-assessed sleep in a sample of pregnant women. As hypothesized, sleep quality was worse in women with lower household incomes. This association was robust to adjustment for several factors known to affect sleep, particularly perceived stress and financial strain. Low SES was also associated with more restless sleep, as depicted by the sleep fragmentation index. Our hypothesis that low SES would be associated with shorter sleep duration was not supported.

Our results are consistent with previous reports of increased sleep disturbances in association with lower SES in other populations (Ertel, Berkman, & Buxton, 2011; Grandner

et al., 2010; Hall et al., 2009; Lallukka et al., 2012; Park et al., 2010; Soltani et al., 2012). Specifically, poor sleep quality and sleep fragmentation are notably higher among people with a “disadvantaged” socioeconomic position (Hall et al., 2009; Lallukka et al., 2012). Our findings regarding sleep quality are consistent with these studies in that the women in our sample with low SES had a PSQI score of 5.5 compared to high SES women who has a score of 3.8. It is plausible that the stress and anxiety associated with smaller incomes, particularly in the current economic climate, may contribute to poor sleep above and beyond the mere fact of low SES. Along similar lines, we are not surprised that we did not observe any association with sleep duration. Many adults, and in particular women, regularly obtain less than the recommended 8 hours of sleep per night (Krueger & Friedman, 2009). Hence, we may have observed a “floor effect”. The average sleep duration in our cohort was 6.5 hours which is similar to the 6 hours and 52 minutes reported by Ertel and colleagues (2011) among a sample of predominantly female immigrant workers. Amongst epidemiologic studies sleep duration of < 7h has been reported by 12.5% of Finnish females aged 30-39 (Lallukka et al., 2012) and 28% of middle-aged women (Krueger & Friedman, 2009).

Our findings are in line with large epidemiologic studies (Lallukka et al., 2012; Li, Sundquist, & Sundquist, 2007; Patel et al., 2010) which show that the effect of low SES on objective measures of sleep may be modified by other sociodemographic variables, particularly race, perceived stress, and financial strain. Consistent findings indicate that blacks are more likely to report short sleep duration (Jackson, Redline, Kawachi, Williams, & Hu, 2013), have disparate beliefs about sleep behaviors (Grandner et al., 2013), and are functionally more impaired as a result of their disrupted sleep than whites (Brimah et al., 2013). Our findings also corroborate the findings by Hall and colleagues (Hall et al., 2009) that financial strain is a significant correlate of sleep quality and continuity. Our results are additionally congruent with the notion that the association between low SES and sleep is affected by other modifiers. For instance, Lallukka et al note that the association between unemployment/low income and poor sleep can partly be accounted by stress and/or poor health status; or that education can dictate health-related behaviors and attitudes (e.g., sleep) (Lallukka et al., 2012). Patel and colleagues posit a “sleep disparity” exists among individuals who are of low SES (Patel et al., 2010). Taken together it is clear that the impact of SES on sleep is multifaceted, and that identifying areas for intervention could be beneficial; this is especially true in pregnant women, as the welfare of the mother and the health of the fetus are at risk.

There are several strengths to this study. First, it is a large cohort of women evaluated longitudinally in the first half of pregnancy. The current literature is primarily derived from cross-sectional designs and often from women in later pregnancy (Baratte-Beebe & Lee, 1999; Beebe & Lee, 2007; Greenwood & Hazendonk, 2004; Lee & Gay, 2004). We contend that sleep in early pregnancy is an essential determinant of the physiological alterations that take place during pregnancy (Okun et al., 2009). Poor sleep, for example, can initiate an unnecessary and unwarranted inflammatory response which can lead to substantial pathophysiology in metabolic, cardiovascular, and angiogenic systems necessary for a healthy pregnancy (Backhaus, Junghanns, & Hohagen, 2004; Bjorvatn et al., 2007; Irwin, Clark, Kennedy, Christian, & Ziegler, 2003; Okun et al., 2011; Opp, 2005). A second strength of the study is that the cohort is diverse and reflects women from a broad SES

spectrum. There is also an adequate representation of the ethnic diversity seen in Pittsburgh. Examining these relationships in multiple ethnicities is important since adverse pregnancy outcomes disproportionately affect women of lower SES, especially women of color (Caughey, Stotland, Washington, & Escobar, 2005; Dole et al., 2004). A novel way to explore these associations has recently been reported by Patel and colleagues (Patel et al., 2010). They examined the interaction between low SES and race and found a “differential vulnerability” among individuals who are poor and of non-white race. While this appears more robust, we were not able to examine this here given the small cell sizes. Another strength is that we have 2-weeks of actigraphy sleep data at three time points, providing an objective assessment of sleep (Littner et al., 2003; Martin & Hakim, 2011). The use of actigraphy allows for long periods of data collection, which provide information on sleep patterns and their variability (Martin & Hakim, 2011; Monk et al., 1994).

We also acknowledge that there are some limitations to our results. We do not have polysomnography (PSG) data from these women. Often in sleep research, PSG is considered the “gold standard” for examining sleep. However, PSG is cost-prohibitive in large cohorts. Further, there is momentum gaining regarding the predictive ability of self-reported health information on morbidity and mortality in non-pregnant cohorts (Halford, Ekselius, Anderzen, Arnetz, & Svardsudd, 2010; Latham & Peek, 2013). We do not have data from later pregnancy, thus we cannot confirm that these sleep disturbances continued across the pregnancy. However, previous data indicate that sleep progressively gets worse rather than better (Okun & Coussons-Read, 2007). Finally, the use of self-reported household income may not be sufficient to adequately address the role that SES plays in sleep during pregnancy. Although the women completed the demographic questionnaire themselves, there may be an issue of self-report bias or exhibition of demand characteristics. These have a possibility of skewing the data. A more comprehensive composite of SES, including current employment and access to healthcare, could be tested (Shavers, 2007). There may also be a gradient effect in that women of extremely low SES may be worse off than women in low-middle SES (Shavers, 2007). The size of our cohort limited our ability to examine this question. Future studies with larger cohorts will be needed to fully answer this question.

Despite the wide acceptance that low SES is a predictor of adverse health outcomes, few studies have examined the effect of SES on sleep. To our knowledge, this is the first report to specifically examine this association in pregnant women. Identifying and understanding the negative consequences of SES on sleep in pregnancy is of clinical importance, given that the number of adverse pregnancy outcomes exceeds over 1 million per year (March of Dimes, 2006). We assert that the associations between SES and sleep are especially important to pregnant women, given the evidence that indices of psychosocial stress, including low SES, are associated with inflammation and neuro-endocrine disturbances, as well as adverse pregnancy outcomes (Coussons-Read et al., 2012; Coussons-Read, Okun, & Nettles, 2007; Lu & Halfon, 2003; Morgen et al., 2008; Pickett, Collins, Jr., Masi, & Wilkinson, 2005). We believe these data can provide an opportunity for healthcare professionals to introduce and frame sleep as a modifiable health behavior, stressing the vital role of sleep hygiene for maternal and fetal health.

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Callouts

1. Disturbed sleep and low socioeconomic status are associated with adverse pregnancy outcomes.
2. Low socioeconomic status is a contributor to poor sleep.
3. Sleep disruption among women with low socioeconomic status may confer an additive risk for adverse pregnancy outcomes.

Table 1Demographic and Sleep Characteristics of 170 Pregnant Women in Early Gestation^a

	Total Cohort (N = 170)	
	Mean	SD
Age	29.5	4.7
Body mass index (prenatal week 12)	26.6	6.3
	%	N
Race		
African American	21.8	37
White	71.8	122
Other	6.4	11
Marital Status		
Never married	18.3	31
Married	64.5	109
Living with partner	15.4	26
Divorced/widowed	1.8	3
Parity		
Nulliparous	56.0	94
Multiparous	74	44.0
Education		
Less than high school	3.6	6
High school graduate	8.3	14
Technical or trade school	4.0	7
Some college	18.3	31
College degree	30.2	51
Some post-graduate work	11.2	19
Post-graduate degree	22.9	41
Income		
Less than \$10,000	18.3	31
\$10,000 – \$34,999	30.7	35
\$35,000 – \$50,000	8.9	15
\$50,000 – \$74,999	16.6	28
\$75,000 – \$99,999	16.6	28
\$100,000 – \$149,999	14.2	24
More than \$150,000	4.7	8

^a Note. 170 women were enrolled and contribute to the demographics. Data are missing from one woman. Actigraphy sleep data are from 154 unique women.

Table 2

Average Sleep Measures from 10-20 Weeks Gestation

	N	Mean	SD	Range
Pittsburgh Sleep Quality Index (PSQI) ^a	170	5.34	2.7	1.0 - 17.0
Sleep duration (minutes)	154	392.6	55.6	210 -504
Sleep Fragmentation Index	154	33.9	10.4	14.8 – 70.3

^aNote. a Square root transformed prior to analyses.

Table 3

Multivariate Linear Regression Models Testing Whether Low Socioeconomic Status is Associated with Poor Sleep

	Overall F statistic	Income > \$50,000/year β for predictor	R^2	R^2
Pittsburgh Sleep Quality Index (PSQI) ^a				
Step 1 ^b	22.89***	-.21**	.42	.03
Step 2 ^c	19.0***	-.19*	.43	.03
Sleep Duration (Actigraphy) (minutes)				
Step 1 ^b	5.56***	.06	.14	.002
Step 2 ^c	3.74**	.04	.14	.001
Sleep Fragmentation				
Step 1 ^b	5.55***	-.26**	.16	.045
Step 2 ^c	5.50***	-.21*	.19	.029

Note. Referent was income > \$50,000/year; referent was “not difficult at all to pay for the very basics.”

^a Square root transformed prior to analyses; for tests of statistical significance,

* P < 0.05,

** P < 0.01,

*** P < 0.001.

^b Step 1 predictor variable was SES with covariates (age, race, marital status, parity, and early perceived stress).

^c Step 2 predictor variable SES with covariates age, race, marital status, parity, and perceived stress, and financial strain).