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Sleep quality across pregnancy and postpartum: effects of parity and race

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ABSTRACT

Background: Despite high prevalence and clinical implications of disturbed sleep during pregnancy, information on changes in sleep across pregnancy and postpartum is incomplete. Moreover, predictors of differential patterns of sleep quality across the perinatal period are poorly defined.
Methods: This study examined subjective sleep quality using the Pittsburgh Sleep Quality Index during each trimester of pregnancy and at 4-11 weeks postpartum among 133 women inclusive of nulliparous and multiparous African Americans and Whites.
Results: At any given assessment, 53%-71% of women reported poor overall sleep quality (Pittsburgh Sleep Quality Index total score > 5). Moreover, 92% reported poor overall sleep quality during at least 1 assessment, including 88% at some time during gestation. Compared to nulliparous women, multiparous women reported poorer overall sleep quality, shorter sleep duration, and poorer sleep efficiency during the first trimester; poorer overall sleep quality and longer sleep latency in the second trimester; and more frequent sleep disturbances (eg, night time and early morning awakenings) during the third trimester. Among nulliparous as well as multiparous women, specific aspects of sleep (eg, subjective sleep quality, sleep disturbances, sleep efficiency) were poorer in African American compared to White women at different time points during pregnancy. No effects of race or parity were observed on sleep parameters at postpartum.
Conclusions: Poor sleep quality during pregnancy as well as early postpartum is highly prevalent among both African American and White women. Both multiparous status and African American race are associated with more disturbed sleep at some time points during pregnancy. These individual differences should be considered in future research and clinical efforts to promote perinatal sleep health.

Introduction

Poor sleep quality is common, with an estimated 22.1% of US adults meeting criteria for insomnia.[1] Sleep issues are more common among women, among whom odds of insomnia are 1.4-1.6 higher compared to men.[1] Moreover, pregnancy is associated with increased occurrence of sleep problems, including insomnia, snoring, restless leg syndrome, and poor subjective sleep quality.[2] Importantly, poor sleep quality and short sleep duration during pregnancy have been associated with adverse outcomes including preterm birth, risk for gestational diabetes, depressive symptoms, placental abruption, small for gestational age, and cesarean delivery.[3–14] Mechanisms underlying these effects include effects on regulation of the hypothalamic pituitary axis and related inflammatory processes.[13,15,16]

Despite the high prevalence and clinical implications of poor sleep during pregnancy, data on changes in sleep across the course of pregnancy and postpartum are limited. Moreover, predictors of differential patterns of sleep quality across the perinatal period are poorly defined. Understanding risk factors and timing for disturbed sleep during pregnancy and postpartum is important for best directing clinical efforts to women who may benefit from clinical intervention.

A key factor of consideration is parity. Multiparous women are likely to have a young child or children in the home, a considerable

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external driver of women's sleep health. In particular, total sleep duration and sleep efficiency are likely to be affected by childcare demands and children's sleep schedules, including nighttime wakings.[17–19] Moreover, there is considerable variability in sleep health among young children; an estimated 20%-30% have some type of sleep problem,[20] and women of children with sleep difficulties report greater fatigue and poorer well-being, indicating that sleep impacts daytime functioning.[21] Thus, parity is an important factor that may substantially impact a woman's ability to respond to endogenous signals that may promote increased sleep to meet the physiological demands of pregnancy.

A second key factor warranting examination is race. Epidemiological studies show that African Americans experience poorer sleep quality than Whites even after statistically adjusting for socioeconomic status.[22,23] Moreover, African American women experience a disproportionate burden of adverse perinatal health outcomes that have been associated with poor sleep, including shorter gestation and preterm birth.[24–27] Despite the clinical relevance of delineating potential racial differences in sleep quality during the perinatal period, such data are incomplete.

Addressing these gaps in the literature, the current study examined subjective sleep quality using the Pittsburgh Sleep Quality Index (PSQI) during each trimester of pregnancy and at 4-11 weeks postpartum among 133 women predominately from lower socioeconomic backgrounds, inclusive of nulliparous and multiparous African Americans and Whites. It was hypothesized that (1) sleep would be poorer in late pregnancy and postpartum as compared to early pregnancy per total overall sleep quality scores as well as subscales of the PSQI and (2) multiparous status and African American race would independently predict poorer sleep in terms of both total overall sleep quality scores and subscales of the PSQI.

Methods

Study design

This study included pregnant women who were recruited from The Ohio State University Wexner Medical Center and the surrounding community of Columbus, OH, for a longitudinal study of perinatal health. The parent study, funded by the National Institute of Child Health and Human Development (R21 HD067670), was designed to examine effects of maternal race on immune adaptation across pregnancy. The current analyses were secondary analyses of sleep data collected as part of this protocol. Study visits were conducted during the first, second, and third trimesters and at 4-11 weeks postpartum. This study was approved by The Ohio State University Biomedical institutional review board. All participants provided written, informed consent and privacy notifications and received modest compensation for participation.

Participants

A total of 144 women were enrolled in this protocol. Women who missed more than 1 of the 3 prenatal study visits ($n = 5$) were excluded from these analyses. As the current analyses focused on racial differences, Hispanic women ($n = 6$) were also excluded from analysis due to low representation of women of this ethnicity in the sample. This resulted in a final sample of 133, including 77 African Americans and 56 Whites. All women were born and raised in the United States. The protocol in which these women were enrolled involved collection of biological markers of immune function. For this reason, women were not eligible if they had current hypertension, diabetes, chronic conditions with implications for immune function (eg, rheumatoid arthritis, multiple sclerosis, or human immunodeficiency virus), fetal anomaly, illicit drug use, or more than 2 alcoholic drinks per week during pregnancy (per self-report or medical record) at the time of enrollment. Women reporting acute illness (eg, cold or flu-like symptoms) or antibiotic use within 10 days of a study visit were rescheduled. Thus, overall, the current study assesses sleep in a generally healthy population without chronic health conditions or specific problematic health behaviors.

Demographics

Age, race/ethnicity, education, annual family income, gravidity, and parity were collected by self-report. Prepregnancy body mass index (BMI; kg/m^2) was calculated using self-reported prepregnancy weight and height assessed at the first visit.

Subjective sleep quality

Sleep quality was assessed by self-report using the PSQI.[28] A score > 5 is indicative of poor sleep. This was administered in interview format by study personnel for accuracy. This measure includes 7 subscales: subjective sleep quality, sleep latency (ie, time to fall asleep), sleep duration, habitual sleep efficiency (ie, time asleep/time in bed; *poor sleep efficiency* was defined as <85%), sleep disturbance (eg, feel too cold, feel too hot, have pain, have bad dreams, have to get up use the bathroom), use of sleeping medications, and daytime dysfunction. The PSQI has high diagnostic sensitivity and specificity in distinguishing good and poor sleepers, including in women during pregnancy.[28,29] Global scores as well as subscale scores show high test-retest reliability across short intervals in adults with insomnia.[30] The PSQI showed acceptable internal consistency in this cohort at each assessment time point (Cronbach αs $= 0.70$-0.75).

Statistical analyses

All statistical analyses were conducted using SAS/STAT software version 9.3 (Cary, NC). Demographic characteristics were summarized by means and standard deviations for continuous variables and number and percent for categorical variables, both overall and by race. Differences in participant characteristics by race were assessed using t tests for continuous and χ^2 tests for categorical variables.

Mixed-effect linear models with autoregressive random subject effects were fit to the overall sleep quality outcome. Generalized linear models with a cumulative logit link (for ordinal values) were fit to the PSQI subscales. Because of relatively low endorsement of use of sleep medication, this variable was dichotomized (yes/no) for analytic purposes rather than using the PSQI subscale which captures frequency of use in an ordinal manner. In addition to examining the ordinal subscales of the PSQI, mixed linear models were also fit to 3 individual components of the PSQI in a continuous manner: sleep latency (minutes taken to fall asleep), sleep duration (hours of actual sleep), and sleep efficiency (percentage of time in bed spent asleep). Each of these models accounts for correlation in measures from the same subject across time. Models included effects for time, race, and parity, and all interaction terms between these 3 effects. Within each model, parameter contrasts for nulliparous versus multiparous were tested at each time point. Contrasts for the race effect were tested separately by parity status at each time point. Linear and quadratic trends were compared across race and parity. χ^2 tests were used to compare poor sleep (defined by PSQI >5) by race and parity. No adjustments were made for multiple comparisons.

Results

Sample characteristics

Demographic characteristics of the sample are summarized in Table 1. The sample was 58% African American and predominately

Table 1
Demographic characteristics by parity and race

	African American nulliparous [n = 12]	European American nulliparous [n = 19]	African American multiparous [n = 65]	European American multiparous [n = 37]
Age [mean (SD)]	23.5 (4.8)	23.3 (3.5)	24.8 (4.2)	25.8 (3.9)
BMI [mean (SD)]	24.9 (5.0)	27.0 (5.3)	29.5 (7.3)	29.0 (7.6)
Annual household income				
<$15,000	6 (50%)	6 (32%)	37 (57%)	13 (35%)
$15,000-$29,999	1 (8%)	6 (32%)	16 (25%)	12 (32%)
$30,000 or above	5 (42%)	7 (37%)	12 (18%)	12 (32%)
Educational attainment				
Some secondary school	1 (8%)	3 (16%)	13 (20%)	5 (14%)
High school graduate	3 (25%)	3 (16%)	14 (22%)	11 (30%)
Some college	3 (25%)	6 (32%)	30 (46%)	13 (35%)
College graduate	5 (42%)	7 (37%)	8 (12%)	8 (22%)
Length of gestation [mean (SD)]	38.5 (3.3)	38.5 (3.6)	39.0 (1.3)	38.9 (2.0)
Preterm birth (<37 wk)	2 (17%)	2 (11%)	4 (6%)	2 (5%)

Overall, groups were highly demographically similar. Multiparous European American women were older than nulliparous European American women ($P = .03$). Multiparous African American women had higher BMIs on average than nulliparous African American women ($P = .04$).

from lower socioeconomic backgrounds, with 73% reporting an annual household income <$30,000. There were no group differences (by race/parity) for income, education, length of gestation, or preterm birth. Multiparous White women were older than nulliparous White women ($P = .03$). Multiparous African American women had higher BMIs on average than nulliparous African American women ($P = .04$).

Sleep in nulliparous and multiparous women over the course of pregnancy

Among nulliparous women, overall sleep quality was worse (indicated by higher total scores on the PSQI) in the third trimester than in the second trimester ($P = .01$) and worse at postpartum than in the first ($P = .01$) or second ($P < .001$) trimesters (Fig. 1). In multiparous women, there were no significant differences between time points in total PSQI scores (P values >.11). Within trimesters, multiparous women reported significantly poorer overall sleep quality, as indicated by higher total scores on the PSQI, during the first and second trimesters (Ps ≤ .03; Fig. 1) but not at the third trimester or in postpartum.

When examining prevalence of poor sleep (PSQI >5) between multiparous and nulliparous women at the second trimester, 38% of nulliparous women vs 58% of multiparous women reported poor sleep ($\chi^2(1) = 4.05, P = .04$). Similar trends at the first and third trimesters were observed but did not reach statistical significance. By postpartum, poor sleep reached its highest prevalence across groups, with 72% of nulliparous and 70.5% of multiparous women scoring >5 on the PSQI.

Examination of the sleep disturbances component of the PSQI revealed differential patterns of results as a function of parity. Among nulliparous women, mean sleep disturbance scores did not significantly change over pregnancy and into postpartum. In contrast, sleep disturbance scores at postpartum were significantly lower in multiparous women compared to the first, second, and third trimesters (Ps < .05). When examining individual items in the subscale score, increased frequency of sleep disturbances due to "other reasons" in both multiparous and nulliparous women was observed at postpartum compared to all trimesters. Among the 51.3% of women (65.5% of nulliparous, 51.1% of multiparous) endorsing this item at postpartum, 96.7% said their reason for trouble sleeping was due to a child/infant waking them. Multiparous women reported more trouble sleeping in pregnancy due to waking at night or early morning, having bad dreams, feeling hot, coughing or snoring, having difficulty breathing, or pain when compared to postpartum when these symptoms were significantly lower (second ;and third trimester vs postpartum, Ps < .05). Nulliparous women did not report changes over this time period except for more difficulty breathing during pregnancy compared to postpartum. Reports of trouble sleeping due to having to get up to use the bathroom at night was highly prevalent for both nulliparous and multiparous women during all 3 trimesters compared to postpartum (59%-69% over pregnancy vs 6% in postpartum).

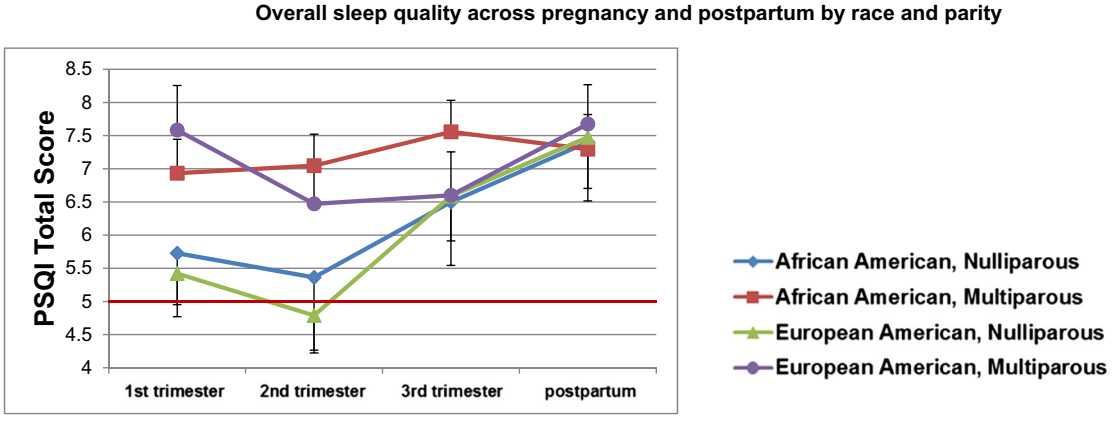

Fig. 1. Multiparous women demonstrated poorer overall sleep quality, as indicated by higher scores on the PSQI, during the first and second trimesters of pregnancy (Ps ≤ .03). In addition, multiparous women showed higher rates of poor sleep (PSQI >5) during the second trimester ($P = .04$). No significant effects of race on overall sleep quality were observed among nulliparous or multiparous groups. Red line indicates cutoff for poor sleep (PSQI >5). Error bars = ±1 SE.

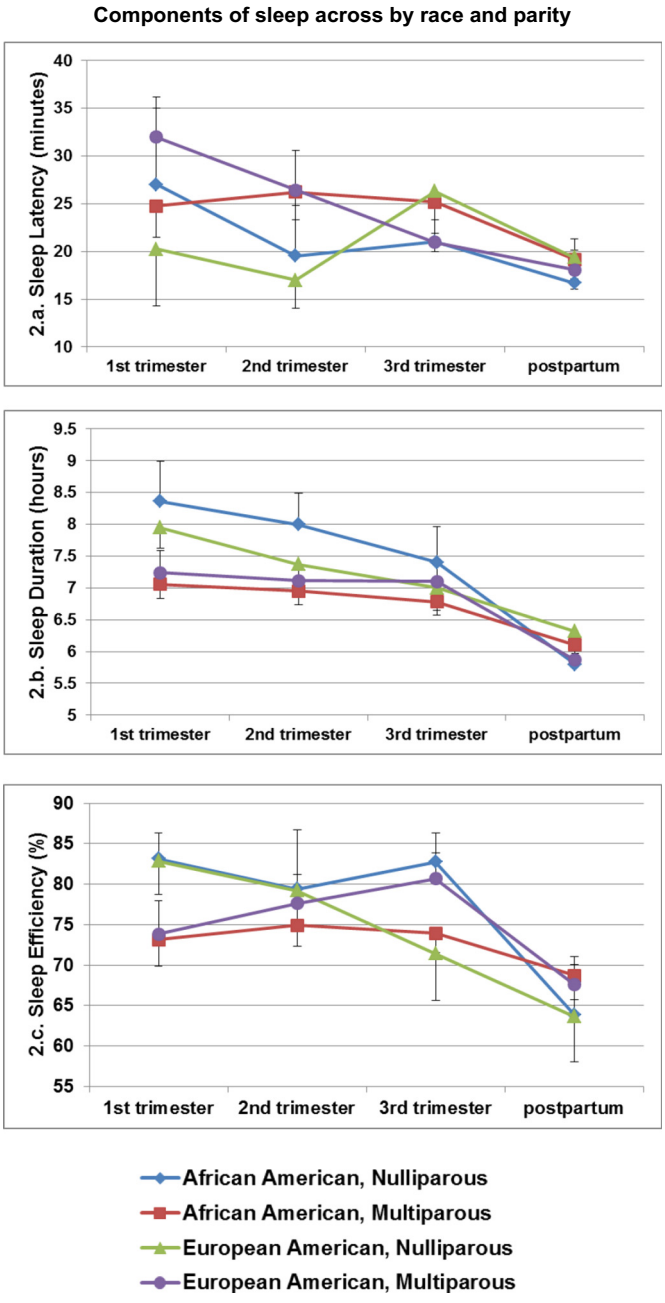

Fig. 2. A-C, Self-reported sleep parameters in women by race and parity. Error bars = ±1 SE.

When comparing nulliparous women to multiparous women at each time point, multiparous women reported more frequent overall sleep disturbance using the PSQI subscale at the third trimester ($P = .05$) but not at the first or second trimester or at postpartum ($Ps > .05$). When examining specific items on the subscale, multiparous women reported more night time or early morning awakenings than nulliparous women at the second and third trimester ($Ps < .05$) but not during the first trimester or postpartum. There was no difference by parity status for waking to go to the bathroom, coughing or snoring, feeling cold, having bad dreams, or pain. There was a difference in reports of breathing comfortably, with multiparous women reporting more frequent discomfort than nulliparous women at the third trimester only ($P = .03$), although the overall frequency was low (means 1.18 vs .96). Multiparous women in the second trimester reported higher frequency of feeling too hot ($P = .05$) compared to the nulliparous.

With respect to sleep duration as an ordinal variable, multiparous women had shorter total sleep duration ($P = .01$) in the first trimester; this result was the same using sleep duration as a single-item continuous measure ($P = .01$; Fig. 2B). There were no differences in sleep duration between multiparous women and nulliparous women at the second and third trimester, or at postpartum.

Multiparous women exhibited poorer sleep efficiency during the first trimester when sleep efficiency was examined as a continuous measure ($P = .04$; Fig. 2C) but not when the ordinal sleep efficiency subscale of the PSQI was used ($P = .23$) or when examining the frequency of those with sleep efficiency <85%, indicating unsatisfactory sleep efficiency.[28,31] Across time points, sleep efficiency of <85% was

Table 2
Sleep across pregnancy and postpartum by parity and race.

	African American Nulliparous [n=12]				European American Nulliparous [n=19]			
	1st	2nd	3rd	PP	1st	2nd	3rd	PP
Total PSQI [Mean (SD)]	5.7 (2.6)	5.4 (3.6)	6.5 (3.0)	7.4 (2.8)	5.4 (2.8)	4.8 (2.5)	6.6 (2.8)	7.5 (3.4)
Poor sleep (PSQI > 5) [%]	7/11 (64%)	4/11 (36%)	5/10 (50%)	8/10 (80%)	7/19 (37%)	8/19 (42%)	13/17 (76%)	13/19 (68%)
Poor sleep efficiency (< 85%)	6/11 (55%)	5/11 (46%)	5/10 (50%)	9/10 (90%)	9/19 (47%)	11/19 (57%)	12/18 (67%)	14/19 (74%)
	African American Multiparous [n=65]				European American Multiparous [n=37]			
	1st	2nd	3rd	PP	1st	2nd	3rd	PP
Total PSQI [Mean (SD)]	6.9 (4.0)	7.0 (3.8)	7.6 (3.7)	7.3 (3.8)	7.6 (4.0)	6.5 (3.8)	6.6 (3.9)	7.7 (3.4)
Poor sleep (PSQI > 5) [%]	35/60 (58%)	40/63 (63%)	43/61 (70%)	38/54 (70%)	22/36 (61%)	19/36 (53%)	19/35 (54%)	24/34 (71%)
Poor sleep efficiency (< 85%)	33/60 (55%)	41/63 (65%)	44/61 (72%)	40/54 (74%)	19/36 (53%)	19/36 (53%)	16/35 (46%)	27/34 (79%)

highest at the postpartum relative to the other trimester visits in both nulliparous and multiparous women (Table 2).

Examination of sleep latency revealed that, during the second trimester, multiparous women evidenced longer sleep latency ($P = .04$), with a trend toward the same effect with sleep latency as a continuous measure ($P = .08$, Fig. 2A). Sleep latency did not differ at the other trimesters or at the postpartum visit.

Effects of race on sleep quality across pregnancy and postpartum

Effects of race were examined among nulliparous and multiparous women separately. No significant differences were observed between African Americans and Whites in overall sleep quality (ie, PSQI total scores) at any assessment time point among either group. Analysis of PSQI subscales and specified continuous items demonstrated that, among multiparous women, Whites had longer sleep latency than African Americans in the first trimester when assessed as an ordinal measure ($P = .01$); however, this effect was not significant when the continuous measure of sleep latency was examined ($P = .14$; Fig. 2A). African American women had more frequent sleep disturbances than White women during the second trimester ($Ps \leq .04$). When examining the items on the sleep disturbance subscale, African American multiparous women had higher reports of feeling cold and less reported waking to use the restroom at the first trimester, had greater pain at the third trimester, and had higher reports of feeling too hot at postpartum when compared to multiparous Whites ($Ps < .05$). African American and White women who were nulliparous did not differ on individual sleep disturbance items at any time point.

Among multiparous women, African American women had poorer subjective sleep quality in the second trimester ($P = .04$) and worse habitual sleep efficiency in the third trimester ($P = .02$) compared to Whites as measured on the ordinal PSQI subscales. However, this difference was not significant using the continuous measure of sleep efficiency ($P = .16$; Fig. 2C) or the clinical cutoff of <85% for poor sleep efficiency (Table 2). At the third trimester, 72% of African American multiparous women reported poor sleep efficiency compared 46% of White multiparous women ($P = .01$). No other differences at each time point by race or within parity group were observed. Across time points, poor sleep efficiency was highest at postpartum relative to the other trimester visits in both African American and European women (Table 2).

Prevalence of poor overall sleep (PSQI >5) did not differ significantly by race at any time point for either parity status. Among multiparous women, poor sleep (PSQI >5) was reported at 1 or more time point during pregnancy by 91% of African American and 86% of Whites ($P = .50$). Within nulliparous women, this occurred in 83% of African American women and 84% of White women ($P = .95$).

A total of 28 women endorsed the use of sleep medication at 1 or more assessment time point: 9 during the first trimester, 10 during the second, 10 at the third, and 8 at postpartum. Among the 29 total endorsements during pregnancy, 38% were less than once per week, 31% once or twice per week, and 31% 3 or more times per week. Among the 8 endorsements at postpartum, 50% were less than once per week, 25% once or twice per week, and 25% 3 or more times per week. Because of the low frequency of endorsement, this variable was dichotomized (use/no use) for analytical purposes as described in the methods. No differences were observed based on race or parity in the use of sleep medication ($P > .35$).

Discussion

This study examined sleep quality across pregnancy and postpartum among a sample of 133 pregnant African American and White women from predominately lower socioeconomic backgrounds. As expected, poor sleep (PSQI >5) was highly prevalent in this sample; across the assessment time points, 53%-71% of women reported poor sleep at any given time. Moreover, across women, 92% reported poor sleep during at least 1 assessment from pregnancy to early postpartum, including 88% at some time during pregnancy.

The role of parity

As hypothesized, parity was a significant correlate of sleep. Nulliparous women exhibited a significant decline in sleep quality in later pregnancy as compared to earlier pregnancy, as indicated by higher scores on the PQSI. In contrast, multiparous women exhibited poorer overall sleep quality than nulliparous women during the first and second trimester of pregnancy and no significant change over the course of pregnancy. However, changes were observed in reports of trouble sleeping, with both multiparous and nulliparous women reporting a frequent need to get up to use the restroom at night during pregnancy, but not in postpartum. Inversely, and as would be expected after the birth of a child, women reported more trouble sleeping due to a child or infant waking them in postpartum compared to pregnancy. In addition, among African American as well as White women, multiparous women reported shorter sleep duration, longer sleep latency, and higher prevalence of poor sleep (PSQI >5) during early/midpregnancy compared to nulliparous women.

Sleep needs increase in pregnancy relative to nonpregnancy, particularly during the first trimester.[32] This is promoted by hormonal changes, particularly rising progesterone, which has soporific effects including increases in daytime sleepiness and decreases in sleep latency.[33,34] The current data support the contention that multiparous women may have more difficulty sleeping due to external demands related to child-rearing, partially captured in reports of increased

nighttime and early awakenings. Multiparous women also reported trouble sleeping due to discomfort in breathing and temperature.

Fewer parity-related differences in sleep quality were observed in the third trimester and postpartum. In late pregnancy, the physical growth of the fetus substantially impacts maternal sleep, with increased complaints of pain, shortness of breath, snoring, difficulty finding a comfortable position, frequent urination, and feeling hot.[35–37] As these factors affect women regardless of parity, fewer parity-related differences in sleep quality in later pregnancy are expected. Similarly, as the demands of having a newborn child at home and recovering from childbirth affect women regardless of parity, greater convergence in sleep quality among nulliparous and multiparous women during early postpartum as compared to early pregnancy is not unexpected.

The role of race

When compared to women of the same parity status, African American women tended to have poorer sleep characteristics than White women. Specifically, compared to women of the same parity, African Americans exhibited more frequent sleep disturbances, poorer subjective sleep quality, and worse sleep efficiency at some time points in pregnancy. However, despite these differences, statistically significant differences in overall sleep quality (total scores on PSQI), prevalence of poor sleep (PSQI >5), or prevalence of poor sleep efficiency were not observed based on race, with the exception of higher prevalence of poor sleep efficiency among multiparous African Americans compared to multiparous White Women in the third trimester.

As described earlier, prior studies demonstrate racial disparities in sleep even after accounting for socioeconomic status.[22,23] The relatively small racial differences observed in the current data set are likely a function of the demographic characteristics of the cohort; women in this study were almost exclusively from low socioeconomic backgrounds. This is a strength of this study, as women from lower socioeconomic backgrounds are underrepresented in this literature. However, it is likely that racial differences in sleep are more readily observable in studies inclusive of greater socioeconomic diversity; as has been observed with other health outcomes, evidence suggests that, compared to Whites, African Americans do not experience the same degree of improvement in sleep quality with increasing socioeconomic status.[38] Thus, because this sample was predominately of lower socioeconomic status, racial differences in the health-related burden of poor sleep are likely underestimated.

In addition, it is important to consider that even with similar exposure to sleep issues, African Americans may be more vulnerable to related adverse physical health effects. For example, in a cross-sectional study of >30,000 adults, the association between short sleep duration and cardiovascular disease was larger among non-Hispanic Blacks vs non-Hispanic Whites.[39] Similarly, our prior data have shown that poor sleep quality during the second trimester of pregnancy predicted immune dysregulation (ie, elevated serum interleukin-8) as well as risk for preterm birth among African Americans but not Whites.[13] Thus, racial differences in susceptibility to sleep-induced adverse health outcomes may exacerbate the ill effects of poor sleep among African Americans.

Limitations and implications for future studies

The current study did not explore psychological and psychosocial factors contributing to sleep in women of either race. For example, prior data link exposure and perceptions of racial discrimination to poor sleep in African Americans, including during pregnancy.[40–43] In addition, experiences of anxiety, pregnancy-specific distress, depressed mood, and/or exposure to childhood abuse may contribute to observed differences by race and parity.[12,44–47] In particular, mental health disorders have been associated with greater differences in subjective sleep quality than in objective measures in pregnant women.[48] These are questions that could be addressed empirically in a larger sample.

Although analyses presented were planned a priori, multiple analyses were conducted using the PSQI data. Thus, results should be interpreted appropriately, with a goal for future replication. In addition, this study did not capture other indicators of sleep health, including restless leg syndrome and sleep disordered breathing (SDB), which are common in pregnancy.[2,37] In particular, relevant to the limited snoring data captured herein, several studies have shown associations between maternal SDB and risk for outcomes including gestational diabetes, hypertensive disorders, and preterm birth.[9,14,49–53]

The focus on the current study was subjective sleep quality. In addition to lack of assessment of SDB, objective indicators of sleep (eg, duration, architecture) were not included. Prior data using polysomnography in 29-33 women assess during each trimester of pregnancy and 1 and 3 months postpartum showed changes in sleep by 11-12 weeks of gestation, with increases in total sleep time but also less deep sleep and more frequent nighttime wakings.[54] In addition, at 3 months postpartum, improvement was observed in some sleep characteristics, but sleep efficiency remained lower than prepregnancy baseline values.[54] Self-rated sleep quality and objective sleep assessments reflect different constructs and do not necessarily correspond strongly with each other.[55] Prior studies have demonstrated greater racial differences in sleep health measured objectively vs subjectively.[22] As these capture different aspects of sleep health, simultaneous assessment provides the most robust approach and should be a goal in future studies.

As a self-report measure, this study used the PSQI. This measure shows good internal consistency and construct validity when used in pregnancy as well as predictive value for health outcomes in pregnancy and postpartum.[56–58] However, limitations should be noted. In particular, in assessing the number of nighttime arousals, waking due to childcare needs best fits in the category of "other reasons" but also might be reported in the "night time or early morning awakening" category, which could overestimate frequency of sleep disturbances of this type. In contrast, the maximum response option for these categories is "three or more times per week," when in actuality many women experience this multiple times per night every night. This could create a considerable ceiling effect whereby variability in frequency of night time awakening due to a child is not fully reflected. Thus, this subscale largely reflects the number of *types* of factors that result in night wakings (eg, bad dreams, feel too hot, have pain, other) rather than the total *number* of wakings. This is reflected in our data in which total sleep disturbance scores as captured by the PSQI were actually lower during the postpartum period than during the third trimester ($P < .001$), whereas examination of specific types of wakings was more nuanced. For example, bathroom use at night was higher in pregnancy than postpartum, whereas nighttime or early morning awakenings were higher in postpartum than in pregnancy. Future research should refine a sleep measure that better quantifies frequency and intensity of these specific sleep disturbances occurring in pregnancy, postpartum, and in parenthood more generally, as such sleep disturbances in women with young children extend well past the infancy stage.[59]

The PSQI also does not assess difficulty in reinitiating sleep after multiple wakings, although this is reflected to some extent in the sleep efficiency score. In addition, napping is not assessed in the PSQI; up to 78% of pregnant women report daytime naps.[37] As the PSQI is broadly used in pregnancy as well as nonpregnancy, its use provides the advantage of comparability with other studies. To address limitations, some have opted to supplement the PSQI with

additional questions regarding frequency and duration of nighttime wakings, ability to fall back to sleep after wakings, and frequency and duration of naps for use in pregnancy and postpartum.[37,60] In addition, the PSQI inquires as to sleep in the past month, per self-report. Retrospective reporting is prone to biases in memory. Supplemental assessment using daily diary would provide useful corroborating information and may show stronger predictive validity. However, this approach does add to participant burden and study feasibility. In sum, although the PSQI is a useful and clinically relevant measure in the perinatal period, its limitations should be recognized.

In the current study, a standard cutoff of >5 on the PSQI was used. Other studies suggest that, given the variety of physical symptoms that accompany pregnancy, a higher cutoff on the PSQI may be more appropriate.[61] However, the focus of the current analyses was on prevalence of poor sleep in pregnant women as compared to standardly used metrics. Therefore, the standard cutoff of >5 on the PSQI was examined. Given the number of analyses conducted, we did not repeat these using different cutoffs because this would increase concerns related to multiple testing.

There were no differences by race or parity in the use of sleeping medications, but this may be a function of infrequent endorsement, requiring a larger sample to capture such effects. Commonly used sleep-promoting medications confer risks during pregnancy, particularly benzodiazepines which are linked with higher rates of preterm birth and small-for-gestational age infants.[62] Fortunately, behavioral approaches to improving sleep quality are highly effective and do not present the risks of pharmacotherapy. In particular, cognitive-behavioral therapy for insomnia (CBT-I) is a highly efficacious treatment,[3] and preliminary data support effectiveness in pregnant populations, as well as preference for CBT-I over alternative options such as pharmacotherapy and acupuncture.[63,64] However, modifications should be considered during the perinatal period. For one, although sleep restriction is highly effective in reducing sleep latency and increasing sleep efficiency, more lenient restriction windows may be appropriate in pregnancy and postpartum. Similarly, more permissive napping should be considered, as evidence suggests that daytime napping has minimal effects on nighttime sleep in pregnant women.[65] Additional aspects of CBT-I such as stimulus control, relaxation, and cognitive restructuring demonstrate clinical utility and are not contraindicated in pregnancy or postpartum.[66] Finally, the sleep of one partner substantially affects other,[67,68] and poor paternal sleep is also seen during pregnancy as well as postpartum.[69] Interventions targeting partners, and the full family unit, may be beneficial.

Conclusions

In sum, these data highlight the prevalence of poor sleep among pregnant women from lower socioeconomic backgrounds. The notable effects of parity on sleep parameters, particularly during early to midpregnancy, as well as some observed effects of race on characteristics of sleep quality highlight the importance of considering individual differences influencing sleep health in pregnancy. Lack of accounting for such factors in epidemiological studies may mask clinically meaningful group differences. In addition, better knowledge of these factors will guide clinical practice. Ultimately, understanding patterns and predictors of sleep quality across pregnancy and postpartum has implications for not only maternal quality of life but also risk of depression and adverse birth outcomes.

Conflict of interest

The authors report no conflicts.

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