Sleep Disturbances in Pregnancy

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OBJECTIVE: To estimate the prevalence and patterns of sleep disturbances during pregnancy among healthy nulliparous women.

METHODS: This was a prospective, cohort study of healthy nulliparous women, recruited between 6 and 20 weeks of gestation, who completed a baseline sleep survey at enrollment with follow-up in the third trimester. The survey was composed of the following validated sleep questionnaires: Berlin Questionnaire for Sleep Disordered Breathing, Epworth Sleepiness Scale, National Institutes of Health/International Restless Legs Syndrome Question Set, Women's Health Initiative Insomnia Rating Scale, and the Pittsburgh Sleep Quality Index. Differences in sleep characteristics between the baseline and third trimester were compared using the paired *t* test or McNemar test for continuous or categorical data, respectively.

RESULTS: One hundred eighty-nine women completed both baseline and follow-up sleep surveys. The mean gestational age was 13.8 (±3.8) and 30.0 (±2.2) weeks at the first and second surveys, respectively. Compared with the baseline assessment, mean sleep duration was significantly shorter (7.4 [±1.2] hours compared with 7.0 [±1.3] hours, $P<.001$), and the proportion of patients who reported frequent snoring (at least three nights per week) was significantly greater (11% compared with 16.4%, $P=.03$) in the third trimester. The percentage of patients who met diagnostic criteria for restless leg syndrome increased from 17.5% at recruitment to 31.2% in the third trimester ($P=.001$). Overall poor sleep quality, as defined by a Pittsburgh Sleep Quality Index score greater than 5, became significantly more common as pregnancy progressed (39.0% compared with 53.5%, $P=.001$).

CONCLUSION: Sleep disturbances are prevalent among healthy nulliparous women and increase significantly during pregnancy.

(Obstet Gynecol 2010;115:77–83)

LEVEL OF EVIDENCE: II

Several investigators have reported associations between sleep disturbances and hypertension, coronary artery disease, diabetes, and depression.[1,2] Most of these associations have been established in the middle-aged and elderly populations. Recent investigations have studied younger individuals, and these studies have also demonstrated a link between sleep disorders and adverse health outcomes.[3–5] However, these studies have not included pregnant women, and there has been little assessment as to whether sleep abnormalities are also associated with adverse health consequences during pregnancy.

The possibility that sleep abnormalities are associated with pregnancy complications is biologically plausible. First, pregnancy has been linked to alterations in sleep.[6–8] Insomnia, snoring, and restless legs syndrome are reported commonly by pregnant women.[6–8] Second, outcomes that have been linked to poor sleep in the nonpregnant population, such as hypertension, diabetes, and depression, have correlates in pregnancy (eg, gestational diabetes, gestational hypertension, postpartum depression). The first step in evaluating the contribution of sleep disturbances to obstetric complications is to fully understand the prevalence and patterns of sleep disturbances during pregnancy. Prior reports on sleep and pregnancy have provided some useful but limited information.[9–16] Several studies have focused only on specific sleep disturbances (eg, snoring),[9,12,14–16] and most have evaluated a very heterogeneous population and did not exclude women with preexisting medical conditions. Also, few studies have evaluated changes in sleep disturbances across pregnancy.[10,11,13–15] These

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Financial Disclosure
The authors did not report any potential conflicts of interest.

ISSN: 0029-7844/10

patterns of change may be of particular relevance to health outcomes given that many pregnancy complications do not manifest until the latter half of pregnancy; only those sleep abnormalities that are persistent or increase substantially may be associated with differences in outcomes. Correspondingly, the objective of this study was to estimate the prevalence of sleep disturbances among healthy nulliparous women and to quantify changes in sleep during pregnancy.

MATERIALS AND METHODS

This study was a prospective observational study conducted at Northwestern Memorial Hospital. The study was approved by the Institutional Review Board of Northwestern University. Patients were recruited in the outpatient setting from among women who received care at Northwestern-affiliated practices. These practices serve women who have both government-based and private health insurance. Women were approached for participation if they were nulliparous and had a singleton gestation. Because other morbidities could contribute to or be associated with sleep abnormalities, women with particular medical conditions were excluded. These conditions included chronic hypertension, heart disease, chronic lung disease, pregestational diabetes, chronic renal disease, and autoimmune disease (excluding treated hypothyroidism). Women who were eligible and agreed to participate provided informed consent.

The population was derived as a convenience sample, and participants were recruited over a 16-month period from February 2007 to June 2008. Study participants were asked to complete a sleep questionnaire in early pregnancy (6–20 weeks) and then again in the third trimester (28–40 weeks). This questionnaire included demographic information such as maternal age, ethnoracial status, prepregnancy weight, employment status, and work schedule. As detailed below, the questionnaire also contained items from several validated sleep surveys in an effort to obtain a comprehensive assessment of the participant's sleep characteristics.

The sleep questionnaire was self-administered and composed of five validated sleep surveys: the Berlin Questionnaire for Sleep-Disordered Breathing, the Epworth Sleepiness Scale, the National Institutes of Health/International Restless Legs Syndrome Question Set, the Women's Health Initiative Insomnia Rating Scale, and the Pittsburgh Sleep Quality Index. The Berlin Questionnaire consists of questions related to the risk of having sleep-disordered breathing (ie, sleep apnea).[17] This questionnaire was used to assess snoring and nocturnal apnea symptoms. Frequent snoring was defined as snoring three or more nights per week. The Epworth Sleepiness Scale was used to determine the level of daytime sleepiness. Epworth Sleepiness Scale scores range from 0–24. Excessive daytime sleepiness was defined as a total score of 10 or more.[18] The National Institutes of Health/International Restless Legs Syndrome Question Set is composed of four questions aimed at providing a diagnosis of restless legs syndrome and assessing symptom frequency.[19] The Women's Health Initiative Insomnia Rating Scale is a five-item survey assessing perceived insomnia symptoms.[20] Scores range from 0–20, with scores greater than or equal to 9 indicating clinically significant insomnia.[20,21] The Pittsburgh Sleep Quality Index is a self-rated questionnaire that assesses sleep quality and disturbances over a 1-month time interval. Nineteen individual items generate seven component scores for subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbances, use of sleeping medication, and daytime dysfunction. The sum of the scores for these seven components yields one global score. Global Pittsburgh Sleep Quality Index scores range from 0–21; an overall score greater than 5 indicates poor sleep quality.[22] The Pittsburgh Sleep Quality Index questions were also used to assess average sleep duration. Participants who reported sleeping on average less than 7 hours per night were considered to have short sleep duration.

To assess overall changes between the baseline and third-trimester surveys, participants were classified as having "stable," "improved," or "worsening" sleep. For example, if an individual reported frequent snoring at the time of the initial survey and still reported this symptom in the third trimester, they were classified as stable regarding frequent snoring. Similarly, if a participant did not complain of frequent snoring at either time point, they were also classified as stable. If an individual's snoring resolved in the third trimester, they were categorized as improved. In contrast, if they reported a new onset of frequent snoring in the third trimester, they were categorized as worsening.

The prevalence of different sleep disorders was estimated using descriptive analyses. Differences in sleep characteristics between the baseline and third trimester were compared using the paired t test or McNemar test for continuous or categorical data, respectively. Associations were explored between sleep patterns and patient characteristics through the use of the t test for continuous variables and the χ^2 test for categorical variables. Multivariable logistic regression was used to estimate the independent association of these patient characteristics with the prob-

Table 1. Demographics of Participants

Characteristic	Value
Age (y)	29.7 (±5.5)
Ethnoracial status	
White	117/189 (61.2)
African American	28/189 (14.8)
Hispanic	21/189 (11.1)
Other	23/189 (12.2)
Prepregnancy BMI	24.1 (±5.4)
Insurance	
Public aid	36/189 (19)
Private	153/189 (81)
Employed	
Initial survey	159/189 (84)
3–5 d/wk or more	136/159 (86)
Fixed night or evening*	4/159 (3)
Third trimester	153/189 (81)
3–5 d/wk or more	132/153 (86)
Fixed night or evening*	6/153 (4)

BMI, bone mineral density.
Data are mean (±standard deviation) or n (%).
* Fixed evening work, 4 PM–12 AM; fixed night work, 7 PM–7 AM.

ability of sleep disturbances. All tests were two-tailed and a value of $P<.05$ was considered statistically significant. Statistical analysis was performed using SPSS 17.0 statistical software (SPSS, Inc., Chicago, IL).

Accounting for the paired design, and assuming the prevalence of any one sleep disturbance to be 15% at baseline,[1] we calculated that 180 participants would be needed to detect a 2.5-fold change in any sleep parameter across pregnancy, with an $\alpha=.05$ and a power of at least 80%. On the assumption of a 10% rate of loss to follow-up, we established a target sample size of 200.

RESULTS

Of the 224 eligible women who were approached, 202 (90%) agreed to participate and completed the baseline survey. One hundred eighty-nine of these women participated in the third-trimester survey as well. The mean gestational age was 13.8 (±3.8) and 30.0 (±2.2) weeks at the first and second surveys, respectively. Demographic characteristics of the study population are provided in Table 1. As illustrated by these data, the population was socioeconomically diverse. A majority of women worked at least part-time, largely during the day. Of note, most women who worked during early pregnancy continued to work through the third trimester.

Baseline sleep survey results for the entire cohort are shown in the top row of Table 2. In early pregnancy, sleep disturbances were relatively common. At the time of the first survey, 11% reported frequent snoring, 17.5% met criteria for restless legs syndrome, and short sleep duration was reported by 26% of participants. Nearly 40% of women reported poor overall sleep quality (Pittsburgh Sleep Quality

Table 2. Prevalence of Sleep Disturbances at Baseline by Patient Characteristic

	Frequent Snoring	Excessive Daytime Sleepiness (ESS Score 10 or More)	Restless Legs Syndrome	Insomnia (WHI-IRS Score 9 or More)	Short Sleep Duration	Poor Sleep Quality (PSQI Score More Than 5)
All participants	11.1	32.8	17.5	37.6	26.2	39.0
Age (y)						
Younger than 24 (n=32)	18.8	46.9	18.8	28.1	16.1	28.1
24–34 (n=126)	9.5	27.8	15.9	37.6	26.4	37.6
35 or older (n=31)	9.7	38.7	22.6	45.2	32.3	54.8
BMI						
Less than 25 (n=129)	6.2	31.8	17.1	32.5	22.7	35.9
25–29 (n=34)	20.6	38.2	14.7	41.2	30.3	35.3
30 or higher (n=26)	23.1*	30.8	23.1	42.3	34.6	57.7
Ethnoracial status						
White and other (n=140)	7.9	31.4	18.6	34.5	22.3	33.1
African American (n=28)	32.1	57.1	10.7	46.4	33.3	57.1
Hispanic (n=21)	4.8*	9.5*	19.0	42.9	38.1	52.4†
Employment status						
Working (n=159)	10.1	31.4	18.9	39.9	28.5	39.9
Not working (n=30)	16.7	40.0	10	23.4	10.3†	33.3

ESS, Epworth Sleepiness Scale; WHI-IRS, Women's Health Initiative Insomnia Rating Scale; PSQI, Pittsburgh Sleep Quality Index; BMI, body mass index.
Data are %.
* $P<.01$.
† $P<.05$.

Index score more than 5). The prevalence of sleep disturbances by different patient characteristics is also presented in Table 2. Logistic regression models of the likelihood of sleep disturbances at baseline were used to estimate the simultaneous effects of age, ethnoracial status, body mass index (BMI), and employment status (Table 3). Obesity (BMI 30 or higher) and African-American ethnoracial status were associated with frequent snoring. Short sleep duration was more common among employed participants. Age older than 35 years as well as African-American and Hispanic ethnoracial status were associated with poor overall sleep quality (Pittsburgh Sleep Quality Index score more than 5).

In the third trimester, the percentage of patients reporting significant sleep disturbances increased (Table 4). Regarding sleep-disordered breathing symptoms (eg, snoring, nocturnal apneas, and daytime sleepiness), the increase in frequent snoring was particularly marked (11.1% to 16.4%, P=.03). Throughout pregnancy, witnessed nocturnal apneas were reported infrequently (2/189 and 4/189 at baseline and the third trimester, respectively). Excessive daytime sleepiness (Epworth Sleepiness Scale score 10 or higher) was common among women at both time points, with no significant changes as pregnancy progressed. The percentage of women whose test results were positive for restless legs syndrome increased significantly from 17.5% to 31.2% (P=.001). At the time of the initial survey, 15.2% of restless legs syndrome–positive patients reported severe symptoms (symptom frequency 5 d/wk or more), which increased to 27.1% in the third trimester. Notably, the percentage of women reporting a short sleep duration increased from 26.2% to 39.9% (P=.001), and the percentage of participants reporting poor overall sleep quality (Pittsburgh Sleep Quality Index score more than 5) increased from 39.0% to 53.5% (P=.001).

Table 3. Logistic Regression Models of the Likelihood of Sleep Disturbances at Baseline: Evaluation of the Simultaneous Effects of Age, Ethnoracial Status, Body Mass Index, and Employment Status

	Frequent Snoring	Excessive Daytime Sleepiness	Restless Legs Syndrome	Insomnia	Short Sleep Duration	Poor Sleep Quality
Age (y)						
24–34 (n=126)	Referent	Referent	Referent	Referent	Referent	Referent
Younger 24 (n=32)	1.20 (0.33–4.39)	1.96 (0.76–5.06)	1.97 (0.62–6.35)	0.55 (0.20–1.48)	0.46 (0.14–1.48)	0.31 (0.11–0.92)
35 or older (n=31)	1.27 (0.31–5.15)	1.82 (0.78–4.24)	1.47 (0.55–3.93)	1.47 (0.65–3.30)	1.46 (0.60–3.52)	2.34 (1.03–5.34)
BMI						
Less than 25 (n=129)	Referent	Referent	Referent	Referent	Referent	Referent
25–29 (n=34)	3.53 (1.13–11.04)	1.22 (0.53–2.79)	0.86 (0.29–2.50)	1.26 (0.57–2.79)	1.43 (0.59–3.45)	0.87 (0.38–2.02)
30 or higher (n=26)	3.85 (1.11–13.43)	0.81 (0.30–2.21)	1.86 (0.63–5.52)	1.45 (0.58–3.67)	2.06 (0.76–5.26)	2.36 (0.91–6.14)
Ethnoracial status						
White and other (n=140)	Referent	Referent	Referent	Referent	Referent	Referent
African American (n=28)	4.39 (1.35–14.25)	2.50 (0.98–6.36)	0.46 (0.11–1.86)	2.56 (0.98–6.71)	2.80 (0.98–8.0)	5.45 (1.91–15.57)
Hispanic (n=21)	0.45 (0.05–3.95)	0.21 (0.04–0.95)	0.88 (0.26–2.94)	1.57 (0.59–4.17)	2.38 (0.85–6.65)	2.79 (1.01–7.72)
Employment status						
Not working (n=30)	Referent	Referent	Referent	Referent	Referent	Referent
Working (n=159)	1.11 (0.30–4.10)	0.97 (0.39–2.45)	2.65 (0.67–10.52)	2.34 (0.86–6.36)	3.91 (1.01–15.06)	1.49 (0.57–3.95)

BMI, body mass index.
Data are odds ratio (95% confidence interval).

Table 4. Comparison Between Initial and Third-Trimester Sleep Survey Results

	Initial Survey	Third-Trimester Survey	*P*
Frequent snoring	21/189 (11.1)	31/189 (16.4)	.03
Excessive daytime sleepiness	62/189 (32.8)	72/189 (38.1)	.2
Mean ESS score	7.9 (±3.5)	8.7 (±3.6)	.001
RLS	33/189 (17.5)	59/189 (31.2)	.001
Insomnia	70/186 (37.6)	101/186 (54.3)	<.001
Mean sleep duration	7.4 (±1.2)	7.0 (±1.3)	<.001
Short sleep duration	48/183 (26.2)	73/183 (39.9)	.001
Poor sleep quality	73/187 (39.0)	100/187 (53.5)	.001
Mean PSQI score	5.4 (±2.9)	6.3 (±3.2)	<.001

ESS, Epworth Sleepiness Scale; RLS, restless legs syndrome; PSQI, Pittsburgh Sleep Quality Index.
Data are n (%) or mean (±standard deviation).

Sleep trends (ie, stable, improved, or worsening) for each sleep measure are shown in Table 5. We used a logistic regression model to estimate which patient characteristics were associated with worsening sleep. Worsening (ie, new-onset) short sleep duration was the only sleep measure to be associated with demographic characteristics. Younger individuals (younger than 24 years) were less likely to report a new onset of short sleep duration (odds ratio [OR] 0.2, 95% confidence interval [CI] 0.06–0.99). In contrast, obese and Hispanic women were more likely to report new-onset short sleep duration in the third trimester (OR 2.4, 95% CI 1.00–5.96; and OR 2.9, 95% CI 1.02–9.47, respectively).

DISCUSSION

The results of this study indicate that sleep disturbances are prevalent among healthy nulliparous women and increase significantly during pregnancy. This is one of a small number of studies that have comprehensively evaluated sleep across pregnancy. Of the few studies that have examined this issue, most have reported similar trends. Pien et al observed an 11.4% increase in sleep-disordered breathing symptoms during pregnancy.[14] Hedman et al reported that sleep duration decreases in the third trimester, whereas frequent snoring, restless legs, and nightly awakenings all increase significantly.[10]

Table 5. Sleep Trends Across Pregnancy

	Stable	Improved	Worsening
Frequent snoring	171/189 (91)	4/189 (2)	14/189 (7)
Excessive daytime sleepiness	137/189 (73)	21/189 (11)	31/189 (16)
RLS	133/189 (70)	15/189 (8)	41/189 (22)
Insomnia	119/189 (63)	19/189 (10)	49/189 (26)
Short sleep duration	128/183 (70)	15/183 (8)	40/183 (22)
Poor sleep quality	126/187 (67)	17/187 (9)	44/187 (24)

RLS, restless legs syndrome.
Data are n (%).

Our study also assessed the relationships between age, BMI, ethnoracial status, employment status, and sleep in pregnancy. Age, obesity and ethnoracial origin have been associated with poor sleep in nonpregnant cohorts.[23–26] We found similar associations in this healthy pregnant population. Additionally, we found a relationship between sleep and employment status. Women who worked were more likely to report short sleep duration, pointing to the fact that environmental factors can significantly affect sleep patterns. Certain environmental factors, such as work schedule, are potentially modifiable, and addressing these issues could lead to interventions that improve sleep during pregnancy.

Of particular interest are our findings regarding short sleep duration and sleep-disordered breathing during pregnancy. During the third trimester, nearly 40% of participants reported sleeping on average less than 7 hours per night, and more than 16% percent reported frequent snoring. Outside of pregnancy, short sleep duration and sleep-disordered breathing have been linked to obesity, diabetes, hypertension, and coronary heart disease.[5,27–33] Research has found that short sleep duration and sleep-disordered breathing are associated with elevated levels of proinflammatory cytokines and oxidative stress markers. It is thought that the enhanced inflammatory and oxidative stress response caused by these sleep disorders promotes endothelial damage and metabolic derangements, which ultimately lead to conditions such as hypertension and non–insulin-dependent diabetes mellitus.[34–37] Given the frequency of short sleep duration and sleep-disordered breathing symptoms during pregnancy, and the evidence implicating inflammation and oxidative stress as key factors in the pathogenesis of obstetric complications, principally preterm birth and preeclampsia,[38–40] it is certainly biologically plausible that short sleep duration and sleep-disordered breathing during pregnancy may contribute to adverse pregnancy outcomes. At present, few studies have addressed this possibility. There are some limited data, principally from retrospective cohorts and case–control studies, suggesting an association between sleep-disordered breathing and preeclampsia.[9,41,42] Further studies (above all, prospective investigations) are needed to explore and understand the impact of sleep disorders on obstetric outcomes.

The main strength of this study is its prospective design with serial questionnaires that permitted the assessment of sleep trends across pregnancy. In addition, the study population was limited to healthy nulliparous women. By choosing to limit our population in this way, we minimized or eliminated certain potential confounding factors, principally sleep disturbances caused by child care and medical conditions. The principal limitation of this study is that it only assessed subjective sleep symptoms. As such, our results provide an estimate of sleep disturbance during pregnancy that ideally would be confirmed by further studies using objective measures of sleep duration and quality. In addition, although the questions/surveys we used have been validated outside of pregnancy, they have not been specifically studied in pregnant women. There are no sleep questionnaires that have been validated in pregnant women. Another limitation is that we were not able to collect prepregnancy sleep data. Ideally, a study of sleep trends in pregnancy would include surveys before pregnancy to compare prepregnancy sleep to both early and later pregnancy patterns. Hedman et al attempted to address this by asking pregnant women to report on their sleep patterns during the 3 months before pregnancy.[10] The validity of such retrospective reporting is unclear.

In summary, we found that sleep disturbances are common and increased in a cohort of young and healthy nulliparous women followed prospectively during pregnancy. Demographic factors, particularly ethnoracial status and BMI, are associated with baseline sleep complaints and sleep deterioration. Clinicians should be encouraged to discuss sleep concerns with their pregnant patients, as complaints are common and certainly may impact quality of life. However, further investigations are needed to determine whether poor sleep may be associated with obstetric complications and whether assessment and treatment of sleep disorders during pregnancy can improve outcomes.

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