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Original Article

Sleep patterns and sleep disturbances across pregnancy

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ABSTRACT

Objective: This study sought to characterize sleep patterns and sleep problems in a large sample of women across all months of pregnancy.
Methods: A total of 2427 women completed an Internet-based survey that included the Pittsburgh Sleep Quality Index (PSQI), Epworth Sleepiness Scale, vitality scale of the Short Form 36 Health Survey (SF-36), Insomnia Severity Index (ISI), Berlin questionnaire, International Restless Legs Syndrome (IRLS) question set, and a short version of the Pregnancy Symptoms Inventory (PSI).
Results: Across all months of pregnancy, women experienced poor sleep quality (76%), insufficient nighttime sleep (38%), and significant daytime sleepiness (49%). All women reported frequent nighttime awakenings (100%), and most women took daytime naps (78%). Symptoms of insomnia (57%), sleep-disordered breathing (19%), and restless legs syndrome (24%) were commonly endorsed, with no difference across the month of pregnancy for insomnia, sleep-disorder breathing, daytime sleepiness, or fatigue. In addition, high rates of pregnancy-related symptoms were found to disturb sleep, especially frequent urination (83%) and difficulty finding a comfortable sleep position (79%).
Conclusions: Women experience significant sleep disruption, inadequate sleep, and high rates of symptoms of sleep disorder throughout pregnancy. These results suggest that all women should be screened and treated for sleep disturbances throughout pregnancy, especially given the impact of inadequate sleep and sleep disorders on fetal, pregnancy, and postpartum outcomes.

Sleep disturbances are highly prevalent during pregnancy. To date, however, studies investigating this issue have predominantly assessed a single point of time or within a trimester. For example, one survey of 650 women in their third trimester compared current sleep patterns with retrospectively recalled sleep patterns prior to pregnancy [1]. In that survey, women reported significantly less total sleep by the end of pregnancy (8.1 to 7.5 h) and increased perceived poor sleep quality (18% to 61%). Pain, discomfort, and frequent urination most often contributed to sleep difficulties at the end of pregnancy. One-quarter of women reported snoring and a third reported significant daytime sleepiness. A similar study of 189 pregnant women recruited between 6 and 20 weeks who were recontacted during their third trimester similarly found that sleep duration decreased, with increased snoring (11% to 16%), increased symptoms consistent with restless legs syndrome (RLS; 18% to 31%), and decreased sleep quality (39% to 54% were "poor sleepers" based on the Pittsburgh Sleep Quality Index or PSQI) [2].

Other studies have assessed specific sleep disorders during pregnancy, including sleep-disordered breathing (SDB), RLS, and insomnia. Most studies have found that snoring and other symptoms of SDB are quite prevalent by the end of pregnancy. For example, one study of 500 women who completed surveys during their first and third trimester found that snoring increased from 7.9% to 21.2% [3]. Other studies have found similar rates of snoring in the third trimester [4]. Insomnia has been less studied; nevertheless, studies indicate that approximately 50% of women experience insomnia during pregnancy [2,5]. Finally, studies find that 18–24% of women meet the criteria for RLS during pregnancy, although the exact point in pregnancy when the women were surveyed in these studies was either not provided or at the end of the pregnancy [6–8].

While past studies have shown that sleep disturbances are highly prevalent during pregnancy, as noted above, these have typically focused on one or two time points or simply grouped all pregnant women together. To date, no single study has assessed sleep across all months of pregnancy. In addition, few studies have assessed both sleep patterns and the breadth of sleep disturbances. Thus, this study sought to characterize sleep patterns and sleep disturbances in a large sample of women across all months of pregnancy.

Abbreviations: SD, standard deviation; PSQI, Pittsburgh Sleep Quality Index; RLS, restless legs syndrome; SDB, sleep-disordered breathing.

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1. Method

1.1. Participants

Participants included 2427 pregnant women: at recruitment, < 2 months ($n = 346$), three months ($n = 298$), four months ($n = 282$), five months ($n = 269$), six months ($n = 265$), seven months ($n = 354$), and ≥8 months ($n = 613$).

1.2. Procedure

All data were collected online. The questionnaire was set as a pop-up screen on BabyCenter, a popular pregnancy website. Completion of the questionnaire was voluntary, there were no exclusionary criteria, and the study was approved by the Institutional Review Board of Saint Joseph's University. No identifying information was collected. Participants were asked to provide their e-mail address at the end of the survey if they were interested in being included in a raffle drawing. The total sample was collected over a 4-day period in April 2014. All participants completed the PSQI and the Epworth Sleepiness Scale. To reduce study attrition, half of the participants were randomly assigned to complete the Insomnia Severity Index (ISI), the Berlin questionnaire, and the vitality scale of the Short Form 36 Health Survey (SF-36); the other half were assigned to the International Restless Legs Syndrome (IRLS) questionnaire and the Pregnancy Symptoms Inventory (PSI). Demographic data were also collected. Data collection was originally set to close when each subset of questionnaires was completed by 130 subjects within each month of pregnancy. However, enrollment occurred so quickly that significantly more participants completed the study, especially those pregnant for ≥8 months.

1.2.1. Pittsburgh Sleep Quality Index [9]

The PSQI is a widely used and well-validated 19-item self-report instrument that measures sleep disturbances in adults [9]. The PSQI provides a global score ranging from no sleep difficulty to severe difficulties. A global score >5 indicates a "poor sleeper," and it has been shown to have a diagnostic sensitivity of 89.6% and a specificity of 86.5% [9]. The expanded version of the PSQI used in this study included additional questions about night wakings and naps, but these additional questions were not included in the global score. For quality control, respondents could not provide extreme data (eg, total sleep <3 h).

1.2.2. Epworth Sleepiness Scale

The Epworth Sleepiness Scale [10] is a widely used measure of daytime sleepiness [10], with scores ranging from 0 to 24. Excessive daytime sleepiness is defined as a total score of ≥10.

1.2.3. Insomnia Severity Index

The ISI [11] is a seven-item measure, with scores ranging from 0 to 28. Scores of ≥8 are considered subthreshold insomnia, with scores of ≥14 indicating insomnia.

1.2.4. Berlin Questionnaire for SDB

The Berlin Questionnaire [12] was used to assess snoring and risk of SDB. Scores on this questionnaire range from 0 to 6; a positive Berlin was a score of ≥2.

1.2.5. National Institutes of Health/IRLS question set

The IRLS question set [13] comprises four questions. The scale has demonstrated high levels of internal consistency, inter-examiner reliability, test–retest reliability, convergent validity, and criterion validity [14]. Individuals are considered positive for RLS when they endorse the four essential symptoms.

1.2.6. Vitality subscale of the SF-36

The SF-36 measures functioning and well-being with strong reliability and validity for both general and disease-specific populations [15], and it has been validated in pregnant women [16]. Participants completed the four-item vitality subscale (energy and fatigue). Scores range from 0 to 100 with higher values indicating increased energy/less fatigue.

1.2.7. Pregnancy Symptoms Inventory

Participants were asked how often a list of 15 symptoms – derived from the PSI [17] – interfered with their ability to fall asleep or stay asleep. Participants responded to each symptom as "never," "rarely," "sometimes," or "often." A symptom was considered endorsed if the participant indicated "sometimes" or "often." The PSI has demonstrated good test–retest reliability and validity.

1.3. Statistical analyses

Means and frequencies were used for demographic information. Analyses of variance were used to compare sleep variables across the month of pregnancy, with effect sizes (partial η^2) reported for all comparisons. Multivariate analyses of covariance (MANCOVAs) were performed across the month of pregnancy on the following sleep pattern continuous variables: (1) bedtime (2) sleep-onset latency, (3) duration and number of night wakings, (4) nighttime sleep, (5) wake time, (5) total sleep time, and (6) daytime sleep (naps). In these analyses, age, education, employment status, additional children, and income were used as covariates to control for their effects. A separate MANCOVA was also conducted for sleep problem variables: (1) PSQI score, (2) Epworth score, (3) Berlin score, and (4) ISI score. Chi-squared analyses were conducted for categorical variables, including percentage of poor sleepers (PSQI), percentage of short sleepers (≤6 h), and sleep-related symptom variables. Effect sizes reported for chi-squared analyses are phi (ϕ). Logistic regression using month of pregnancy, education, employment status, income, age, and primiparous versus multiparous status as predictors was conducted to predict poor versus good sleep using the PSQI total score (>5 = "poor") and daytime sleepiness. To ensure that the unequal sample sizes, especially the large sample of women who were in their 8th month of pregnancy, were not affecting the results, all analyses were duplicated: (1) restricting all groups to the first 260 enrolled participants and (2) restricting just the 8-month group to the first 260 participants and including all others. Descriptive results were nearly identical and no differences were found in statistical outcomes; thus, all analyses reported include the entire sample to maintain increased power. Because of the large cohort size and the multiple analyses, findings for individual analyses were considered significant if $P < 0.001$.

2. Results

2.1. Demographics

Complete demographic data for the entire sample are provided in Table 1. Most women were between the ages of 25 and 34 years (63.1%) and Caucasian (56.2%). Approximately half had a college education (57.8%) and half were employed full time (51.5%). The sample was almost evenly split between those with household incomes under $50,000 (41.9%) and those over (58.1%). Approximately half (51.8%) of the participants were multiparous. No significant differences were noted across month of pregnancy for any demographic variable.

Table 1
Participant demographics.

	Total %	Total *n*
Age of respondent		
18–24	17.0	413
25–29	29.2	708
30–34	33.9	822
35–39	15.9	386
40 +	4.0	98
Ethnicity		
African American	14.8	269
Asian/Pacific Islander	7.2	130
Caucasian	59.2	1077
Hispanic	17.0	309
Native American	3.0	55
Other/did not answer	7.4	135
Income		
Under $25,000	17.9	326
$25,000–$34,999	12.5	227
$35,000–$49,999	11.5	209
$50,000–$74,999	16.4	299
$75,000–$99,999	12.8	233
$100,000–$124,999	8.7	158
≥ $125,000	10.8	196
Did not answer	9.4	170
Employment status		
Full time	51.5	936
Part time	13.3	242
Home/student	29.1	530
Other	4.5	110
Education		
Some high school	2.8	51
High school	11.0	200
Some college	27.6	502
College	34.7	631
Postgraduate	23.1	420

2.2. Sleep patterns

Data on nighttime and daytime sleep are presented for each month of pregnancy (Tables 2, 3, and 4). MANCOVA analysis revealed an overall significant effect for sleep patterns for the independent variable month of pregnancy (*Wilks'* $\lambda = 0.90$; $F = 4.60$; $P < 0.001$). Significant differences across pregnancy were found for bedtime, number and duration of night wakings, nighttime sleep, and total sleep duration. Overall, women later in pregnancy had later bedtimes, increased number and duration of night wakings, less nighttime sleep, and less total sleep, although there were minimal effect sizes for these variables. Overall, 37.9% of women obtained short nighttime sleep (≤6 h), with women at the end of pregnancy more likely to get short sleep (51.4%) than women at the start of pregnancy (30.3%; $\chi^2 = 72.69$, $P < 0.001$). Most women reported napping a least once a week (77.7%) with no significant differences across month of pregnancy ($P = 0.173$). Overall, total sleep duration across the 24 h averaged 7.28 h, with total sleep decreasing across pregnancy from 7.61 to 6.85 h ($F = 13.73$, $P < 0.001$).

Table 3
Daytime and total sleep variables across month of pregnancy.

	Number of days nap per week		Nap duration (min)		Total sleep across 24 h (h)	
	Mean	SD	Mean	SD	Mean	SD
≤2 months	2.41	2.21	91.12	47.81	7.58	1.75
3 months	2.61	2.14	85.83	40.30	7.58	1.76
4 months	2.34	2.04	86.52	45.54	7.61	1.72
5 months	2.27	2.10	93.35	47.32	7.47	1.66
6 months	2.07	2.03	85.94	43.09	7.19	1.54
7 months	2.26	2.05	88.70	44.51	7.13	1.51
≥8 months	2.50	2.13	86.99	40.64	6.85	1.60
Total	2.37	2.11	88.20	43.82	7.28	1.67
ANOVA	2.23*		0.99		13.73***	
Effect size	0.01				0.03	

*$P < 0.05$; **$P < 0.01$; ***$P < 0.001$.

2.3. Sleep disturbances

MANCOVA analysis revealed an overall minimally significant effect for sleep problem scales (PSQI, Epworth, ISI, and Berlin) for the independent variable month of pregnancy (*Wilks'* $\lambda = 0.94$; $F = 1.75$; $P = 0.014$). As assessed via the PSQI global score, most (76.3%) women reported poor sleep, ranging from 72.0% to 72.8% during months 4, 5, and 6, to 83.5% at 8 + months (see Table 4). Month of pregnancy, age, other children, education level, employment status, and income significantly predicted poor (PSQI > 5) versus good sleep ($F(6.1811) = 13.20$, $P < 0.001$), although these variables accounted for only 4.2% of the variance. Month of pregnancy ($t = 3.58$), education ($t = 4.56$), and income ($t = 4.07$) significantly predicted sleep quality, with increased month of pregnancy, lower education, and lower income predicting higher likelihood of poor sleep ($P < 0.001$). Primiparous versus multiparous status did not predict sleep quality.

Disturbed sleep patterns were very common (Tables 2 and 4); for instance, one-third of women (33.1%) noted that it took them >30 min to fall asleep. Waking at least once per night was universal (96.8–100.0%) throughout pregnancy (average = 2.71 times per night for 70.5 min). A small percentage of women (4.4%) took sleep medications at least three times per week. However, 11.4% indicated that they had taken sleep medications at some point in the past month, with no difference across month ($P = 0.450$).

Approximately half of the women (49.3%) experienced significant daytime sleepiness as assessed by the Epworth; no difference in prevalence was noted across month of pregnancy (Table 5). Month of pregnancy, age, other children, education level, employment status, and income did not predict daytime sleepiness (Epworth

Table 2
Nighttime sleep variables across month of pregnancy.

	Bedtime		Sleep-onset latency (min)		Number of wakings		Duration of wakings (min)		Wake time		Nighttime sleep (h)	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
≤2 months	10:17	1.33	49.25	48.98	2.34	1.20	60.18	63.09	6:50	1.48	7.01	1.58
3 months	10:08	1.36	47.62	49.45	2.47	1.18	74.11	68.82	6:53	1.55	7.02	1.65
4 months	10:23	1.30	44.06	44.27	2.50	1.23	61.73	62.18	7:06	1.44	7.10	1.55
5 months	10:15	1.37	45.59	44.07	2.56	1.16	63.30	62.98	6:46	1.54	6.93	1.53
6 months	10:33	1.36	43.75	44.27	2.53	1.13	73.59	69.33	7:01	1.40	6.75	1.53
7 months	10:29	1.19	51.20	49.00	2.84	1.24	71.06	64.88	6:54	1.51	6.63	1.45
≥8 months	10:29	1.37	51.56	48.52	3.19	1.30	79.93	68.33	6:53	1.54	6.31	1.51
Total	10:23	1.33	48.31	47.41	2.71	1.26	70.48	66.33	6:54	1.50	6.75	1.56
ANOVA	4.27 ***		1.67		26.14***		4.94***		1.68		14.97***	
Effect size	0.01				0.06		0.01				0.04	

*$P < 0.05$; **$P < 0.01$; ***$P < 0.001$.

Table 4
Percent sleep problems based on PSQI.

	Felt too hot (3 + /week)	Taken sleep medication (3 + /week)	Taken sleep medication (past month)	Trouble staying awake (3 + /week)	Lack of enthusiasm considered a "big problem"	Percent poor sleepers (PSQI)	PSQI score	Sleep-onset latency >30 min	Wake during the night	Short night sleep (≤6 h)	Short total sleep (≤6 h)	Nap during the day
<2 months	31.5	4.3	11.3	11.0	13.0	74.0	8.08	60.4	96.8	30.3	17.1	77.5
3 months	33.2	4.4	11.7	10.1	28.2	76.2	8.52	59.1	97.0	32.6	17.8	81.2
4 months	22.3	3.9	12.8	7.1	15.6	72.0	7.92	56.4	97.9	30.5	16.7	79.4
5 months	23.0	2.2	7.4	7.4	14.5	72.5	7.81	56.1	97.8	32.3	17.5	75.5
6 months	30.6	4.5	11.6	6.4	11.3	72.8	8.32	55.8	97.0	33.2	20.8	72.1
7 months	33.6	2.8	11.7	4.2	11.6	75.1	8.55	62.1	100.0	40.1	22.3	771
8 months +	43.7	6.4	14.0	6.5	14.0	83.5	9.55	61.5	100.0	51.4	33.1	79.1
Total	33.0	4.4	11.6	7.4	15.2	76.3	8.55	59.3	100.00	37.9	22.4	77.7
Chi-squared/ANOVA	89.0***	11.0	9.0	41.1***	69.2***	25.8***	11.9	6.02	11.7	72.69***	59.39***	9.02
Effect size (ϕ)	0.19			0.13	0.17	0.10	0.03			0.17	0.16	

*$P < 0.05$; **$P < 0.01$; ***$P < 0.001$.

>10 + ; $F(6.1811) = 15.24$, $P = 0.013$). The addition of PSQI score and short total sleep predicted daytime sleepiness ($F(6.1811) = 2.71$, $P < 0.001$), although it accounted for only 6.3% of the variance. SF-36 vitality subscale scores were also quite low (mean = 32.12 out of 100), with no significant changes across month ($P = 0.012$). Snoring was reported by 29.8% of women and 18.8% received a positive Berlin score. RLS symptoms increased across pregnancy, ranging from 18.6% at three months to 31.8% at seven months, for an average of 24.4%. Finally, 57.3% of women obtained a score of ≥8 on the ISI, indicating at least subthreshold insomnia; 14.2% reported symptoms of significant insomnia, with no differences across month ($P = 0.730$).

Specific pregnancy-related physical symptoms were found to disturb sleep (Table 6). The most frequently reported cause of sleep disruption across all of pregnancy was frequent urination (83.1%), ranging from 72.3% at the start of pregnancy to 91.9% at the end. Being unable to find a comfortable position became almost universal by the end of pregnancy (94.1%), starting at 56.1% at <2 months with increasing prevalence each month. Other symptoms that increased across pregnancy were hip/pelvic pain, back pain, reflux, and leg cramps. As expected, nausea decreased from a high at three months (48.9%). Hunger (39.5%) and itchy skin (27.6%) remained relatively constant. There also were a number of psychologically based symptoms that disrupted sleep (Table 7). These included vivid dreams (43.5%) as well as worrying about the baby (38.7%), pregnancy (38.0%), and labor/delivery (23.2%). On average, pregnant women experienced 6.37 of these 15 total symptoms (standard deviation (SD) = 3.30); women early in pregnancy averaged fewer sleep-disrupting symptoms (mean = 5.00, SD = 2.88) than those at the end of pregnancy (mean = 7.73, SD = 3.04, $F(6.1063) = 14.37$, $P < 0.001$). As expected, worrying about the baby, pregnancy, and labor/delivery were all highly correlated ($r = 0.54–0.70$, $P < 0.001$). Back and hip/pelvic pain were also correlated ($r = 0.34$, $P < 0.001$), and both were associated with difficulty finding a comfortable position ($r = 0.27–0.31$, $P < 0.001$).

3. Comments

To the best of our knowledge, this study is the first large-scale survey of sleep during pregnancy that looked at data month by month. Across pregnancy, women experienced poor sleep quality, insufficient nighttime sleep, significantly disrupted sleep, and significant daytime sleepiness. Overall, 76% of the women were found to be poor sleepers, as assessed by the PSQI [9]. This rate of poor sleep is much higher than for women in the general population. For example, in a global study of women with young children (birth to 6 years), 55% were found to experience poor sleep; other studies have found rates of poor sleep in women ranging from 35% to 52% [18–20]. In our study, sleep was also highly disrupted across pregnancy, with almost all women reporting frequent night wakings (100% throughout most of pregnancy), averaging two to three times per night for over an hour per night. Pregnancy-related symptoms also affected the sleep of almost all the women surveyed, especially frequent urination and difficulty finding a comfortable position.

Unsurprisingly, daytime sleepiness was reported by almost half of the women. Almost 80% of the women reported taking naps, likely to compensate for both disrupted nighttime sleep and inadequate sleep duration. Thus, napping during the day should be considered the norm for pregnant women. Most women also reported decreased energy/increased fatigue throughout pregnancy, with scores significantly lower than published norms of vitality in women [15]. This decreased vitality was observed very early in pregnancy and did not change significantly over the course of pregnancy, which echoes the results of similar studies of pregnant women [21]. Notably, this finding is contrary to common lore that energy levels, as well as daytime sleepiness and sleep in general, are typically better in

Table 5
Percent sleep disturbances by month of pregnancy.

	Epworth score	% Epworth ≥10	Vitality subscale of the SF-36	Insomnia Severity Index (ISI)	ISI ≥8	ISI ≥14	Restless Legs Syndrome (RLS) (IRLS score = 4)	Snore (Berlin)	Berlin positive (score ≥ 2)
<2 months	9.69 (4.72)	54.3	30.96 (16.42)	8.54 (4.26)	53.5	15.3	19.3	24.8	14.9
3 months	10.17 (4.74)	50.3	29.89 (17.17)	9.44 (4.31)	60.7	16.3	18.6	27.4	21.6
4 months	9.46 (4.80)	48.6	34.19 (15.13)	8.85 (4.06)	59.4	12.0	24.6	26.3	19.7
5 months	9.41 (4.61)	49.1	33.26 (14.06)	8.35 (9.86)	61.5	14.6	24.6	34.1	21.6
6 months	9.32 (4.85)	47.5	35.08 (17.08)	7.74 (9.82)	55.9	11.8	33.3	24.2	15.7
7 months	9.66 (4.48)	49.4	33.21 (16.12)	9.21 (4.82)	53.7	17.2	31.8	35.2	23.4
8 months +	9.39 (4.57)	47.0	29.66 (14.04)	8.64 (3.91)	57.1	12.4	20.6	34.2	15.8
Total	9.57 (4.66)	49.3	32.12 (15.76)	8.70 (6.22)	57.3	14.2	24.4	29.8	18.8
Chi-squared/ ANOVA	1.24	5.35	2.75	1.10	3.61	3.33	16.52 *	9.76	6.94
Effect size (ϕ)							0.13		

* $P < 0.05$; **$P < 0.01$; ***$P < 0.001$.

the second trimester [22]. We saw no evidence of a "second-trimester honeymoon."

In addition, sleep was highly disrupted throughout the night not only by pregnancy-related symptoms but also by diagnosable sleep disorders. For instance, while RLS symptoms were found to be similar at the start of pregnancy as normative samples, these symptoms peaked at six months of pregnancy (33%). This suggests that health-care practitioners should be evaluating pregnant women for RLS symptoms, especially because treatments for RLS can be highly effective [23]. Finally, snoring was also highly prevalent (30%), with almost one in five pregnant women endorsing symptoms indicative of sleep apnea. A recent meta-analysis of 24 studies found that moderate-to-severe SDB is associated with gestational diabetes, pregnancy-related hypertension, preeclampsia, preterm delivery, low birth weight, intrauterine growth restriction, and low Apgar scores [24]. Note that, in our sample, we do not know whether any of the participants were experiencing any of these other medical concerns. However, given the multitude of potential negative outcomes, we suggest that all women be screened for SDB throughout pregnancy.

One interesting finding was the high prevalence of sleep-related medication use by women during pregnancy. Approximately one in 25 women reported medication use at least three times a week, and more than one in 10 reported use in the past month. Note that women with depression, which was not assessed in this study, may have been more likely to use a sleep aid. Given the general concerns about taking medications during pregnancy, the need for alternative treatment strategies to improve sleep throughout pregnancy clearly exists. Fortunately, there is extensive literature on the efficacy of non-pharmacologic interventions for sleep disorders, including insomnia and SDB [25,26]. Appropriate recommendations of strategies to ameliorate many of the pregnancy-related symptoms that impact sleep should be readily provided by health-care practitioners; such recommendations could significantly impact not only current sleep issues but also the potential negative outcomes associated with sleep disturbances during pregnancy, including fetal outcomes, obstetric outcomes, and postpartum depression [27,28].

As with all studies, a number of limitations should be considered when interpreting these findings. First, as expected from an Internet-based survey, the cohort in this study may have been skewed toward women with higher education and higher income, although half of the participants reported household incomes of <$50,000. If there was any bias, however, it was likely consistent across all months of pregnancy. Women with concerns about their sleep also may have been more likely to participate, but again these differences were likely consistent across all months. We also did not assess sleep prepregnancy. Furthermore, as always, relying on self-report has inherent limitations. Although the PSQI is a widely used instrument, it is based on subjective report. Interestingly, a recent study found that subjective report was more closely associated with negative postpartum outcomes than objective reports [29], suggesting the usefulness of continued use of this methodology. Finally, other information that might influence sleep throughout pregnancy was not collected, including body weight, physical health status, and mental health status.

This study is the first to provide normative data of sleep throughout each month of pregnancy. We found that women experience poor sleep across pregnancy, and that a substantial proportion of pregnant women do not get adequate sleep. Pregnant women reported high rates of symptoms associated with a multitude of sleep disorders, including insomnia, RLS, and SDB, as well as pregnancy-related symptoms that disrupt sleep. Notably, women experienced significant daytime sleepiness and low energy; these did not improve across pregnancy, contrary to commonly held beliefs that sleepiness

Table 6
Percent physical symptoms that disturbed sleep (sometimes/often) by month of pregnancy.

	Nausea	Hunger	Reflux	Leg cramps	Frequent urination	Back pain	Hip/pelvic pain	Itchy skin	Uncomfortable position	Baby movement	Contractions
<2 months	32.4	41.2	28.4	20.9	72.3	49.3	31.3	30.4	56.1	1.4	2.0
3 months	48.9	48.9	31.4	20.4	82.5	54.7	38.7	32.1	72.3	9.5	4.4
4 months	28.9	43.7	33.1	24.6	84.5	50.7	40.1	26.1	81.7	19.0	3.5
5 months	18.3	34.4	34.4	31.3	80.2	51.1	45.8	26.0	76.3	27.5	3.1
6 months	15.8	34.6	49.6	42.1	78.9	60.9	55.6	28.6	81.2	55.6	5.3
7 months	10.8	35.7	55.4	47.8	86.0	68.2	64.3	21.0	86.0	64.3	12.1
8 months +	21.6	38.7	68.0	50.0	91.9	70.3	74.8	28.8	94.1	68.0	31.1
Total	24.9	39.5	45.0	35.2	83.1	59.0	52.1	27.6	79.4	37.8	10.6
Chi-squared/ ANOVA	74.82***	10.09	96.48***	69.02***	28.12***	31.42***	102.11***	5.97	88.74***	308.94***	135.54***
Effect size (ϕ)	0.26		0.30	0.25	0.16	0.17	0.31		0.29	0.54	0.36

*$P < 0.05$; **$P < 0.01$; ***$P < 0.001$.

Table 7
Percent psychological symptoms that disturbed sleep (sometimes/often) by month of pregnancy.

	Vivid dreams	Worry about baby	Worry about pregnancy	Worry about labor/delivery
<2 months	43.2	34.5	37.2	16.2
3 months	52.6	50.4	54.0	26.3
4 months	52.1	36.6	37.3	21.8
5 months	46.6	32.8	34.4	16.0
6 months	39.1	41.4	41.4	23.3
7 months	42.7	37.6	29.9	25.5
8 months +	33.8	38.3	35.1	29.3
Total	43.5	38.7	38.0	23.2
Chi-squared/ANOVA	18.98**	11.64	21.46**	13.78*
Effect size (ϕ)	0.13		0.14	0.11

*$P < 0.05$; **$P < 0.01$; ***$P < 0.001$.

and fatigue improve during the second trimester. These results suggest that health-care providers should carefully screen for sleep disturbances throughout pregnancy, particularly given the impact of inadequate sleep and sleep disorders on fetal, pregnancy, and postpartum outcomes.

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Conflict of interest

Jodi Mindell has served as a consultant and speaker for Johnson & Johnson. Rae Ann Cook and Janeta Nikolovski are employees of Johnson & Johnson.

The ICMJE Uniform Disclosure Form for Potential Conflicts of Interest associated with this article can be viewed by clicking on the following link: http://dx.doi.org/10.1016/j.sleep.2014.12.006.

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