Disturbed sleep and preterm birth: A potential relationship?

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Summary

Purpose: Many women report disturbed sleep during pregnancy, but its impact on clinical outcomes remains unknown. This study examined subjective sleep quality and daytime sleepiness in relation to preterm birth. *Methods:* A convenience sample of 220 pregnant women completed the Pittsburgh Sleep Quality Index (PSQI), the Epworth Sleepiness Scale (ESS), and the Perceived Stress Scale (PSS) during the second trimester. Women who had preterm and full-term births were compared on these measures. *Results:* The preterm birth rate of the sample was 14.6 %. Sleep latency, the period from lights out to sleep onset, was significantly longer in the preterm group, which also reported a tendency to use more sleep medications, but had lower PSQI daytime dysfunction scores. Perceived stress did not differentiate preterm and full-term groups. *Conclusion:* Disturbed sleep in pregnancy may be associated with preterm birth. Future studies should examine specific physiological factors that underlie this increased vulnerability.

Key words: Pregnancy; Preterm birth; Sleep; Psychological stress.

Introduction

Prematurity, birth prior to 37 weeks of gestation, occurs in 12.7% of all births in the United States and is the primary cause of neonatal death and morbidity, accounting for over one-third (10,364) of infant deaths in 2005 [1, 2]. Associated morbidity includes a high prevalence of respiratory distress syndrome, necrotizing enterocolitis, and intraventricular hemorrhage which often result in permanent neurological disabilities [3]. The economic costs of prematurity are significant. Estimates from the Institute of Medicine [3] place the 2005 annual expense associated with preterm birth in excess of $26.2 billion. Given the widespread prevalence of this problem and the high human and economic costs, research increasing the elucidation of the factors that contribute to the development of preterm birth is an important public health priority.

Numerous physiological and psychosocial risk factors associated with preterm birth have been identified. Infection, a history of prior preterm birth, and Black race appear to be major determining factors. Other known risks include smoking, low socioeconomic status, multiple gestations, inadequate maternal weight gain, substance abuse, uterine anomalies, shortened cervix, short inter-pregnancy interval, and psychosocial stress. Such physiological and psychological stressors associated with preterm birth are believed to activate the maternal/fetal hypothalamic pituitary adrenal (HPA) axis and immune/inflammatory processes, ultimately triggering the uterine and cervical changes that result in preterm labor and, ultimately, preterm birth [4]. Since the neurochemical responses of these pathways are also known to adversely affect normal sleep [5], we hypothesized that disturbed sleep might be a significant summary indicator of the risk for preterm birth.

Materials and Methods

The study was IRB approved. A convenience sample of 220 pregnant women, between 20-29 weeks gestation, was recruited from 15 obstetrical practices during routine office visits. Inclusion criteria included women between 20 and 29 weeks gestation, ages 20 to 40 inclusive, who intended to deliver at one of the study-site hospitals. The ability to read and understand English was also necessary in order to complete the consent form and questionnaires. Exclusion criteria included a history of drug/alcohol abuse, previously diagnosed sleep disorders, a psychiatric diagnosis, and/or a debilitating acute or chronic illness. During routine office visits, after providing informed consent, subjects completed questionnaires that measured quality of nocturnal sleep (the Pittsburgh Sleep Quality Index [PSQI]) [6], daytime sleepiness (the Epworth Sleepiness Scale [ESS]) [7], and perceived psychosocial stress (Cohen's Perceived Stress Scale [PSS]) [8]. The PSQI also generated data on subjective sleep variables, including sleep latency (in minutes), sleep efficiency (time in bed spent asleep, expressed as percentage) and total sleep time (in minutes). Data were also obtained from subjects' antenatal medical records to ensure study eligibility and to obtain demographic and clinical data. After delivery, data were obtained from the subjects' medical records to determine gestational age at delivery.

Due to lack of normally distributed data, we employed chi-square and Mann-Whitney U tests for comparisons between women with full-term and preterm births. Logistic regression was used to determine whether variables that discriminated between the groups on univariate analyses also differentiated the groups using multivariant models.

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Table 1. — *Comparison of sleep measures during the second trimester of women with preterm vs term deliveries.*

	Preterm (< 37 wks) n (%) 32 (14.55) mean (SD)	Term (≥ 37 wks) n (%) 188 (85.5) mean (SD)	Sample N = 220 mean (SD)	Test Statistic[1]	*p* value[1]
PSQI Global Score	6.81 (2.50)	6.71 (3.22)	6.72 (3.13)	2846.00	0.63
Sleep efficiency (%)	85.16 (13.28)	86.32 (12.45)	86.15 (12.55)	2853.00	0.64
Sleep latency (min)	26.09 (19.91)	18.53 (14.94)	19.63 (15.94)	2370.50	0.03*
ESS	8.94 (4.0)	8.95 (4.12)	8.95 (4.10)	2964.50	0.45
PSQI Sleep quality	1.19 (0.74)	1.20 (0.72)	1.20 (0.72)	2999.00	0.49
PSQI Sleep latency	1.28 (1.11)	1.05 (0.96)	1.08 (0.99)	2687.00	0.16
PSQI Sleep duration	0.81 (0.74)	0.89 (0.87)	0.88 (0.85)	2908.00	0.37
PSQI Habitual sleep efficiency	0.66 (0.83)	0.62 (0.91)	0.63 (0.90)	2844.00	0.29
PSQI Sleep disturbances	1.63 (0.55)	1.63 (0.59)	1.63 (0.58)	3006.00	0.50
PSQI Use of sleeping medications	0.28 (0.68)	0.17 (0.60)	0.19 (0.61)	2718.00	0.05
PSQI Daytime dysfunction	0.91 (0.64)	1.16 (0.68)	1.13 (0.68)	2447.00	0.03*

SD = Standard Deviation; PSQI = Pittsburgh Sleep Quality Index (Scores are based on 0-3 scale with 3 indicating worse problem); ESS = Epworth Sleepiness Scale; [1] Mann Whitney U Test; *$p < 0.05$.

Results

The overall rate of preterm birth in this cohort was 14.6%. However, when prior twin deliveries were excluded the rate dropped to 9.55%. There were no differences in women carrying to full term versus preterm in maternal age, gestational age when the PSQI and the other instruments were completed, race, education, marital status, PSS score, smoking, alcohol use, and infection during pregnancy. Women with preterm births were more likely to have had a previous preterm birth (41.2% vs 12.1%; chi-square = 1002.5, $p < 0.01$) or twin births (34.4% vs 2.1%; chi-square = 44.76, $p < 0.01$) but were no more likely to be primiparous (46.9% vs 34.0%; chi-square = 1.96, $p = 0.16$) than women with full-term births.

Sleep measures are shown in Table 1 and indicate that women carrying to full term reported a shorter time to fall asleep, less use of sleep medication but had a higher daytime dysfunction score. Pre-pregnancy sleep quality did not differentiate women with full-term versus preterm births. Multiple logistic regression analyses designed to predict full-term versus preterm status based on PSQI Global score, PSS score, sleep latency, total sleep time, sleep efficiency, race, infection and previous preterm birth status indicated that both longer sleep latency (OR = 1.04; 95% CI 1.01 - 1.07) and previous pre-term birth history (OR = 0.30; 95% CI 0.10 - 0.92) independently predicted women carrying to full term (cumulative r-squared = .084)

Discussion

Sleep latency, the period from "lights out" until sleep onset, was the only sleep variable that was significantly different in the preterm group. Latencies from the full-term group were similar to the polysomnographic data (19.6 minutes SD 9.1) reported in another group of healthy pregnant women in the second trimester [9]. Despite these findings, mean sleep latency values for both groups in our study were below the 30-minute criterion identified as problematic by the PSQI, which suggested that sleep onset insomnia was not a problem in this sample. Nonetheless, the reason for the somewhat prolonged sleep latency in the preterm group remains unclear, and could hold significance from several perspectives. For example, the longer sleep latency could be a subtle indicator of potential physiologic processes leading to the eventual initiation of pre-term labor. Conversely, the longer sleep latency per se might represent vulnerability or even a potentially modifiable risk for preterm labor. Further research will be necessary to identify sleep latency as a key issue of cause and effect.

Despite the significance of prolonged sleep latency, the more general lack of associations between the other measured variables in this study (PSQI, ESS, sleep efficiency, total sleep time, and PSS) and preterm birth may be explained by limitations in measurement. Measurement of sleep quality was made in the second trimester, the period that is typically associated with the best sleep quality during pregnancy [10]. This period was chosen as a measurement point in order to capture data from those subjects who would potentially deliver a preterm neonate in the late second and early third trimester. However, the mean gestational age for preterm birth was 33.4 weeks (SD 3.2), which resulted in an interval of over seven weeks from the time of measurement. Since sleep quality decreases during the course of pregnancy [11], it is likely that the single assessment made in the second trimester reflected better sleep quality than that experienced in the third trimester when labor onset occurred. Similarly, the single measurement of psychological stress in the second trimester may not have reflected the stress experienced in the third trimester.

A limitation may also exist in the subjective nature of the sleep measurements. While both the PSQI and the ESS provide important dimensions of sleep quality, they are limited by the individual's cognitions and perceptions and may not accurately reflect true sleep characteristics. Studies that evaluated the correlation between subjective and objective assessments, as measured by polysomnography, reveal that subjects frequently underestimated total sleep time. However, outcomes from other research of self-reported "good sleepers" and "bad sleepers" revealed that subjective assessments closely mirrored those

obtained from polysomnography. Further studies conducted with both subjective measures and polysomnography during pregnancy would be required to clarify these issues.

Conclusion

To identify a potential relationship between preterm birth and sleep quality, the sleep quality of a sample of 220 subjects in the second trimester of pregnancy was assessed, using subjective tools. Sleep latency, the period from "lights out" to sleep onset, was statistically longer in the group that delivered preterm and was an independent predictor of preterm birth in a multivariate model that contained other known predictors. Further research is warranted to explore the physiological and psychological factors that may contribute to sleep latency and to identify the quality of sleep near the time of both preterm and term deliveries.

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References

[1] Martin J.A., Hamilton B.E., Sutton P.D., Ventura S.J., Menaker F., Kimeyer S. *et al*.: *Natl*. *Vital Stat*. *Rep*., 2007, *56,* 1.
[2] Mathews M.S., MacDorman M.F.: *Natl*. *Vital*. *Stat*. *Rep*., 2008, *57,* 1.
[3] Institute of Medicine. Preterm birth: causes, consequences, and prevention. Washington, DC: National Academy Press, 2007.
[4] Goldenberg R.L, Rouse D.J.: "Prevention of premature birth". *N*. *Engl*. *J*. *Med,* 1998, *339*, 313.
[5] Friess E., Windemann K., Steiger A., Holboer F.: "The hypothalamic-pituitary-adrenocortical system and sleep in man". *Adv*. *Neuroimmunol*., 1995, *5,* 111.
[6] Buysse D.J., Reynolds C.F. 3rd, Monk T.H., Berman S.R., Kupfer D.J.: "The pittsburgh sleep quality index: a new instrument for psychiatric practice and research". *Psychiatry Res*., 1989, *28,* 193.
[7] Johns M.W.: "A new method for measuring daytime sleepiness: the Epworth sleepiness scale". *Sleep*, 1991, *14,* 540.
[8] Cohen S., Kamarck T., Mermelstein R.: "A global measure of perceived stress". *J*. *Health Soc*. *Behav,* 1983, *24,* 385.
[9] Coble P.A., Reynolds C.F. 3rd, Kupfer D.J., Houck P.R., Day N.L., Giles D.E.: "Childbearing in women with and without a history of affective disorder. I. Psychiatric symptomatology". *Compr. Psychiatry,* 1994, *35,* 205.
[10] Lee K.A.: "Alterations in sleep during pregnancy and postpartum: a review of 30 years of research". *Sleep Med*. *Rev.,* 1998, *2*, 231.
[11] Lee K.A., Zaffke M.E., McEnany G.: "Parity and sleep patterns during and after pregnancy". *Obstet*. *Gynecol*., 2000, *95,* 14.

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