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Disturbed Sleep, a Novel Risk Factor for Preterm Birth?

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Abstract

Objective: The etiology of preterm birth (PTB) is likely caused by multiple factors, which may include disturbed sleep. We evaluated whether sleep disturbance was associated with PTB and whether the association was affected by other psychosocial risk factors.
Methods: Pregnant women ($n = 217$) for whom we had depression and sleep data at 20 or 30 weeks gestation and delivery information were evaluated. Logistic models were used to test the hypotheses that disturbed sleep was associated with PTB.
Results: Time in bed at 20 weeks was significantly associated with risk for preterm delivery (odds ratio [OR] 1.43, 95% confidence interval [CI] 1.08-1.88). However, after controlling for depression/selective serotonin reuptake inhibitors (SSRI) status, history of PTB, age, employment, and marital status, this relationship was no longer significant (OR 1.26, 95% CI .92-1.71). No other relationships were significant.
Conclusions: We report preliminary evidence suggesting that poor sleep may contribute to risk for PTB. Although it is speculative and additional work is needed to confirm or refute whether sleep is an independent or mediating risk factor for PTB, disturbed sleep does appear to play a role in adverse pregnancy outcomes.

Introduction

Preterm birth (PTB) is a major health priority for the United States and a research priority of the National Institutes of Health (NIH). It is the leading cause of infant morbidity because of increased respiratory disease, neonatal infections, and neurodevelopmental impairments, as well as infant mortality.[1] There are also significant financial and emotional consequences for the family and society at large.[2,3] Despite an increase in public awareness and research funding, the rate of PTB in the United States continues to grow primarily as a result of indicated deliveries.[4–6] Approximately 9%–12% of all women will deliver before 37 weeks gestation.[2,7] PTB is hypothesized to be a multifactorial phenomenon caused by genetic, biologic, social, and environmental factors, which likely interact to increase risk.[8] Although 25%–40% of preterm births are associated with specific precipitating factors, such as infection,[9] the precipitating event frequently is unknown. Hence, there is a clear need to identify and evaluate additional risk factors.

Various psychosocial and behavioral risk factors are associated with PTB, including a history of PTB, poor prenatal care, race, low socioeconomic status (SES), obesity, smoking, and stress. However, these risk factors do not adequately predict who will develop PTB.[8,10] One possibility for the inability to adequately predict PTB is that researchers take too simplistic an approach.[11] Most studies only evaluate one domain, whether it is socioeconomic, behavioral, or biologic. Evaluating interrelated risk factors could potentiate the identification of women who may be more vulnerable to deliver prematurely.

Sleep may be one behavioral pathway that may link established risk factors, such as depression, race, and low SES, with PTB.[12–14] Mounting evidence states that sleep is worse for depressed women,[15,16] African American women,[17] and women under financial strain.[16,17] Thus, sleep disturbance may be associated with PTB based on its association with other established risk factors. Additional evidence in support of this stems from the extensive literature showing an association between disturbed sleep and a host of adverse health outcomes, including cardiovascular disease (CVD),[18] metabolic syndrome,[19] and depression.[20,21]

Sleep in the context of depression is a salient factor to evaluate in pregnant women. Depressed women, particularly women who are untreated, are up to three times more likely to deliver prematurely than nondepressed women.[3,22–25] Furthermore, although disturbed sleep is a defining symptom of depression and often its most debilitating feature,[12] it is also a risk factor for the development of new and recurrent

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depression.[20,26,27] High-risk women, those with a history of depression, may be more vulnerable to the effects of sleep disturbance during pregnancy.[27–29] Pregnancy is associated with significant sleep disturbance,[30,31] as well as an increase in mood dysregulation,[15,28] and sleep disturbances are even further exacerbated in depressed pregnant women.[15,32]

We propose that disturbed sleep, particularly in conjunction with depression, may be a novel yet significant risk factor for PTB. Evidence that sleep disturbance is associated with PTB is sparse, relying solely on a recent study that reported that women who delivered preterm had longer sleep onset latencies (SOL).[33] There is, however, mounting evidence that sleep disturbance is associated with other adverse pregnancy outcomes, such as longer labor, increased risk of cesarean delivery, and postpartum depression (PPD).[31,34,35]

This intriguing relationship becomes more interesting when antidepressant use is included. Selective serotonin reuptake inhibitors (SSRIs) are the most widely prescribed antidepressants[36] but have been associated with increased risk of PTB.[25,37–39] Furthermore, although they are efficacious at reducing depressive symptoms, they often disturb sleep by increasing sleep latency, awakenings after sleep onset, and decreasing total sleep time and rapid eye movement (REM) sleep.[13,36] The nature of the complex interactions among sleep, depression status, and SSRI use on PTB is not known.

By taking a multidisciplinary approach, we sought to determine if sleep disturbance in the second or third trimester is associated with increased risk for PTB, after adjusting for the recognized risk factors depression and SSRI use. To evaluate our hypothesis, we evaluated subjective sleep collected at 20 and 30 weeks gestation using sleep items from the Structured Interview Guide for the Hamilton Depression Rating Scale with Atypical Depression Supplement (SIGH-ADS)[40] in 217 pregnant women who were currently depressed and/or taking an SSRI or not depressed and/or not taking an SSRI.

Materials and Methods

Participants

Participants were part of the Antidepressant Use During Pregnancy prospective observational study that evaluated whether the presence of depression or antidepressant medication use during pregnancy was associated with adverse pregnancy outcomes. Details of the recruitment process, inclusion criteria, and exclusion criteria are described elsewhere.[25] Briefly, pregnant women 15–44 years of age, able to speak English, with a singleton pregnancy, and <20 weeks gestation were recruited. In the current analyses, four groups of women were identified: (1) depressed and taking an SSRI, (2) depressed and not taking an SSRI, (3) remitted and taking an SSRI, and (4) not depressed and not taking an SSRI. The current analyses includes 217 of the 238 women reported in the parent study for whom we have sleep data and depression/medication data at 20 and 30 weeks gestation and delivery information. All participants provided written and informed consent. The study was approved by the Institutional Review Boards at the Cleveland and Pittsburgh sites.

Procedures

The presence of clinical depression was determined at enrollment (20 weeks) using the Structured Clinical Interview for DSM-IV (SCID).[41] Additional maternal assessments were completed at 20 and 30 weeks of gestation. Delivery records were reviewed at 2 weeks postpartum. Descriptive data for the sample included demographic characteristics, SSRI use, smoking status, alcohol use, and parity. In the parent study, depression severity was assessed at each time point with the 29-item SIGH-ADS.[40]

Sleep variables were obtained from the SIGH-ADS.[40] We assessed SOL, defined as the amount of time the participant stated it took her to fall asleep; total sleep duration (TSD), defined as total nocturnal sleep excluding time to sleep onset and time spent awake at night; time spent in bed; sleep efficiency (SE), defined as the amount of total sleep duration divided by time spent in bed multiplied by 100%; and symptoms of insomnia, defined as difficulty initiating sleep, difficulty maintaining sleep, or early morning awakening. PTB was defined as delivery of a viable infant at <37 completed weeks of gestation.

Statistical analyses

Descriptive statistics were calculated to describe the sample using means and standard deviations (SD) for continuous measures, such as age and sleep, and frequencies and proportions were calculated to describe categorical measures, such as race and depression status. Logistic regression models were estimated to test the association between sleep measures and preterm delivery at both weeks 20 and 30. Measures estimating duration of some aspect of sleep (e.g., time spent in bed) were divided by 60 in order to change the unit of analysis from minutes to hours, thereby facilitating a more intuitive interpretation of ORs. All models adjusted for the effect of depression and SSRI status at the time of assessment (week 20 or 30), as well as history of PTB, age, marital status, and employment status. No corrections were made for conducting multiple tests because this was an exploratory study; results should be evaluated accordingly. Analyses were performed using SAS 9.0. Models were significant at $p < 0.05$.

Results

Subjects

Of the 217 women, 26 (12.0%) delivered preterm. Of these, there were 7 women who delivered early preterm and 19 who delivered late preterm. The characteristics of the participants at enrollment are displayed in Table 1. Women were approximately 30 years of age, >75% were Caucasian, and nearly two thirds were at least college educated. About one quarter of women endorsed some alcohol use by 20 weeks gestation, but only 8% reported more than one drink per week. Just over 12% indicated they were actively smoking about 5 cigarettes per day at 20 weeks gestation. Women who delivered preterm were younger ($p < 0.01$), fewer were employed ($p < 0.01$), and fewer were married ($p = 0.03$) than women who delivered at term. These variables were evaluated in the logistic models as covariates.

Table 2 shows depression and SSRI status for the whole group as well as by delivery status at week 20 and week 30. PTB occurred more often among women who were using SSRI medications at 20 and 30 weeks gestation. There were no overall differences in the number of PTBs between depressed and nondepressed women. However, there were differences

Table 1. Demographic Measures at 20 Weeks Gestation by Delivery Status Among Pregnant Women With/Without Depression and Taking/Not Taking a Selective Serotonin Reuptake Inhibitor

Measure	*Total* (n = *217*)	*Preterm* (n = *26*)	*Term* (n = *191*)	*Analyses*		
				OR	*95% CI*	p
Age at week 20	30.1 ± 5.8	27.2 ± 5.5	30.5 ± 5.8	0.90	(0.84-0.97)	< 0.01
White race						0.54
Yes	169 (77.9)	19 (11.2)	150 (88.8)	0.74	(0.29-1.87)	
No	48 (22.1)	7 (14.6)	41 (85.4)			
Education level						0.25
< High school	16 (7.4)	4 (25.0)	12 (75.0)			
High school	23 (10.6)	3 (13.0)	20 (87.0)	0.45	(0.09-2.37)	0.35
Some college	40 (18.4)	7 (17.5)	33 (82.5)	0.64	(0.16-2.57)	0.53
College	87 (40.1)	9 (10.3)	78 (89.7)	0.35	(0.09-1.30)	0.12
Graduate school	51 (23.5)	3 (5.9)	48 (94.1)	0.19	(0.04-0.95)	< 0.05
Employed						< 0.01
Yes	128 (59.3)	8 (6.3)	120 (93.8)	0.26	(0.11-0.63)	
No	88 (40.7)	18 (20.5)	70 (79.5)			
Married/cohabiting						< 0.03
Yes	158 (72.8)	14 (8.9)	144 (91.1)	0.38	(0.16-0.88)	
No	59 (27.2)	12 (20.3)	47 (79.7)			
Parity	2.0 ± 1.2	2.1 ± 0.9	2.0 ± 1.2	1.10	(0.78-1.55)	0.60
Parity						0.32
1	84 (39.3)	6 (7.1)	78 (92.9)			
2	77 (36.0)	9 (11.7)	68 (88.3)	1.72	(0.58-5.08)	0.33
3+	53 (24.8)	8 (15.1)	45 (84.9)	2.31	(0.75-7.08)	0.15
Ever smoked during pregnancy						0.26
Yes	28 (13.0)	5 (17.9)	23 (82.1)	1.92	(0.65-5.64)	
No	187 (87.0)	19 (10.2)	168 (89.8)			
Number of cigarettes per day	4.9 ± 0.9	5.0 ± 0.7	4.8 ± 1.0	1.27	(0.40-4.03)	0.69
Ever drank during pregnancy						0.60
Yes	66 (30.8)	6 (9.1)	60 (90.9)	0.77	(0.29-2.05)	
No	148 (69.2)	17 (11.5)	131 (88.5)			
Number of drinks per occasion	2.3 ± 2.1	2.8 ± 3.6	2.3 ± 1.9	1.10	(0.79-1.54)	0.56
Prepregnancy BMI	26.8 ± 7.2	26.7 ± 6.5	26.8 ± 7.3	1.00	(0.94-1.06)	0.95
History of preterm birth						< 0.04
Yes	21 (10.3)	6 (28.6)	15 (71.4)	3.43	(1.19-9.90)	
No	182 (89.7)	19 (10.4)	163 (89.6)			

BMI, body mass index; CI, confidence interval; OR, odds ratio; *p*, probability.

depending on whether the woman was depressed or not and taking or not taking an SSRI. For instance, at 20 weeks, women without current major depressive disorder (MDD) and taking an SSRI (26.9%) (OR 4.15, 95% CI 1.43-12.0) (i.e., treatment responders), as well as women with current MDD and taking an SSRI (25.0%) (OR 3.76, 95% CI 1.04-13.6), had a greater percentage of preterm delivery compared to women without MDD and not taking an SSRI (11.0%) (referent group).

Logistic models were run to test the hypotheses that various aspects of sleep disturbance at 20 or 30 weeks gestation were associated with PTB. Unadjusted models first tested whether each sleep variable at either 20 or 30 weeks was associated with PTB. Adjusted models included depression/SSRI status, age, employment, marital status, and history of PTB (Tables 3 and 4). In this secondary analysis, SSRI use as an independent covariate was a significant correlate of PTB in all models.

In the unadjusted set of models, time in bed at 20 weeks gestation was significantly associated with increased risk for delivering preterm. In the adjusted models, time in bed at 20 weeks was no longer a significant correlate of PTB (Table 3). No other sleep variable at 20 weeks was associated with PTB. For the unadjusted models evaluating sleep at 30 weeks gestation, time in bed and time to sleep showed a trend for an association (Table 4). In the adjusted models, however, no sleep variable was significantly associated with PTB.

Discussion

Although many factors are associated with PTB, its exact cause often is unknown. Hence, there is a great need to identify additional risk factors, particularly those that can be modified. We provide preliminary evidence that extends the emerging evidence that disturbances in subjectively reported sleep are associated with adverse pregnancy outcomes.[34,35,42] Although there was an indication of a relationship between certain aspects of sleep and PTB, the effects were attenuated after controlling for traditional risk factors. This suggests, but does not confirm, that aspects of sleep may be associated with PTB as a consequence of depression/SSRI status, history of PTB, age, employment, or marital status. It may also merely be a reflection of power. We can only speculate at this time if sleep is an independent or a mediating variable between other known risk factors, such as depression or SSRI use, and PTB.

Table 2. Depression and Selective Serotonin Reuptake Inhibitor Measures at 20 and 30 Weeks Gestation by Delivery Status Among Pregnant Women with/without Depression and Taking/Not Taking a Selective Serotonin Reuptake Inhibitor

	Week 20						*Week 30*					
				Analyses						*Analyses*		
Measure	*Total* (n=*212*)	*Preterm* (n=*26*)	*Term* (n=*186*)	*OR*	*95% CI*	p	*Total* (n=*197*)	*Preterm* (n=*21*)	*Term* (n=*176*)	*OR*	*95% CI*	p
MDD						0.41						0.36
Yes	51 (24.1)	8 (15.7)	43 (84.3)	1.48	(0.60-3.63)		49 (24.9)	7 (14.3)	42 (85.7)	1.60	(0.60-4.21)	
No	161 (75.9)	18 (11.2)	143 (88.8)				148 (75.1)	14 (9.5)	134 (90.5)			
SSRI						<0.01						<0.001
Yes	42 (19.8)	11 (26.2)	31 (73.8)	3.67	(1.56-8.74)		44 (22.3)	12 (27.3)	32 (72.7)	6.00	(2.33-15.4)	
No	170 (80.2)	15 (8.8)	155 (91.2)				153 (77.7)	9 (5.9)	144 (94.1)			
MDD/SSRI						<0.04						<0.01
−MDD/−SSRI	135 (63.7)	11 (8.1)	124 (91.9)				126 (64.0)	7 (5.6)	119 (94.4)			
−MDD/+SSRI	26 (12.3)	7 (26.9)	19 (73.1)	4.15	(1.43-12.0)	<0.01	22 (11.2)	7 (31.8)	15 (68.2)	7.93	(2.44-25.7)	<0.001
+MDD/−SSRI	35 (16.5)	4 (11.4)	31 (88.6)	1.45	(0.43-4.88)	0.55	27 (13.7)	2 (7.4)	25 (92.6)	1.36	(0.27-6.94)	0.72
+MDD/+SSRI	16 (7.5)	4 (25.0)	12 (75.0)	3.76	(1.04-13.6)	<0.05	22 (11.2)	5 (22.7)	17 (77.3)	5.00	(1.42-17.5)	<0.02

MDD, major depressive disorder.

Sleep is a defining feature of depressive episodes,[12,43] but various manifestations of disturbed sleep accompany depressive episodes.[12,14,43] Insomnia, for example, is the most frequent complaint of depression, but complaints of greater time spent in bed and long sleep duration are indicative of atypical depression.[14,44] Further evaluation of these subtypes is warranted. Poor sleep is included in the constellation of depressive symptomatology, but it may also serve as a proxy for greater symptom severity.[45] This is supported by our current data. A greater percentage of women had complaints of insomnia in the untreated (depression, but no SSRI) group (62.9%) vs. those in the control (no depression, no SSRI) group (28.9%). Similar findings can be observed by examining sleep efficiency. The average SE for control women was 90.3%, compared to nonresponders (depression, with SSRI use) 85.7% and untreated (74.2%). It is uncertain if sleep is indeed acting as an independent risk factor for PTB or if it increases risk via exacerbation of depressive symptomatology or is influenced by SSRI use. Larger cohort studies are required to begin to elucidate the role of sleep in PTB.

Table 3. Odds Ratios for Sleep Measures at 20 Weeks Gestation and Delivery Status Among Pregnant Women with/without Depression and Taking/Not Taking a Selective Serotonin Reuptake Inhibitor

				Unadjusted[a]			*Adjusted*[b]		
Measure	*Total* (n=*212*)	*Preterm* (n=*26*)	*Term* (n=*186*)	*OR*	*95% CI*	p	*OR*	*95% CI*	p
HRSD insomnia[c]						0.30			0.21
Yes	78 (36.8)	12 (15.4)	66 (84.6)	1.56	(0.68-3.56)		1.84	(0.72-4.74)	
No	134 (63.2)	14 (10.4)	120 (89.6)						
Duration of onset delay (min)	28.5±41.8	38.7±56.7	27.0±39.3	1.36	(0.85-2.17)	0.20	1.41	(0.83-2.41)	0.21
Duration of middle insomnia (min)	41.5±66.4	43.5±44.6	41.2±69.0	1.03	(0.72-1.47)	0.88	0.95	(0.58-1.54)	0.84
Time napping (min)	49.1±195	117±467	39.6±113	1.07	(0.98-1.18)	0.14	1.07	(0.98-1.17)	0.14
Time in bed (min)[d]	528±86	569±92	522±84	1.43	(1.08-1.88)	<0.02	1.26	(0.92-1.71)	0.15
Time not sleeping (min)	70.0±85.1	82.1±79.0	68.3±86.0	1.10	(0.86-1.42)	0.45	1.09	(0.78-1.51)	0.62
Time sleeping (min)	458±112	487±126	454±110	1.19	(0.94-1.50)	0.16	1.11	(0.87-1.43)	0.41
Sleeps <7 hours						0.77			0.80
Yes	54 (25.5)	6 (11.1)	48 (88.9)	0.86	(0.33-2.27)		0.86	(0.29-2.59)	
No	158 (74.5)	20 (12.7)	138 (87.3)						
Sleeps >9 hours						0.25			0.77
Yes	32 (15.1)	6 (18.8)	26 (81.3)	1.85	(0.68-5.03)		1.19	(0.38-3.75)	
No	180 (84.9)	20 (11.1)	160 (88.9)						
Time sleeping and napping (min)	507±228	603±492	494±158	1.09	(0.99-1.19)	0.08	1.07	(0.99-1.17)	0.11
Sleep efficiency[e]	86.7±15.6	85.2±14.2	86.9±15.8	0.99	(0.97-1.02)	0.60	0.99	(0.96-1.02)	0.70

[a]Logistic models use hours as unit of measurement for all continuous sleep measures except efficiency.
[b]Adjusted for MDD, SSRI, age, employment, marital status, and history of preterm birth.
[c]Defined as having at least one of the following symptoms: nightly difficulty falling asleep, waking during the night (except for voiding), and waking up early, unable to get back to sleep.
[d]Difference between time lay down to sleep and current morning wakeup.
[e]100×time sleeping/time in bed.
HRSD, Hamilton rating scale for depression.

Table 4. Odds Ratios for Sleep Measures at 30 Weeks Gestation and Delivery Status Among Pregnant Women with/without Depression and Taking/Not Taking a Selective Serotonin Reuptake Inhibitor

Measure	Total (n=197)	Preterm (n=21)	Term (n=176)	Unadjusted[a] OR	95% CI	p	Adjusted[b] OR	95% CI	p
HRSD insomnia[c]						0.25			0.12
Yes	79 (40.1)	6 (7.6)	73 (92.4)	0.56	(0.21-1.52)		0.41	(0.13-1.30)	
No	118 (59.9)	15 (12.7)	103 (87.3)						
Duration of onset delay (min)	25.6±54.6	33.8±31.7	24.6±56.7	1.13	(0.79-1.61)	0.50	1.14	(0.77-1.68)	0.52
Duration of middle insomnia (min)	39.3±45.9	36.2±34.6	39.7±47.1	0.90	(0.48-1.68)	0.74	0.54	(0.24-1.19)	0.13
Time napping (min)	26.4±42.3	36.0±47.0	25.3±41.7	1.35	(0.78-2.33)	0.29	0.91	(0.47-1.74)	0.77
Time in bed (min)[d]	521±113	564±146	516±108	1.19	(0.98-1.45)	0.08	1.14	(0.91-1.42)	0.27
Time not sleeping (min)	65.0±72.6	70.0±43.4	64.4±75.4	1.06	(0.76-1.48)	0.74	0.87	(0.51-1.50)	0.63
Time sleeping (min)	456±106	494±153	451±98	1.23	(0.97-1.57)	0.09	1.21	(0.93-1.57)	0.16
Sleeps <7 hours						0.97			0.96
Yes	57 (28.9)	6 (10.5)	51 (89.5)	0.98	(0.36-2.67)		0.97	(0.31-3.02)	
No	140 (71.1)	15 (10.7)	125 (89.3)						
Sleeps >9 hours						0.96			0.87
Yes	29 (14.7)	3 (10.3)	26 (89.7)	0.96	(0.26-3.50)		0.88	(0.20-3.91)	
No	168 (85.3)	18 (10.7)	150 (89.3)						
Time sleeping and napping (min)	481±112	520±147	477±106	1.20	(0.96-1.49)	0.11	1.15	(0.89-1.49)	0.28
Sleep efficiency[e]	87.8±11.3	87.0±8.8	87.9±11.6	0.99	(0.96-1.03)	0.72	1.02	(0.97-1.07)	0.47

[a]Logistic models use hours as unit of measurement for all continuous sleep measures except efficiency.
[b]Adjusted for MDD, SSRI, age, employment, marital status, and history of preterm birth.
[c]Defined as having at least one of the following symptoms: nightly difficulty falling asleep, waking during the night (except for voiding), and waking up early, unable to get back to sleep.
[d]Difference between time lay down to sleep and current morning wakeup.
[e]100×time sleeping/time in bed.

There is substantial evidence that SSRIs influence sleep, yet the relationships are dependent on the SSRI evaluated and whether sleep is evaluated by polysomnography or self-report.[12,13,36] Women in our sample were taking a range of SSRIs, which allowed us to evaluate only the effects of this class of drugs rather than individual medication effects. Moreover, only ~10% of the women either initiated or terminated medication use from week 20 to week 30. It is not clear from these data if changes in sleep are a result of improvements in depressive symptomatology or resultant of SSRI use; we can only speculate at this time. Future studies evaluating specific medications and using polysomnography in addition to self-report are needed to allow a more detailed examination of this relationship.

Several psychosocial correlates have been implicated as risk factors for PTB, including stress, race, SES, and marital status.[3,11,46] In the current analysis, we found that younger age and being unemployed are correlates of risk. These are in accordance with some studies[3,11] but not all.[47] Peacock et al.[3] noted a clustering of variables. In younger women, income was lower, education did not extend beyond high school, fewer were married, and depression was a greater concern, whereas among older women, more were married and had higher incomes and more education. Although sleep was not evaluated in these studies, there is ample evidence that sleep is more disturbed among women who fall into the first category.[17,48,49] We suggest that disturbed sleep may be a behavioral representation of a woman's psychosocial milieu: lower SES (lower income, minimum education, blue collar/nonprofessional job), young age, dissatisfaction in marital status, or endorsement of poor health behaviors. Thus, one could speculate that sleep, when operationalized as a proxy for other psychosocial correlates, may be a risk factor for PTB.

In addition to the clustering with other psychosocial risk factors, evolving evidence confirms that poor sleep quality,[50–52] sleep restriction,[53–55] and sleep fragmentation[56,57] are robust correlates of adverse immune changes, especially increased levels of inflammatory cytokines. Inflammation is a recognized biologic pathway through which all the aforementioned risk factors may contribute to PTB risk.[3,31,46,58,59] Although lessening the burden of low SES or race, for example, may not be practicable, improving sleep is an option that could buffer against some of the adverse effects of other risk factors. In other words, we speculate that obtaining sufficient sleep may increase a woman's resilience and be protective in the presence of various unmodifiable circumstances, such as low income, age, and minority status. This hypothesis requires additional testing that could include behavioral modification techniques for improving sleep.

These findings are provocative, but there are several limitations that preclude our ability to make any sweeping generalizations. First, the sleep data derived from the SIGH-ADS are retrospective and subject to recall bias. Although this is a common format in which sleep data often are collected, prospective data, including self-report and objective assessments, would be preferential. Moreover, we did not have sleep history before pregnancy. Second, our sample was not powered to answer these questions. There were only 26 women who delivered preterm. Because there are several variables noted to predict PTB, such as race and SES, the ability to control for all of them while maintaining power was difficult. Moreover, we had too few African American women who had PTB to evaluate the race relationship. Future designs should increase ethnic representation to effectively evaluate this relationship. We also acknowledge that our results differ somewhat from the initial report of these data.[25] This is because the exposure

definitions in the primary article are defined across pregnancy with respect to PTB, whereas the definition of depression used here is defined at 20 weeks, with SSRI use possibly varying at 20 and 30 weeks. Lastly, we did not have information about spontaneous vs. indicated delivery. The associated etiologies are distinct, and it is likely that a woman's sleep may be distinct as well. We hope to evaluate larger cohorts to determine if their disturbed sleep independently contributes to PTB.

In summary, the present results modestly suggest that disturbed sleep may be a risk factor for PTB. We propose that this likely co-occurs in the presence of other established risk factors, which supports the hypothesis that risk is determined by a cluster of risk factors[3] and is multifactorial.[8] Evaluating multiple risk factors simultaneously may facilitate the identification of at-risk women and allow initiation of risk-specific treatment.[60] A benefit of assessing subjective sleep disturbance as a risk factor is that it is a behavior that can be measured easily and quickly during prenatal visits, making it clinically relevant. More importantly, sleep is a modifiable behavior.[61,62] Improvement in sleep is associated with improvement in depressive symptomatology and reduced depressive episodes.[12,13]

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Disclosure Statement

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