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Women with Postpartum Weight Retention Have Delayed Wake Times and Decreased Sleep Efficiency During the Perinatal Period: A Brief Report

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Abstract

Objective—This study assessed sleep and circadian rhythms across the perinatal period in new mothers with and without postpartum weight retention (PPWR).

Methods—Weight was measured at 2 and 16 weeks postpartum in 21 women with previous major depression or bipolar disorder (mean age 29.5±4.7 years) who self-reported pre-pregnancy weight during third trimester. Wrist actigraphy was acquired at 33 weeks gestation and postpartum weeks 2, 6, and 16. Circadian phase was measured at 33 weeks gestation and 6 weeks postpartum. The Horne-Östberg Morningness-Eveningness Questionnaire and Pittsburgh Sleep Quality Inventory were completed during third trimester. Women were classified as PPWR+ if weight at 16 weeks postpartum exceeded pre-pregnancy weight by ≥5kg.

Results—Compared to pre-pregnancy, average weight gain (±SD) was 6.3±8.8 kg at 2 weeks postpartum and 5.2±8.5 kg at 16 weeks postpartum. ANOVA showed that PPWR+ women (n=8, 38%) had later sleep offset times and lower sleep efficiencies than PPWR− women at all time points and were more likely to report snoring during pregnancy.

Conclusions—Data from this small sample showed that women with PPWR had more disturbed sleep and later wake times and were more likely to report symptoms of sleep-disordered breathing. Future work in larger samples should examine whether interventions to improve sleep during pregnancy decreases PPWR.

Keywords

sleep; circadian; DLMO; pregnancy; postpartum; postpartum weight retention

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Introduction

Significant weight gain in the perinatal period is associated with increased risk of overweight/obesity among women of childbearing age (1, 2), higher incidence of chronic diseases later in life (3), and disadvantages to offspring (4). Sleep disturbances that are ubiquitous in the perinatal period, including shortened, fragmented sleep and altered sleep timing (5, 6), as well as changes in work and meal schedules, may contribute to perinatal weight gain. Indeed, sleep restriction and later meal times are associated with weight gain and/or higher caloric intake in non-perinatal adults (7, 8). A handful of epidemiologic studies have linked shorter self-reported postpartum sleep duration with greater postpartum weight retention (PPWR, (9–12). For instance, using the Project Viva cohort (13), Gunderson and colleagues showed that short self-reported sleep duration at 6 months postpartum (defined as ≤ 5 hours per night) significantly increased the risk of PPWR at 1 year postpartum (9). We are aware of no study that has examined associations between PPWR and sleep or circadian rhythms during pregnancy or that has measured sleep objectively.

The aim of this study was to examine whether sleep timing and duration or circadian phase across the perinatal period (including pregnancy and the postpartum period) were associated with postpartum weight retention. We hypothesized that shorter sleep duration, later sleep timing, and later dim light melatonin onset (DLMO) would be related to PPWR at 16 weeks postpartum.

Methods

Participants

This study is a secondary analysis of a larger study (14, 15) in which perinatal women, ages 18–40, with a history of major depression (MDD) or bipolar disorder (BPD) (but not in a mood episode at enrollment) were recruited with flyers and brochures distributed in obstetric offices, newspaper advertisements, and direct mailings. History of MDD or BPD and absence of a mood episode at enrollment were confirmed by a Structured Clinical Interview for DSM-IV Disorders (SCID I/P, (16). Participants completed the Horne-Östberg Morningness-Eveningness Questionnaire (MEQ, (17)) and the Pittsburgh Sleep Quality Inventory (PSQI, (18)) at enrollment. We excluded potential participants who had a primary Axis I diagnosis other than MDD or BPD; a diagnosed sleep disorder; a high-risk pregnancy; current night shift work; a disability that interfered with testing; current alcohol/drug dependence; or expectation that infants would have a nighttime caregiver other than the mother. We did not select participants on the basis of parity, feeding plans, or medication use other than hypnotics. The Rhode Island Hospital Institutional Review Board approved this study. Participants signed informed consent and received monetary compensation for their time and effort.

Sleep Measures

Participants wore wrist actigraphs (Micro Motionlogger Watch, AMI, Ardsley, NY) continuously on the nondominant wrist for one week at 4 times across the perinatal period:

33 weeks gestation and postpartum weeks 2, 6, and 16. Actigraphy data were recorded in 1-minute bins using zero crossing mode and were analyzed using Action-W software (AMI), which has been validated with polysomnography (19). We estimated the following sleep measures from actigraphy using supplemental information from participants' daily sleep diaries (20): sleep onset time (first of three continuous epochs of sleep occurring after the bedtime reported on the sleep diary); sleep offset time (last epoch of 5 continuous epochs of sleep occurring before the wake time reported on the sleep diary); sleep period time (SPT, hours between sleep onset and sleep offset); total sleep time (TST, hours of estimated sleep occurring between sleep onset and sleep offset); and sleep efficiency (TST ÷ SPT * 100).

Circadian Rhythms Measurement

We measured dim light salivary melatonin onset (DLMO) phase at 33 weeks gestation and 6 weeks postpartum. Participants collected saliva at home using a kit that included labeled Salivettes (Sarstedt, Nümbrecht, Germany), a saliva collection log, a scale to weigh samples, and dark welder's glasses (Uvex, Smithfield, RI) to be worn continuously during saliva collection to avoid light-induced melatonin suppression. Saliva was collected every 30 minutes from ~2.5 hours before to ~3 hours after predicted DLMO phase, determined from sleep diary data (21). Participants were telephoned or texted at each sample time to prompt saliva collection and to confirm they were wearing the welder's glasses. Participants logged the time and weight of each sample and refrigerated the Salivettes overnight; samples were collected the next day, centrifuged, and frozen at −20°F.

Saliva samples were assayed for melatonin using radioimmunoassay (Alpco, Salem, NH). We computed DLMO phase by linear interpolation between the times of saliva samples before and after the melatonin levels reached the threshold for melatonin onset, defined as 4 pg/ml (22).

Weight Measures

Self-reported pre-pregnancy weight was obtained during the 33-week assessment with the question 'What was your approximate weight one year ago?' At 2 and 16 weeks postpartum, a researcher measured participants' weights to the nearest 0.1 lb. using a digital scale. We divided the sample into postpartum weight retention groups (PPWR+ and PPWR−), with PPWR+ defined as ≥5kg weight retention from pre-pregnancy to 16 weeks postpartum (3, 4).

Analyses

We performed statistical analyses with SPSS Statistics, Version 19 (IBM, Chicago, IL). Because the weights in our sample were normally distributed, we used repeated measures ANOVA and independent samples t-tests to compare sleep and circadian measures between groups across the perinatal period. We used Chi-square to compare reported snoring between groups. Data are summarized with mean±SD; tests with alpha < .05 were considered statistically-significant.

Results

Participants

Data were available from 21 women (mean age 29.5±4.7 years): 17 with a history of MDD and 4 with a history of BPD. Median number of lifetime mood episodes was 1 (range=1–4). Four participants were nulliparous, and the median number of children among those who were experienced mothers was 1 (range 1–3 children). Twelve participants (57.1%) were working for pay at least part-time during third trimester and 80.9% were involved with or living with their baby's father. Average MEQ score was 48.7±7.9, including 2 moderate morning-types, 13 neither types, and 6 moderate evening-types (17).

Weight

Across the whole sample, weights were 73.5±19.4 kg at pre-pregnancy, 79.9±18.9 kg at 2 weeks postpartum, and 78.7±20.4kg at 16 weeks postpartum, corresponding to body mass indices of 27.4±8.0 kg/m^2, 29.6±7.1 kg/m^2, and 29.1±7.9 kg/m^2, respectively. The mean weight gain from pre-pregnancy to 2 weeks postpartum was 6.3±8.8 kg. On average, the sample experienced a 1.1±3.3 kg weight loss from 2 to 16 weeks postpartum. At 16 weeks postpartum, 38% of the women (n=8) weighed ≥5kg over their reported pre-pregnancy weight and were classified as PPWR+. In the PPWR+ group, average postpartum weights were 90.2±16.5kg at week 2 and 90.0±17.3kg at week 16, compared to 73.5±17.9kg at week 2 and 71.8±19.6kg at week 16 in the PPWR− group. Average reported pre-pregnancy weights did not differ between groups (PPWR+ = 76.3±15.5kg and PPWR− = 71.8±21.9 kg; t=−0.50, df=19, p=.63).

Sleep and Circadian Rhythms

Table 1 shows sleep and circadian measures for the full sample and the PPWR+ and PPWR− groups. Women with PPWR had later sleep offset times and lower sleep efficiencies than those without PPWR. Trends for later sleep onset times and later DLMOs were seen in the PPWR+ group, but these effects did not reach statistical significance. SPT, TST, and MEQ score did not differ between PPWR groups.

As expected, sleep offset, SPT, and sleep efficiency changed across the perinatal period in both groups. There were no Time × PPWR group interactions.

Self-reported sleep quality measured with the PSQI at 33 weeks gestation showed significant sleep disturbance in our pregnant sample, with a mean PSQI score of 6.6±3.3. PSQI score did not differ significantly between PPWR groups (PPWR+ = 7.4±3.1 and PPWR− = 6.2±3.5; t=−0.81, df=19, p=.49).

Snoring

Because of associations between weight and sleep-disordered breathing, we examined whether PPWR+ women were more likely to report snoring on PSQI Item 5e administered at gestational week 33. Seventeen women (13 PPWR− and 4 PPWR+) reported no trouble sleeping due to coughing or loud snoring in the last month; 1 reported snoring/coughing less than once a week, 2 reported snoring/coughing once or twice a week, and 1 reported

snoring/coughing three or more times a week. All four participants who reported *any* snoring/coughing were in the PPWR+ group (Chi Square = 8.03, df=3, p=.045).

Discussion

In this study, we observed that women who retained ≥ 5 kg of weight gained during the perinatal period had greater objective sleep disturbance during pregnancy and the postpartum period than women who did not retain excess weight at 16 weeks postpartum. Furthermore, our data indicate that women with PPWR had later wake times across the perinatal period and were more likely to report symptoms of sleep-disordered breathing during third trimester than those who retained <5 kg.

By using actigraphy to measure sleep objectively and including measures of sleep timing and sleep during pregnancy, our study extends findings of previous research showing associations between self-reported postpartum short or disturbed sleep and self-reported (11) or measured (9, 10, 12) postpartum weight gain. Maternal obesity has been linked to a plethora of negative health outcomes for both mother and infant, including higher rates of caesarean section, venous thromboembolism, and maternal mortality, as well as preterm delivery and macrosomia (3). Likewise, sleep disturbance in pregnancy is associated with poor health maternal-infant outcomes, which depending on the nature of the sleep disturbance, can range from higher risk of pregnancy-induced hypertension and preeclampsia to gestational diabetes to increased rates of perinatal depression. Understanding the interplay of disrupted sleep and weight gain/retention in the perinatal period is critical for addressing the pathophysiologic processes that contribute to increased morbidity and mortality in mothers and infants.

One potential mechanism for our observed findings is circadian delay or misalignment among the women with PPWR. On average, this group had significantly later sleep offset times of 50 minutes or greater at all 4 time points studied. The PPWR+ group also showed a tendency towards later sleep onset times and later DLMOs, though group differences were not statistically significant (likely due to insufficient power in this small sample). A growing body of literature links circadian misalignment to metabolic changes that predispose to weight gain in non-perinatal samples (23, 24), and we speculate that delayed sleep/circadian rhythms may play a role in PPWR.

Since only women in the PPWR+ group endorsed snoring/coughing during pregnancy, another possible explanation is that some women with PPWR had undiagnosed sleep-disordered breathing, which has also been linked to weight gain in women (25). Thus, unrecognized sleep apnea could have contributed to the decreased sleep efficiency and later sleep offset times observed in the PPWR+ women.

Limitations of this study include the small, heterogeneous sample and inclusion only of women with a previous history of a mood disorder. In addition, on average, women in our sample were overweight/obese at all time points. Thus, our findings may not generalize beyond this sample, i.e., to healthy weight women or those without depression or bipolar disorder. Another limitation is the reliance on self-reported pre-pregnancy weight. We

anticipate that larger, prospective cohort studies of perinatal women (e.g., NuMom2B (26)) will seek to confirm the preliminary observations reported here.

In summary, in our study, postpartum weight retention was associated with later sleep offset and decreased sleep efficiency during pregnancy and the postpartum period. Delayed and/or disturbed sleep during the perinatal period may be a modifiable risk factor for PPWR, and future work should seek to determine whether interventions that improve sleep and/or stabilize circadian rhythms decrease risk of excessive weight gain and retention in perinatal women.

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Table 1

Perinatal Sleep, Circadian Rhythms, and Weight in PPWR+ and PPWR− groups

	33 Weeks	2 Weeks	6 Weeks	16 Weeks	Effect of Week/Group
Measure					
Sleep Onset	00:18±61min	00:22±61min	00:03±74min	00:02±86min	**Week**: F(3,17)=0.64, p=.59
PPWR+					
PPWR−	23:25±89min	23:14±58min	23:37±74min	23:01±73min	**Group:** F(1,19)=3.93, p=.06
Full Sample	23:45±82min	23:40±67min	23:47±73min	23:25±82min	
Sleep Offset	09:01±91min	09:40±104min	08:52±103min	08:19±105min	**Week**: F(3,17)=7.80 p<.001
PPWR+					
PPWR−	07:20±54min	08:01±74min	08:02±63min	06:52±59min	**Group:** F(1,19)=7.97, p=.011
Full Sample	07:59±85min	08:39±97min	08:21±82min	07:25±88min	
Sleep Period Time	525±90min	557±83min	528±51min	498±74min	**Week**: F(3,17)=3.34, p=.025
PPWR+					
PPWR−	475±51min	528±65min	492±75min	457±110min	**Group:** F(1,19)=2.78, p=.11
Full Sample	494±71min	539±72min	506±68min	473±98min	
TST	379±112min	350±94min	372±37min	396±67min	**Week**: F(3,17)=1.21, p=.31
PPWR+					
PPWR−	405±51min	371±38min	363±54min	375±110min	**Group:** F(1,19)=0.03, p=.87
Full Sample	395±78min	363±64min	366±47min	383±95min	
Sleep Efficiency	74.0±14.1%	65.9±4.7%	72.3±5.4%	80.2±5.1%	**Week**: F(3,17)=21.77, p<.001
PPWR+					
PPWR−	85.8±4.4%	72.0±7.2%	75.5±7.7%	85.3±6.8%	**Group:** F(1,19)=7.79, p=.012
Full Sample	81.3±10.8%	69.7±7.0%	74.3±7.0%	83.4±6.6%	
DLMO	22:17±81min		22:13±120min		**33 Weeks:** t=−1.77, df=17, p=.09
PPWR+ (n=7)					
PPWR− (n=12)	21:17±66min		21:44±86min		**6 Weeks:** t=−.566, df=14, p=.58
Full Sample	21:39±76min		21:56±100min		
Weight	76.3±15.5 kg	90.1±16.5 kg		90.0±17.5 kg	**Week**: F(2,18)=16.68 p<.001
PPWR+					
PPWR−	71.8± 21.9 kg	73.5± 17.9 kg		71.8± 19.6 kg	**Group:** F(1,19)=2.48, p=.13

	33 Weeks	2 Weeks	6 Weeks	16 Weeks	Effect of Week/Group
Full Sample	73.5±19.4 kg	79.9±18.9 kg		78.7±20.4 kg	**Time * Group:** F(2,18)=18.73, p p<.001
BMI					**Week**: F(2,18)=15.79 p<.001 **Group:** F(1,19)=0.35, p=.56 **Time * Group:** F(2,18)=17.54, p p<.001
PPWR+	26.8±5.0kg/m^2	31.6±5.2kg/m^2		31.5±5.7kg/m^2	
PPWR−	27.7±9.6kg/m^2	28.3±8.0kg/m^2		27.7±8.9kg/m^2	
Full Sample	27.4±8.0kg/m^2	29.6±7.1kg/m^2		29.2±7.9kg/m^2	