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Brief Research Report

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Preliminary report: Sleep duration during late pregnancy predicts postpartum emotional responses among parents at risk for postpartum depression

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Abstract

Introduction: Sleep loss is common during the perinatal period; however, few studies have assessed potential consequences of insufficient sleep for postnatal emotional responding, a key contributor to parenting behaviors with implications for parent–infant bonding and mental health. To generate hypotheses for future work assessing perinatal sleep and emotion-related outcomes, this pilot study explored whether prenatal sleep duration predicted postnatal emotional responding in a sample at risk for postpartum depression.

Methods: Participants were nine birthing parents with a prior mood disorder who were not in a current episode at enrollment. We estimated sleep with actigraphy collected for 1 week at 33 weeks' gestation and at 2 and 6 weeks postpartum. Following each week, participants completed an emotional evaluation task, rating the valence and arousal of standardized images from the International Affective Picture System. We tested whether average prenatal (33 weeks) nighttime sleep duration predicted concurrent and future responsiveness to emotional images, quantified by participants' reaction times and arousal/valence ratings.

Results: *Shorter prenatal sleep* duration predicted *faster reaction times*, both concurrently and at 2 weeks postpartum (*ps* ≤ .05), as well as *lower arousal ratings for negative images* at 2 and 6 weeks postpartum (*ps* ≤ .043).

Conclusions: In this small sample of birthing parents at risk for postpartum depression, shorter prenatal sleep duration predicted faster reactions to emotional stimuli and blunted arousal responses to negative images. Although preliminary, these findings justify further study of the role of prenatal sleep in postpartum emotional responses and how these factors may impact parent-infant outcomes.

Key words: actigraphy; pregnancy; postpartum depression; cognitive function

Statement of Significance

Our longitudinal pilot study explored whether individual differences in sleep duration during late pregnancy predict variability in *emotional responding*—reactivity to emotional cues and events—during early postpartum. Despite the critical role of emotional responding in the parent–infant relationship and child mental health, no prior studies to our knowledge have examined how prenatal sleep may impact parents' emotional responding in the early postpartum. Our pilot data show that less sleep in late pregnancy predicts faster prenatal and postnatal response times during an emotional judgment task. We also found a tentative link between shorter prenatal sleep duration and reduced discrimination of emotional content in the postpartum period, though future work is needed to replicate these results.

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Parents of new infants face novel challenges in how they respond to emotional stimuli. Responding adaptively to emotional cues and events is critical not only for parents' own mental health [1] but also for providing appropriate feedback to infants [2–4], which has long-term implications for child development [5]. Critically, sufficient sleep supports emotional responding [6–9] and has been associated with perinatal mental health outcomes [10, 11] and differences in caregiving behaviors [12, 13]. For instance, one study found that mothers with longer sleep displayed more emotional availability—including sensitivity, structuring, nonintrusiveness and nonhostility—during infants' bedtime routines [13]. Though disrupted sleep is common in the perinatal period [11], it remains unclear how perinatal sleep might impact intermediate mechanisms, including emotional responding, that may contribute to differences in caregiving [4]. Also understudied is whether inadequate sleep during pregnancy carries over to influence postpartum emotional responding specifically, despite studies linking prenatal sleep to postpartum psychiatric health overall [10, 11].

As a first step in exploring these questions, we used a longitudinal design in which sleep, mood, and emotional responding were measured in birthing parents during late pregnancy (33 weeks gestation), 2 weeks postpartum, and 6 weeks postpartum. We chose late pregnancy because of prior work linking sleep disturbances in this window with postnatal mental health symptoms [10, 11, 14] and studies suggesting increased parental brain plasticity during the perinatal period [15–17], which could increase the impact of sleep loss during pregnancy on subsequent emotional responding. We followed up at 2 weeks postpartum to capture parents' sleep and emotional responding soon after birth while allowing for sufficient post-delivery recovery time, and at 6 weeks postpartum because it is commonly considered a key timepoint for assessing postpartum mood [18] and occurs before many parents' return to work. Furthermore, because the larger study was a prospective investigation of the development of postpartum depression [19], we enriched the sample for depression risk by including only those who met diagnostic criteria for a past depressive episode AND who were not depressed at study enrollment. Such individuals are also at heightened risk for dysregulated postpartum caregiving behavior [20–22], and thus it is crucial to understand the possible impact of insufficient prenatal sleep on postnatal emotional responding in this population.

Methods

Embedded within a larger multi-year study of sleep and perinatal mood disorders [19] for which funding and data collection concluded in 2015 (see Supplementary Methods), birthing parents with prior depressive episode(s) (either major depression or bipolar disorder, determined via the Structural Clinical Interview of the DSM-IV-TR [23])—but no current mood episode at enrollment—wore wrist actigraphs (AMI, Ardsley NY) for approximately 1 week at each of three timepoints: 33 weeks gestation, 2 weeks postpartum, and 6 weeks postpartum. Actigraphs measured activity in 1-minute epochs using a piezoelectric bimorph beam in zero-crossing mode, and sleep–wake was estimated using the Sadeh algorithm for adult populations [24] in Action-W software. In line with prior work from our laboratory [19], we also administered daily sleep diaries to help confirm actigraphy-derived sleep onsets/offsets. Our overall sleep measure of interest was average nighttime total sleep time (TST), defined as average number of minutes asleep between nocturnal sleep onset and offset across nights at each timepoint.

Following each week of at-home, actigraph-estimated sleep recording, participants completed the Edinburgh Postnatal Depression Scale (EPDS)[25] and a computerized emotional evaluation task. This task was added during the final year of the larger study (August 2014–December 2015) to gather hypothesis-generating data, limiting our sample size for the current analysis. To enhance recruitment and retention, all study visits were completed in participants' homes, in a private area that protected patient confidentiality and minimized distraction from the infant or others. At least two researchers were always present to ensure safety and watch over the infant if needed. During the emotional evaluation task, participants used an onscreen nine-point Self-Assessment Manikin [26] scale to rate the valence of negative, neutral, and positive images from the International Affective Picture System (IAPS) [26], and the level of emotional arousal that each image evoked. Reaction time, valence, and arousal ratings were generated for each image, which were then averaged for each valence category at each timepoint [26]. Image sets were matched in valence, arousal, and content across timepoints, and we excluded infant and sleep-related images. Sixty pictures were shown per set, with set order randomized across participants and images within sets presented quasi-randomly. No more than two images of the same valence were shown sequentially.

For our main analyses, Pearson's correlations tested whether average nighttime TST in the third trimester (gestation week 33) predicted concurrent and future responsiveness to emotional images, as measured by reaction times and arousal/valence ratings. For postnatal outcomes, partial correlations controlling for concurrent sleep TST were also conducted to quantify the unique influence of prenatal sleep TST on postnatal emotional response. Analyses were conducted in IBM SPSS 28.0.

Results

Participants

In total, nine birthing parents (seven with major depression history, two with bipolar disorder history) completed the tasks in the current analysis. Participants' mean ± SD age at enrollment was 24.4 ± 3.5 (range 19-30) years. Parent sex was female, and the sample was racially and ethnically diverse: four identified as Multiracial without indicating ethnicity; three identified as White, non-Hispanic; and two identified as Hispanic/Latinx without indicating race.

Longitudinal sleep and mood

As in prior actigraph studies [27, 28], parents contributed seven nights of scoreable sleep data on average at each timepoint, with a range of 5-8 nights prenatally, 5-7 nights at 2 weeks postpartum, and 5-9 nights at 6 weeks postpartum. Parent TST did not change significantly from prenatal to postpartum (repeated measures ANOVA: $F(2,16) = 1.23$, $p = .32$), likely due to individual variability (Fig. 1A). Regarding mood, mean EPDS scores were below the clinical threshold for depression [30] at enrollment (Fig. 1B) and did not change significantly postpartum (repeated measures ANOVA: $F(2,16) = 0.50$, $p = .62$).

Reaction times to IAPS images

Averaged across valences and arousal judgments, shorter prenatal (33 weeks) TST predicted faster reaction times to all IAPS images, both at the same timepoint ($r(9) = .67$, $p = .049$; Fig. 1C, left) and 2 weeks postpartum ($r(8) = .71$, $p = .0498$; Fig. 1C, middle). In contrast, prenatal TST did not significantly predict reaction

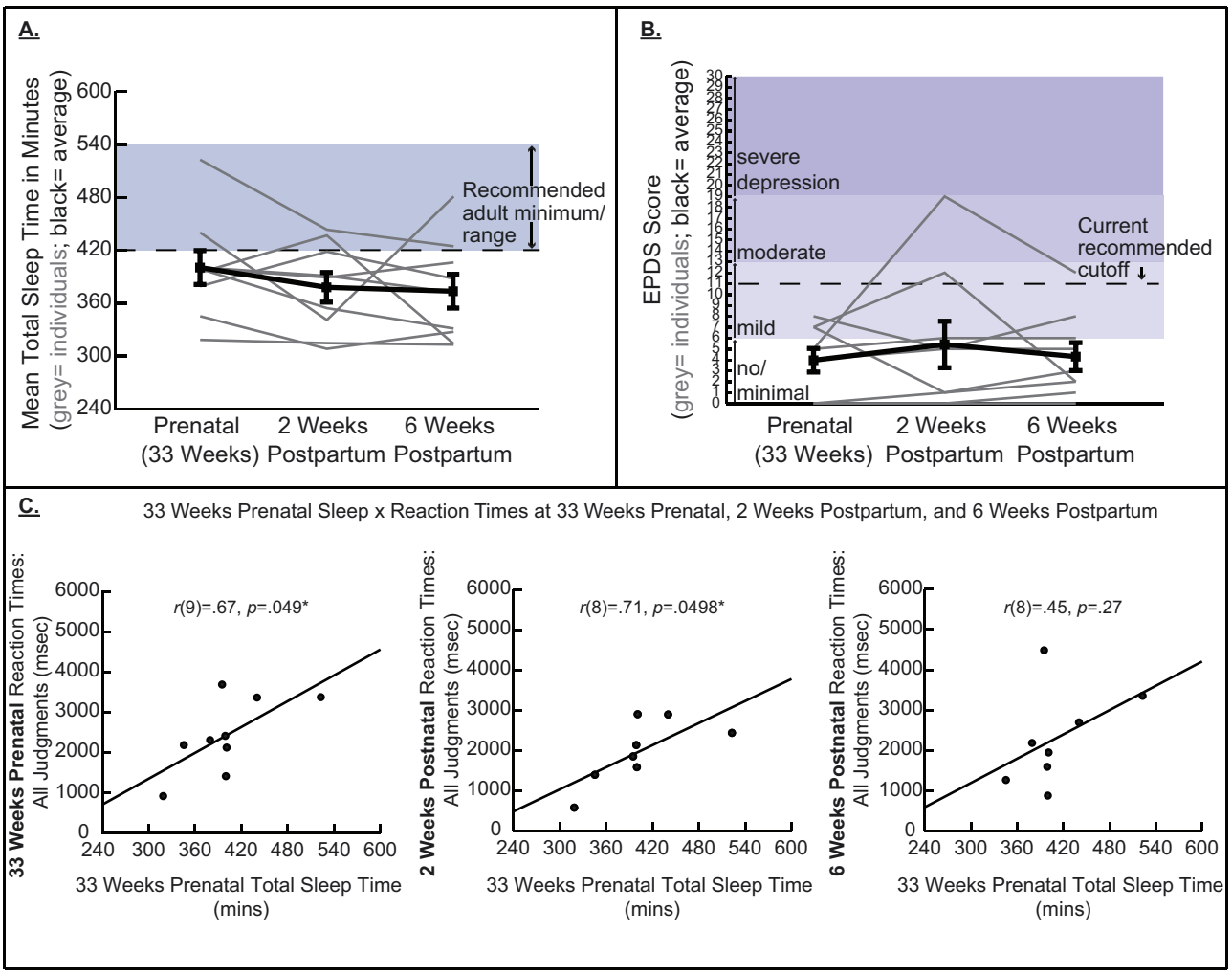

Figure 1. Sleep and depression characteristics of the study sample, and correlations between prenatal sleep and pre/postnatal reaction times during an emotional judgment task. (A) Birthing parents' total sleep time from late pregnancy (33 weeks) to early postpartum (6 weeks). Grey lines = individual participant trajectories; black line = mean ±1 standard error. The majority of parents (7/9) slept <7 hours per night—the minimum sleep time recommended for adult populations [29]—at all timepoints. (B) Birthing parents' scores on the Edinburgh Postnatal Depression Scale (EPDS) from late pregnancy to early postpartum. Grey lines = individual participant trajectories; black line = mean ± 1 standard error. Depression scores did not change over time; however, two parents at postnatal week 2 and one at week 6 scored > 11. The cutoff threshold of 11 or higher for detection of major depression is based on a recent meta-analysis [30] suggesting that 11 maximizes both sensitivity and specificity for the assessment. (C) Correlations between total sleep time (minutes) at 33 weeks gestational age (GA) and reaction times at the same timepoint (left); 2 weeks postpartum (middle); and 6 weeks postpartum (right). Reaction times are averaged across all image types (negative, neutral and positive) and judgment tasks (valence ratings and arousal ratings). Figures depicting reaction times for each image type and judgment task separately are in the Supplement. *$p < .05$.

times at 6 weeks postpartum ($r(8) = .45$, $p = .27$; Fig. 1C, right). Furthermore, 2 weeks postpartum TST did not significantly predict 2 weeks postpartum reaction times ($r(8) = .43$, $p = .29$), and 6 weeks postpartum TST did not predict 6 weeks postpartum reaction times ($r(8) = -.008$, $p = .98$).

For prenatal reaction times, follow-up correlations (Supplementary Fig. S1A) showed that the relation to prenatal TST was mainly driven by reaction times when rating *negative item valence* ($r(9) = .70$, $p = .036$) and *neutral item arousal* ($r(9) = .82$, $p = .007$). Correlations between prenatal TST and prenatal reaction times for other ratings were not significant; however, all coefficients were in the same direction and above Cohen's medium effect size threshold of $r > .3$. Follow-up tests probing associations between prenatal TST and reaction times at 2 weeks postpartum (Supplementary Fig. S1B) were similar: participants with shorter prenatal TST had significantly faster reaction times at 2 weeks postpartum when rating their *arousal* toward *neutral* images ($r(8) = .82$, $p = .012$) and when rating *positive image valence* ($r(8) = .79$, $p = .020$). Shorter TST was nonsignificantly related to faster reaction times when rating *negative image valence* ($r(8) = .67$, $p = .069$). After controlling for concurrent TST at 2 weeks postpartum, the association between average TST at 33 weeks' gestation and reactions times at 2 weeks postpartum remained significant only for participants' arousal ratings toward neutral images ($r(5) = .82$, $p = .023$). Nonetheless, all other correlations remained in the same direction with medium–high effects ($rs = .40$-$.65$).

While prenatal TST did not predict 6 weeks postpartum IAPS reaction times when averaged across valence and arousal judgments, exploratory analyses of reaction times for individual judgment categories (Supplementary Figure S1C) showed that less prenatal TST predicted significantly faster 6 weeks valence ratings of positive images specifically (controlling for 6 weeks TST: $r(5) = .79$, $p = .034$). Though not significant, all other correlations

between prenatal TST and 6 weeks reaction times were in the same direction (controlling for 6 weeks TST: *rs* = .33-.62).

Finally, to address the possibility that participants' IAPS reaction times could be related to depressive symptoms (i.e., psychomotor slowing) in this at-risk sample rather than sleep per se [11, 31], we also examined associations between sleep duration, reaction times, and EPDS scores. Neither TST at 33 weeks' gestation nor participants' reaction times for the significant correlations above were associated with concurrent Edinburgh-rated depression (all *ps* > .32; see Supplementary Results), suggesting that the associations observed between prenatal sleep and reaction times were not confounded by depression.

Valence and arousal ratings of IAPS images

Regarding participants' rating scores, prenatal TST did not predict participants' valence or arousal ratings for any image category during the pregnancy timepoint (all *ps*>.28; Supplementary Table S1). However, when controlling for concurrent sleep minutes, shorter prenatal TST was associated with rating *negative* images as significantly *less negative* ($r(5) = -.78$, $p = .037$) and *less arousing* ($r(5) = .77$, $p = .043$) at 2 weeks postpartum. Though not statistically significant, shorter prenatal TST also predicted a tendency to rate *positive* images as *less positive* ($r(5) = .64$, $p = .12$), and *neutral* images as *more arousing* ($r(5) = -.67$, $p = .10$). Furthermore, shorter prenatal TST predicted rating *negative* images as significantly *less arousing* at 6 weeks postpartum ($r(8) = .88$, $p = .004$; controlling for 6 weeks sleep: $r(5) = .80$, $p = .031$). No other correlations between prenatal TST and participants' ratings at any timepoint approached significance (all *ps* > .20).

Discussion

Insufficient perinatal sleep is common and associated with a host of poor outcomes for birthing parents and infants, including suboptimal parent-infant interactions [13]. Nevertheless, the intermediate mechanisms underlying links between perinatal sleep, mental health, and parenting are poorly understood. Specifying these mechanisms is important to understand vulnerability to sleep insufficiency during critical developmental periods, to determine if sleep-related risks can be mitigated by addressing sleep problems, and to develop interventions targeting outcomes with the greatest importance to lifelong well-being.

Our findings in this small sample provide preliminary, hypothesis-generating evidence that birthing parents' sleep duration during late pregnancy may predict postpartum emotional responding. Specifically, shorter sleep duration at 33 weeks gestation was associated with faster reaction times when evaluating emotional images, both concurrently and in the early weeks following childbirth. Furthermore, while prenatal TST did not predict concurrent ratings of emotional stimuli, it did predict postnatal emotional ratings in a way similar to findings in non-perinatal populations [7], with shorter sleepers endorsing judgments less aligned with those expected for each image category (i.e., negative as less negative and arousing, positive as less positive, neutral as more arousing). While exploratory, these findings suggest that insufficient prenatal sleep may lead to more impulsive reactions and impaired emotional discrimination in early postpartum. Conversely, more sleep during pregnancy may be a precursor for slower, more deliberate emotional evaluation and thoughtful emotional responses in the early perinatal period. Although slower psychomotor responses could alternatively be interpreted as a depression symptom [11], our supplemental analyses showed that neither prenatal TST nor participants' reaction times were associated with concurrent Edinburgh-rated depression, suggesting that our findings are not solely explained by depression.

Given the importance of parent emotional discrimination and reactivity for adaptive caregiving [3, 4, 32, 33], the relations between insufficient prenatal sleep and postnatal emotional responding that we observed here could have lasting consequences for parenting behavior, parent-infant relationships, and child mental health [34]. However, as we did not include IAPS follow-ups beyond 6 weeks or dyadic parent-infant assessments, we are currently limited in understanding the ultimate meaning of our findings for parents' long-term mental health and parent-child outcomes. Another limitation is that our sample only included birthing parents with a prior history of a mood disorder. This population was the main focus of the larger study [19] given the heightened probability of postpartum depression among parents with a previous history of depression [35, 36]. Thus, while this limitation precludes us from understanding whether the relations between prenatal sleep and postnatal emotional responding are generalizable, it is important to explore these relations in clinical samples composed of individuals who are at higher risk for disturbed sleep, perinatal mood disorders, and difficulties with parent–child bonding and relationships [20, 21].

Conclusion

Our results justify the need to evaluate the role of adequate prenatal sleep in postnatal emotional responses. Future studies are needed to replicate our findings in a larger sample and investigate longer-term associations between prenatal sleep and parent emotional responding, including how these associations predict child well-being.

Supplementary material

Supplementary material is available at *SLEEP Advances* online.

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Disclosure Statement

Conflict of interest statement: no conflicts to disclose.

Author Contributions

Gina Mason (Conceptualization [equal], Data curation [supporting], Formal analysis [lead], Visualization [lead], Writing—original draft [lead], Writing—review & editing [lead]), Zachary Cohen (Conceptualization [equal], Data curation [equal], Investigation [equal], Methodology [equal], Writing—review & editing [supporting]), Jessica Obeysekare (Conceptualization [equal], Data curation [equal], Investigation [equal], Methodology [equal], Writing—review & editing [supporting]), Jared Saletin (Conceptualization [supporting], Methodology [supporting], Supervision [supporting], Writing—review & editing [equal]), and Katherine Sharkey

(Conceptualization [equal], Data curation [equal], Funding acquisition [lead], Investigation [lead], Methodology [lead], Resources [lead], Supervision [lead], Writing—review & editing [equal])

Data Availability

De-identified data underlying this manuscript will be shared upon reasonable request to the corresponding author.

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