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Review

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Associations between sleep and circadian rhythm disruption and perinatal anxiety

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This review summarizes findings on the role of sleep and circadian rhythm disruption in perinatal anxiety. Sleep disruption is concurrently and prospectively associated with anxiety in pregnancy and postpartum. Findings on circadian rhythm disruption and perinatal anxiety are mixed. Treatments targeting sleep may be most beneficial for reducing anxiety symptoms when delivered during pregnancy. Extant findings suggest sleep and circadian rhythms play a role in perinatal anxiety and its treatment.

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The perinatal period is both a momentous time of joy and excitement and a time of risk for psychopathology. Considerable research has examined depression in the perinatal period, revealing high prevalence rates (26.3%)[1], well-established risk factors, including low social support, physical health conditions, and sleep disruption[1,2], and adverse effects on infant outcomes[3,4]. In contrast, much less attention has been given to perinatal anxiety. This relative paucity of research is particularly notable given the high prevalence of perinatal anxiety. Approximately 15% of women experience an anxiety disorder during pregnancy[5,6], and 9–17% experience an anxiety disorder during postpartum[5–7]. Rates are even higher in some specific anxiety disorders. For example, approximately 9% of women will develop OCD within the first 6 months postpartum[8], a prevalence rate substantially higher than the ~1% 12-month prevalence of OCD in the general population[9]. Further, 15–24% of perinatal women experience clinically significant anxiety symptoms[5,10], and many women report new or worsening anxiety symptoms during the postpartum period[7,10]. Thus, the perinatal period represents a unique risk window for anxiety symptoms and disorders, which may contribute to the higher rates of anxiety disorders observed for women compared to men[11].

The high prevalence of perinatal anxiety is an important public health issue, as perinatal anxiety is associated with a range of adverse maternal and infant outcomes. For mothers, perinatal anxiety is associated with comorbid eating disorders[12], suicide risk[13], and higher childbirth fear[14]. Perinatal anxiety is also associated with adverse outcomes for infants both proximally and distally to delivery. In the near-term, perinatal anxiety is associated with adverse infant obstetric outcomes, such as risk for pre-term birth[15], lower Apgar scores (an assessment of infant health performed shortly after delivery, where lower scores may indicate need for medical attention)[16], higher likelihood of birth complications[16], and lower likelihood of breastfeeding and shorter breastfeeding duration[17,18]. Notably, these relations are observed over and above relevant covariates such as medical risk[15], age, and parity[15,18]. In the long term, perinatal anxiety is associated with adverse emotional and behavioral health outcomes for the child. For example, postpartum anxiety is associated with lower social-emotional development in children at age 2 years[19], anxiety during pregnancy is associated with higher internalizing and externalizing symptoms in children at ages 8–9 years[20], and anxiety during pregnancy is associated with higher impulsivity in children at ages 14–15 years[21]. Thus, perinatal anxiety is associated with worse emotional and behavioral trajectories for children, and these effects can be observed into the teenage years. These trajectories may be due in part to the consequences of perinatal anxiety on early maternal caregiving behaviors; indeed, perinatal anxiety is associated with lower maternal-infant bonding[22] and lower maternal responsivity to the infant[23].

Sleep and circadian rhythm disruption: candidate risk factors

The high prevalence rates and associated consequences of perinatal anxiety symptoms and disorders highlight the need to identify modifiable predictors that could be targeted for treatment. However, despite being more common than perinatal depression[6], perinatal anxiety remains understudied[24,25], and risk factors for perinatal anxiety are not well-delineated. One candidate predictor of perinatal anxiety is sleep and circadian rhythm disruption. Sleep plays a crucial role in cognitive and emotional functioning[26,27]. Sleep disruption can refer to disruptions to the continuity of sleep, such as insufficient sleep duration and low sleep efficiency (i.e., the ratio of sleep duration to time spent in bed), the architecture of sleep (i.e., time spent in stages of sleep, defined in part by electrical activity in the brain), or subjective aspects of sleep, such as insomnia symptoms (i.e., subjective difficulties with sleep initiation and maintenance) and perceived sleep quality. In the perinatal literature, assessment of sleep has largely focused on subjective sleep duration, sleep quality, and insomnia symptoms, though some studies have used objective measures such as actigraphy and polysomnography. Human physiology and behavior, including sleep, vary across the 24-h day in a rhythmic pattern driven by the endogenous circadian clock. Circadian rhythm disruption may be indicated by the timing, amplitude, and/or

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alignment of markers of the circadian clock. Timing of the circadian clock can be assessed using biomarkers such as melatonin[28], or estimated using indicators such as sleep timing and chronotype (individual differences in the temporal organization of behavior[29]). The circadian clock is entrained by light exposure[30]; thus, assessment of light may also provide insight into circadian rhythm disruption.

Notably, changes in sleep and circadian rhythms are characteristic of the perinatal period. Studies using subjective measures of sleep suggest that insomnia symptoms increase and sleep quality decreases from early to late pregnancy[31,32]. Studies using objective measures further find that sleep duration, sleep efficiency, and time spent in deep stages of sleep decrease across pregnancy[33,34] followed by a sharp reduction in sleep duration in the early postpartum period due to infant caregiving demands[34,35]. Extant findings also suggest changes in markers of circadian rhythms during the perinatal period, though findings are less consistent than those observed for sleep. Relative to pre-pregnancy, bedtimes shift earlier across pregnancy[36]. Studies of sleep timing in postpartum offer mixed results: One study found that wake time was significantly later in the first 2–4 weeks postpartum compared to the third trimester of pregnancy and subsequently significantly earlier at 12–16 weeks and 12–15 months[37], whereas another study found that both bedtimes and waketimes, as well as chronotype, shifted progressively earlier across 24 months postpartum compared to the third trimester of pregnancy[38]. However, in the absence of circadian biomarkers, changes in sleep timing in pregnancy could reflect alterations to the homeostatic sleep drive, and changes in sleep timing in the postpartum could reflect changes in the allocation of sleep to compensate for sleep loss during nocturnal caregiving. Importantly, melatonin, the primary biomarker of the timing of the human circadian clock, does exhibit changes during the perinatal period. Total melatonin output increases across pregnancy and decreases substantially following delivery[39,40]. Changes in melatonin output may contribute to changes in melatonin amplitude, though amplitude was not assessed in these studies. However, one study comparing postpartum women 4–10 weeks following delivery to nulliparous controls also found lower melatonin output, including lower percent rise relative to baseline[41], suggesting blunted melatonin amplitude. Only one study to date has examined change in circadian melatonin phase during the perinatal period, finding that melatonin onset was delayed by ~42 min from the third trimester to 6 weeks postpartum, and the phase angle between sleep onset and DLMO shortened[42], suggesting increased circadian misalignment.

The extant literature indicates that the perinatal period is a time of risk for sleep and circadian rhythm disruption and new or worsening anxiety. The adverse consequences of perinatal anxiety for both mother and infant highlight the need to identify modifiable risk factors for perinatal anxiety. Given the considerable research linking sleep and circadian rhythm disruption to anxiety in the general population[43], this review considers the extant research linking sleep and circadian rhythm disruption to perinatal anxiety and applications of behavioral sleep and circadian medicine in the perinatal period (see Supplementary Table 1 for summaries of individual studies reviewed).

Associations between sleep and circadian rhythm disruption and anxiety in pregnancy

Several studies have found a concurrent association between subjective sleep disruption and anxiety during pregnancy, with the most consistent link observed in late pregnancy. Indeed, higher anxiety is associated with longer sleep onset latency[44,45], more nocturnal awakenings[45], lower sleep quality[45,46], greater global sleep disturbance[47], and higher insomnia symptoms[48] in the third trimester of pregnancy. In the second trimester, some studies show that higher anxiety is associated with greater global sleep disturbance[49] and higher insomnia symptoms[50]; however, other studies have found no association between anxiety and global sleep disturbance[45] or sleep quality[46] in the second trimester. Finally, higher anxiety is associated with shorter sleep duration[51] and greater global sleep disturbances[49] in the first trimester. Further, studies that have examined the association between subjective sleep disruption and anxiety across all 3 trimesters have found that higher anxiety is associated with shorter sleep duration, lower sleep quality[52], and higher insomnia symptoms[53].

Notably, these associations are observed in both healthy and community (i.e., including those with and without physical and/or mental health conditions) pregnant women, suggesting the link between subjective sleep disruption and anxiety is not fully accounted for by existing pathology. Similar effects are, however, observed in clinical samples, as higher insomnia symptoms are associated with higher worry in pregnant women seeking psychiatric care[54], and pregnant women with stress-related sleep disturbance are more likely to screen positive for generalized anxiety disorder and posttraumatic stress disorder[55].

In contrast, the few studies that have used objective sleep measures (i.e., actigraphy) found no association between objective sleep and anxiety during pregnancy[47,56,57]. It is possible that the association between sleep disruption and anxiety during pregnancy is more strongly linked to subjective aspects of sleep, such as perceived quality, versus aspects of sleep continuity that are measured by actigraphy. Alternatively, subjective sleep disruption may represent a combination of actual sleep and psychological distress[57], which may explain the discrepancies observed for subjective versus objective sleep and anxiety. Additional work using both subjective and objective measures of sleep is needed to understand these discrepant findings. Likewise, few studies have examined indicators of circadian rhythm disruption as correlates of anxiety during pregnancy. One study that measured chronotype found no association with anxiety in late pregnancy[44]. Another study found no association between self-reported light exposure and anxiety, although there was an association between greater evening light exposure and higher perceived stress in the third trimester[46]. See Fig. 1.

Prospective associations between sleep and circadian rhythm disruption in pregnancy and anxiety in postpartum

There is also a consistent prospective relation observed between insomnia symptoms in pregnancy and postpartum anxiety. Insomnia during pregnancy predicts increased postpartum general anxiety[48,50,58], as well as postpartum OCD[50] and PTSD symptoms[59]. Similarly, trajectory analyses indicate that perinatal women with an insomnia trajectory report higher postpartum anxiety than women in the subthreshold or no insomnia trajectory groups[60]. Three of these studies also examined the effects of insomnia during pregnancy on obstetric outcomes and found that women with insomnia during pregnancy were no more likely to have a cesarean section than women without insomnia during pregnancy, suggesting the links between insomnia in pregnancy and anxiety in postpartum are not better accounted for by obstetric risk[48,50,58].

Findings regarding a prospective relation between other aspects of sleep disruption in pregnancy and postpartum anxiety are less consistent. Though some studies have shown a prospective relation between lower sleep quality in pregnancy and higher postpartum anxiety[61,62], one study did not observe this effect over and above the effects of education and anxiety during pregnancy[63]. Similarly, though only two studies have specifically examined the prospective relation between sleep duration in pregnancy and postpartum anxiety, findings are mixed[38,62]. Further, two smaller studies (i.e., $N < 50$) of healthy women found no association between sleep disruption in pregnancy and postpartum anxiety[56,57], suggesting the existence of factors that may make women more vulnerable to the effects of sleep disruption in pregnancy on postpartum anxiety.

Evidence for an association between circadian rhythm disruption in pregnancy and postpartum anxiety is also mixed. One study of women with a history of a mood disorder found no association between sleep timing in pregnancy and postpartum OCD symptoms, but did find that a longer phase angle in pregnancy (i.e., later sleep timing relative to circadian phase, measured by dim light melatonin onset) was associated with higher postpartum OCD symptoms[64]. In contrast, a study of healthy women found no prospective relation between chronotype in pregnancy and postpartum

anxiety. These findings suggest that physiological measures of circadian rhythms (e.g., melatonin phase) may be needed to reveal potential effects of circadian rhythm disruption on postpartum anxiety in vulnerable women. See Fig. 2.

Associations between sleep and circadian rhythm disruption and anxiety in postpartum

Fewer studies have examined the associations between sleep and circadian rhythm disruption and anxiety in the postpartum period, but findings similarly point to an association between sleep disruption and higher anxiety. In women with a history of depression, greater global sleep disturbance is associated with higher anxiety from 1 to 6 months postpartum[65], and shorter subjective sleep duration is associated with higher anxiety, particularly during the early postpartum period[66]; however, sleep duration did not prospectively predict postpartum anxiety[66]. Further, women with consistently high subjective sleep disturbance up to 6 months postpartum report higher anxiety than women with low or increasing sleep disturbance trajectories[67]. In contrast to the lack of evidence for an association between objective sleep and anxiety in pregnancy, higher objective wake after sleep onset (i.e., time spent awake after initially falling asleep) predicts higher anxiety symptoms in the postpartum period, though this effect was at trend-level[68]. There is also preliminary evidence for a link between circadian rhythm disruption and postpartum anxiety. One study that used multiple methods of assessment of sleep and circadian rhythms found that greater subjective biological rhythm disruption and higher mean activity at night (i.e., higher average nocturnal activity measured by actigraphy) were associated with higher anxiety from 1 to 12 weeks postpartum. This study also found earlier mean light exposure timing (i.e., time at which average light exposure is centered) was associated with higher anxiety, specifically at 6–12 weeks postpartum[69]. In contrast, one study found no association between sleep timing and anxiety in postpartum women[66]. These findings highlight the need for additional work to understand the role of sleep and circadian rhythm disruption in anxiety during the postpartum period. See Fig. 2.

Potential mechanisms linking sleep and circadian rhythm disruption to perinatal anxiety

Sleep and circadian rhythm disruption have known downstream consequences for physiological, cognitive, and affective function[70–72]. These consequences may point to putative mechanisms by which sleep and circadian rhythm disruption contribute to perinatal anxiety. Circadian misalignment occurs when there is a mismatch between the circadian clock and social demands and/or desynchrony between central (i.e., brain) and peripheral (e.g., liver, muscle, etc.) clocks[73]. Exposure to light, the primary time cue for the central circadian clock in humans, at night (e.g., during nocturnal caregiving) may contribute to circadian misalignment by delaying the circadian clock. Multiple theoretical mechanisms of anxiety-related disorders, such as monoamine signaling and hypothalamic-pituitary-adrenal axis function, are under circadian control and/or interface with the circadian system[71]. Findings from the animal literature also show that circadian misalignment during pregnancy results in alterations in maternal hormone rhythms and circadian gene expression and has adverse consequences for offspring[74]. Thus, the physiological consequences of circadian rhythm disruption may in turn contribute to anxiety in the perinatal period.

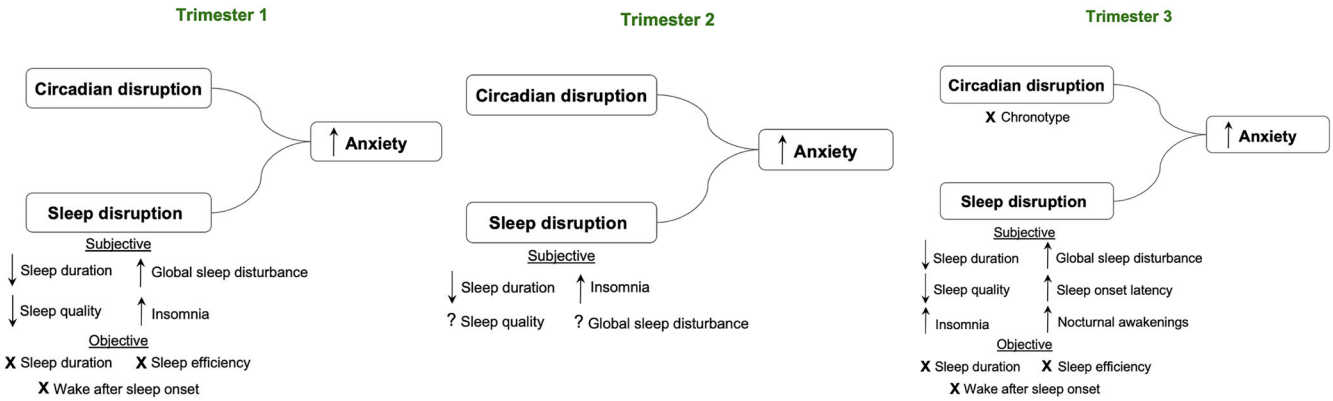

Fig. 1 | Summary of associations between sleep and circadian rhythm disruption and anxiety during pregnancy by trimester. Arrows (↑↓) indicate significant findings, **X** indicates null findings, and **?** indicates mixed findings.

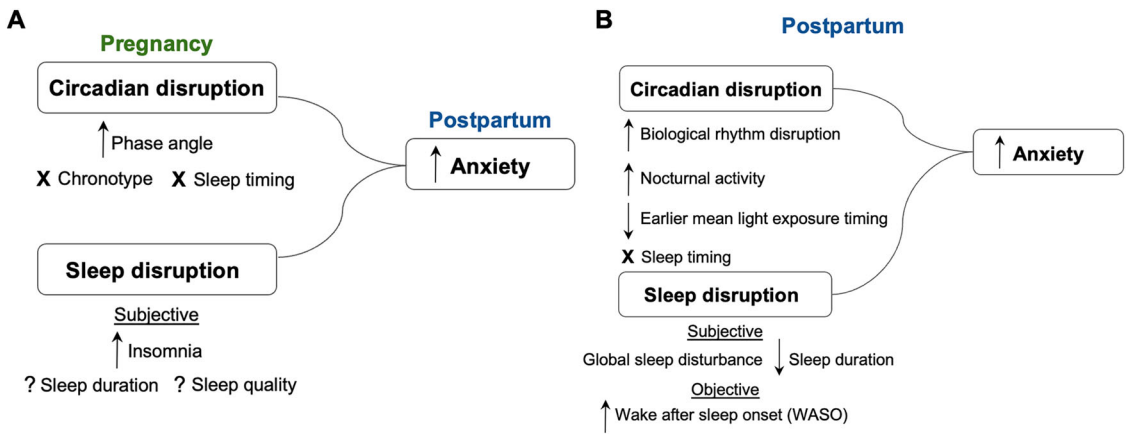

Fig. 2 | Summary of associations between sleep and circadian rhythm disruption and perinatal anxiety. Summary of associations between sleep and circadian rhythm disruption in pregnancy and postpartum anxiety (**A**) and associations between postpartum sleep and circadian rhythm disruption and anxiety (**B**). Arrows (↑↓) indicate significant findings, **X** indicates null findings, and **?** indicates mixed findings.

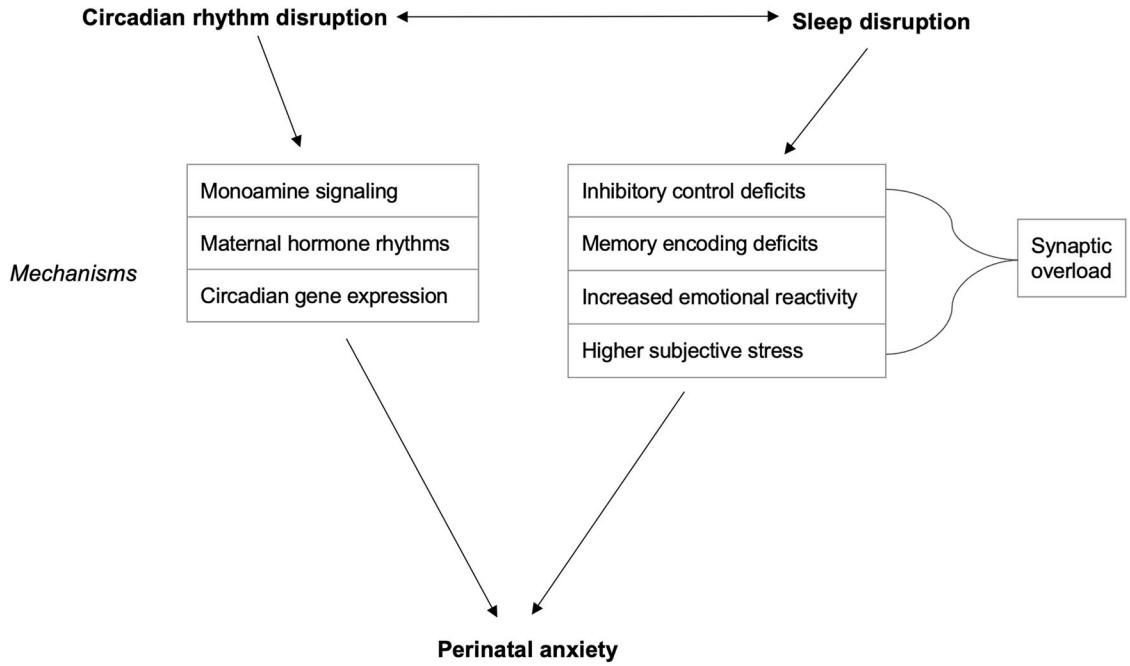

Fig. 3 | Putative mechanisms by which sleep and circadian rhythm disruption may contribute to perinatal anxiety.

Sleep is theorized to function to consolidate and organize information accumulated during the waking day through long-term synaptic potentiation, a process known as synaptic homeostasis[75]. In the absence of sufficient sleep, synaptic overload may then contribute to deficits in cognitive and emotional function due in part to decreased neuronal signal-to-noise ratios and reduced plasticity[75]. These cognitive and emotional impairments of sleep disruption have been well-documented in the general population. For example, prior work has demonstrated that sleep loss results in deficits in inhibitory control[76] and memory encoding[77], as well as increased emotional reactivity to negative stimuli[78] and higher subjective stress to stressors[79]. The known disruptions to sleep experienced by perinatal women may therefore have similar downstream consequences that confer vulnerability for anxiety. See Fig. 3.

Notably, sleep and circadian rhythm disruption are characteristic of the perinatal period, whereas clinically significant anxiety is relatively more rare[80,81]. Possible explanations for this imbalance come from the 3P model of insomnia, which proposes that chronic insomnia arises from a combination of predisposing, precipitating, and perpetuating factors[82]. Indeed, pregnancy and childbirth are common precipitating factors for developing insomnia[83,84]. Predisposing factors refer to individual differences that increase vulnerability for insomnia, for example, personality traits such as neuroticism. Further, there are individual differences in sensitivity to sleep and circadian rhythm disruption, which may confer vulnerability for perinatal anxiety. Indeed, prior work in healthy adults has demonstrated that sensitivity to the consequences of sleep deprivation and circadian misalignment for cognitive performance is trait-like[80,81]. Perpetuating factors refer to behaviors engaged in to compensate for sleep loss that maintain insomnia over time. For example, daytime napping, a common compensatory strategy for sleep fragmentation due to nocturnal caregiving, is associated with more wake after sleep onset in postpartum women[85]. Further, though few studies have characterized personal light exposure in the perinatal period, extant findings suggest postpartum women are exposed to insufficient intensities of daytime light[86], which may exacerbate sleep and circadian rhythm disruption. Thus, the extant literature offers several factors that may increase vulnerability to and/or amplify the negative effects of sleep and circadian rhythm disruption, which may in turn contribute to perinatal anxiety.

Implications of maternal sleep disruption for infant outcomes

As noted above, it is well-established that maternal anxiety during pregnancy and postpartum is associated with adverse outcomes for infant physical and mental health[15,16,19,20]. Likewise, maternal sleep and circadian rhythm disruption are associated with adverse infant outcomes. Worse subjective maternal sleep disruption during pregnancy predicts worse infant sleep at age 1[87], although one study did not detect this predictive effect when infant sleep was assessed at 6 weeks postpartum[88]. Likewise, worse subjective[89,90] and objective[91,92] postpartum maternal sleep is associated with worse infant sleep, particularly during the early postpartum months[93]. Maternal sleep disruption during pregnancy[94] and postpartum[95–97] has also been associated with a more difficult infant temperament[95]. Further, later objective maternal sleep timing and higher maternal intra-daily variability in diurnal activity rhythms during pregnancy predict higher externalizing symptoms in infants at age 1[87], and insomnia during pregnancy predicts worse social-emotional development in children at age 2[98].

Downstream effects of maternal sleep and circadian rhythm disruption on infant outcomes may occur through physiological mechanisms, such as neurodevelopment[99]. For example, objective sleep irregularity and later sleep timing during pregnancy predict smaller total cortical gray and white matter values and smaller subcortical gray matter volumes, respectively, in neonates[100]. Another non-mutually exclusive possibility is that maternal sleep and circadian rhythm disruption influence infant outcomes through behavioral pathways. Indeed, postpartum insomnia is associated with lower maternal-infant bonding[90], and lower postpartum sleep regularity and later sleep timing are associated with lower objectively rated parenting quality[101].

Effects of behavioral sleep and circadian medicine on perinatal anxiety

The consistent link between perinatal insomnia and anxiety symptoms suggests the utility of treatments targeting insomnia symptoms to reduce perinatal anxiety. Cognitive behavior therapy for insomnia (CBTI) is a behavioral sleep medicine treatment that is effective at reducing insomnia symptoms in the general population[102] and in the perinatal period[103]. In addition to treating insomnia, CBTI has also been shown to reduce anxiety in the general population[104,105]. However, evidence for anxiety reduction following CBTI during the perinatal period varies by study sample and time of treatment delivery. In pregnant women with insomnia, CBTI

delivered during pregnancy yields medium to large improvements in subjective[106,107] and objective[107] sleep during pregnancy and medium reductions in anxiety during pregnancy. Further, improvements in insomnia as a result of CBTI during pregnancy are associated with reductions in perseverative thinking[108]. In contrast, one study that delivered CBTI in pregnancy and postpartum to women with elevated insomnia symptoms found no effect of CBTI on postpartum anxiety symptoms[109], and another study that delivered CBTI to postpartum women with insomnia likewise found no effect on postpartum anxiety[110]. Further, a study that delivered CBTI in pregnancy and postpartum to healthy women also found no effect on anxiety symptoms in late pregnancy or postpartum[111]. Together, these findings suggest that improving insomnia symptoms through CBTI may be most beneficial for anxiety symptom reduction among women with clinical insomnia during pregnancy, but less impactful for postpartum anxiety symptoms in women with less severe sleep disruption.

Light therapy is a chronotherapy involving the application of timed light exposure, commonly morning bright light[112]. Although prior work suggests that light therapy is effective for reducing perinatal depression symptoms[113], the efficacy of light therapy for perinatal anxiety is unclear. One study of postpartum women with insomnia who were instructed to complete 20 min of light therapy each morning and minimize evening light exposure found no significant change in anxiety compared to treatment as usual (i.e., routine care)[110]. However, no study has examined the effect of light therapy on perinatal anxiety in women with an anxiety disorder, although there is preliminary evidence that longer doses (e.g., 1 h) of light therapy reduce anxiety symptoms in adults with anxiety-related disorders in the general population[114,115].

Opportunities for behavioral sleep and circadian medicine in the perinatal period

Though mixed, the extant findings suggest that directly targeting sleep disruption may have some anxiety-reducing effects in the perinatal period. Behavioral sleep and circadian medicine may be particularly desirable during the perinatal period, as pregnant women report preferring CBTI to medication or acupuncture for the treatment of insomnia[116]. Further, stigma and concerns about being perceived as an "unfit mother" are identified as being barriers to seeking treatment for perinatal anxiety[117,118]; thus, treatments targeting sleep and circadian rhythms may offer an easier point of entry to mental health care for perinatal women. However, recent findings also suggest there is a need for improvement in the application of sleep and circadian medicine to the perinatal period. For example, qualitative patient feedback provided after a trial of digital CBTI for pregnant women with insomnia revealed that women found the treatment was limited by a lack of tailoring to the specific challenges of the perinatal period[108]. Thus, future work is needed to assess the utility of sleep and circadian medicine treatments tailored for the perinatal period for improving perinatal anxiety.

Conclusions and future directions

The strength of the association between sleep disruption and perinatal anxiety varies by assessment period, sleep measure, and study sample. In pregnancy, subjective sleep disruption is most consistently linked to higher anxiety in the third trimester, and insomnia symptoms, relative to other sleep indicators, are the most robust correlate of anxiety. There is also consistent evidence that insomnia symptoms in pregnancy predict postpartum anxiety symptoms, whereas findings for prediction by sleep quality and duration are mixed. The few studies that have examined prospective relations between postpartum sleep disruption and anxiety find that both subjective and objective measures of sleep disruption predict higher postpartum anxiety. Across the perinatal period, studies that have found no association between sleep disruption and anxiety have largely examined healthy women, suggesting that physical or mental health risk factors may amplify the effects of sleep disruption on perinatal anxiety. Similarly, studies examining the efficacy of CBTI in the perinatal period suggest potential utility of intervening on insomnia symptoms to reduce anxiety during pregnancy among those with clinical insomnia, whereas these benefits may not extend to the postpartum period or to women with less disturbed sleep.

In contrast, the extant research examining associations between circadian rhythm disruption and perinatal anxiety is limited, and findings are mixed. At present, there is no evidence that later chronotype or later sleep timing are associated with perinatal anxiety. However, studies using objective measures reveal associations between perinatal anxiety and circadian phase angle, diurnal activity rhythms, and light exposure. These findings suggest that there is more to be learned about the potential role of circadian rhythms in perinatal anxiety.

Future work in this area is needed to address the limitations of the extant research. One notable issue is the reliance on general measures of anxiety versus perinatal-specific measures, which may underestimate the effect of sleep disruption on perinatal anxiety. For example, prior work suggests that the prevalence of perinatal OCD is underestimated in the absence of assessing perinatal-specific symptoms[8]. Similarly, few studies have used objective measures of sleep and circadian rhythm disruption. Although subjective measures are more feasible, particularly in this difficult-to-recruit population, wearables offer a relatively low-burden objective measure that can provide insight into multiple indicators of sleep and circadian rhythm disruption, including sleep/wake, diurnal activity rhythms, and personal light exposure. Further, none of the studies reviewed here examined the role of the distribution of caregiving responsibilities, which could moderate the reported effects in the postpartum period. Another limitation of the extant research is the dearth of studies in clinical samples. No study has examined the role of sleep and circadian rhythm disruption in perinatal anxiety in women with an anxiety disorder, at risk for an anxiety disorder, or with a history of an anxiety disorder. The majority of the work reviewed here was conducted in healthy or community samples, though a few studies examined women with a history of depression or women with insomnia. Thus, the degree to which these findings extend to women with clinically significant anxiety is unknown, representing an important question for future research.

Despite these limitations, the work conducted in this area also has several strengths, including the frequent use of longitudinal designs and large sample sizes. The extant literature suggests that sleep disruption is associated with perinatal anxiety both concurrently and prospectively. In contrast, there is insufficient evidence for a similar association between circadian rhythm disruption and perinatal anxiety, though the few studies using objective measures suggest more work in this area is needed. Behavioral sleep medicine approaches, such as CBTI, offer novel, non-pharmacological treatments for sleep disruption during pregnancy. Thus, sleep and circadian health may represent an important perspective from which to understand perinatal anxiety.

Data availability

No datasets were generated or analyzed during the current study.

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