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REVIEW ARTICLE

Exploring the Relationship Between Circadian Rhythm Shifts and Postpartum Depression

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This review paper explores the relationship between circadian rhythm and postpartum depression (PPD). Postpartum depression is a prevalent and debilitating mood disorder that affects a significant number of women after childbirth. Emerging evidence suggests that disruptions in circadian rhythm may contribute to the development of PPD. This paper provides an overview of the current understanding of circadian rhythm disturbances in the postpartum period, their potential impact on PPD, and the underlying mechanisms involved. Additionally, therapeutic approaches targeting circadian disruptions in the prevention and treatment of PPD are discussed. Further research in this field has the potential to provide novel insights and interventions for the management of PPD.

Keywords: Postpartum depression; Circadian rhythm; Mechanism; Forced desynchrony

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INTRODUCTION

Postpartum depression (PPD) is a mood disorder that occurs in women after childbirth. It is characterized by a persistent and pervasive feeling of sadness, low mood, and a loss of interest or pleasure in daily activities. PPD can have a significant impact on the mother's mental health, her relationship with the infant, and the overall well-being of the family. PPD is a prevalent mental health condition affecting women worldwide. The reported prevalence rates vary across studies and cultural contexts. The estimated prevalence of PPD ranges from 10% to 20% of adult mothers yearly, making it one of the most common postpartum complications [1].

PPD symptoms can vary in severity and duration, including persistent sadness, guilt or worthlessness, changes in appetite and sleep patterns, loss of interest in activities, difficulty bonding with the baby, and recurrent thoughts of self-harm or harming the infant [2]. It significantly impacts the mother's emotional, physical, and cognitive well-being, disrupting the mother-infant bond, impairing maternal functioning, and potentially leading to chronic depressive episodes if untreated. PPD also affects the mother's quality of life, relationships, and parenting abilities [3]. The impact extends to the infant, causing disrupted attachment, impaired social-emotional development, cognitive delays, and long-term risks of behavioral problems and mental health issues [4].

Circadian rhythm refers to the approximately 24-hour cycle that governs the timing of biological processes in organisms, including humans. It is controlled by the master clock located in the suprachiasmatic nucleus of the hypothalamus, which receives light information from the retina to synchronize the internal clock with the external environment. The circadian rhythm influences sleep-wake cycles, hormone secretion, metabolism, and gene expression, among other physiological functions [5].

One area where circadian rhythm exerts a profound influence is mood regulation. Studies have demonstrated that disruptions to the circadian rhythm, such as irregular sleep patterns, jet lag, or shift work, can significantly impact mood and emotional well-being. When the circadian clock is misaligned with the external environment or disrupted by external factors, it can lead to dysregulation of mood and increased vulnerability to mood disorders [6-8]. Circadian processes play a crucial role in the regulation of neurotransmitters, such as serotonin and dopamine, which are essential for mood stability. The circadian rhythm influences

the synthesis, release, and clearance of these neurotransmitters, impacting mood regulation [9].

Disruptions to the circadian rhythm have been associated with mood disorders, including major depressive disorder (MDD), bipolar disorder, and seasonal affective disorder. Individuals with mood disorders often exhibit alterations in their circadian rhythm, including disrupted sleep patterns and abnormal hormone secretion [10,11].

SLEEP DISTURBANCE IN POSTPARTUM PERIOD

During the perinatal period, sleep problems and circadian rhythm disturbances are highly common. The third trimester of pregnancy increases the occurrence of sleep apnea [12], leading to frequent arousals. Additionally, the high prevalence of periodic limb movement during sleep can disrupt the ability to achieve restful sleep [13]. Prior to childbirth, expecting mothers often experience difficulties falling asleep, staying asleep, and experiencing restful sleep due to physical discomfort, hormonal changes, anxiety, and frequent bathroom trips. Additionally, concerns about the upcoming birth and the well-being of the baby can contribute to sleep disturbances [14].

After childbirth, sleep disruptions continue to be a challenge for new mothers. The demands of caring for a newborn, including feeding, diaper changes, and comforting, often result in fragmented and reduced sleep. The infant's irregular sleep-wake cycle and frequent night awakenings further impact the mother's ability to achieve adequate sleep. Additionally, postpartum physical discomfort, hormonal fluctuations, and emotional adjustments can contribute to sleep difficulties [15].

Research has consistently shown a strong association between sleep disturbances and PPD. Studies have demonstrated that women experiencing sleep difficulties in the postpartum period are at a higher risk of developing PPD or experiencing more severe depressive symptoms. Disrupted sleep can exacerbate the emotional and psychological challenges of the postpartum period, making women more vulnerable to mood disorders [16].

In a preliminary communication, Sharkey et al. [17] aimed to examine circadian phase shifts and mood changes throughout the perinatal period in women with a history of MDD. The study included 23 pregnant women with a history of MDD and 25 healthy control participants. The researchers collected data on circadian rhythms, sleep patterns, and mood using actigraphy, sleep diaries, and mood scales. They found that women with a history of MDD experienced greater circadian phase shifts during the perinatal period compared to the control group. These phase shifts were associated with more severe depressive symptoms. The researchers suggested that women with a history of MDD may be more susceptible to circadian rhythm disturbances during pregnancy and the postpartum period, which could contribute to mood changes and increase the risk of developing PPD.

Pregnant women with evening chronotypes exhibit unhealthy lifestyle habits and sociodemographic characteristics commonly associated with a higher risk for PPD. They also have an increased likelihood of developing PPD symptoms in the first month after delivery [18]. In a study involving 98 healthy mothers at 1 month postpartum, salivary melatonin concentrations taken 30 minutes after awakening were found to be a potentially useful circadian phase marker for identifying the awakening time and detecting circadian rhythm shifts in postpartum mothers. Specifically, elevated melatonin levels could indicate mothers with a delayed circadian rhythm [19].

A KIND OF FORCED DESYNCHRONY?

Forced desynchrony is an experimental condition that creates a mismatch between the internal circadian biological clock and external time. It allows researchers to study the regulation of the internal clock by manipulating sleep-wake patterns. This method helps investigate the characteristics and mechanisms of circadian rhythms, including circadian phase shifting [20]. Forced desynchrony disrupts the internal clock, leading to circadian phase shifting. Participants in these experiments try to align their internal clock with external time by adjusting their sleep-wake schedules or light conditions [21,22].

Postpartum mothers may experience a situation similar to forced desynchrony. The postpartum period is a critical time for women, characterized by significant physiological and psychological changes. Among these changes, sleep disturbances and disruptions to the circadian rhythm are common and can have implications for maternal health and well-being. During pregnancy, women experience alterations in their sleep-wake patterns and hormonal fluctuations, which are necessary for fetal development and preparation for childbirth. Following delivery, the abrupt change in hormone levels, increased caregiving responsibilities, and infant feeding schedules can further disrupt the circadian rhythm [23,24].

Pregnant and postpartum women often experience disrupted sleep. A study examined whether sleep timing during the third trimester of pregnancy predicted postpartum symptoms of mania, depression, and obsessive-compulsive disorder (OCD). The results showed that late sleepers reported more symptoms at 2 weeks postpartum. Delayed sleep timing was associated with increased symptoms of mania, depression, and OCD in the postpartum period. Sleep timing may be a modifiable risk factor for PPD [25].

Recent studies have reported that circadian phase shifts may be responsible for developing mood episodes such as depression [6,7]. The unique chronic sleep deprivation experienced during perinatal periods is likely to induce shifting in the circadian rhythm of new mothers, increasing the risk of mood disorders such as PPD.

Several factors contribute to circadian rhythm disruptions in the postpartum period. The demands of newborn care, including nighttime feedings and diaper changes, can disrupt the regular sleep-wake cycles and lead to fragmented and insufficient sleep for mothers. Additionally, hormonal changes, such as decreased lev-

els of progesterone and estrogen, can influence sleep patterns and circadian regulation.

As summarized in Figure 1, the various causes of sleep disturbance during the perinatal period result in forced desynchrony-like situation, delaying circadian phase and ultimately increasing the risk of postpartum depression.

HYPOTHESES FOR BIOLOGICAL MECHANISMS

Circadian rhythm disturbance has been implicated as a potential contributor to PPD through various biological mechanisms. While the precise mechanisms are not yet fully understood, several hypotheses have been put forward.

One hypothesis revolves around hormonal dysregulation. Hormonal changes during pregnancy and the postpartum period, including fluctuations in estrogen, progesterone, and oxytocin levels, can disrupt circadian rhythms and impact mood regulation [26,27]. These hormonal shifts may influence the delicate balance of neurotransmitters and other signaling molecules involved in mood regulation, potentially contributing to the development of PPD.

Another hypothesis suggests that the disrupted sleep-wake cycle experienced in the postpartum period plays a significant role. Sleep disturbances such as fragmented sleep, frequent awakenings, and sleep deprivation can disrupt the normal synchronization of circadian rhythms. This disruption can negatively affect mood and contribute to the onset of PPD [28]. This disrupted sleep pattern is reminiscent of the concept of forced desynchrony discussed earlier.

Furthermore, circadian rhythm disruptions can influence neurotransmitter function, particularly those involved in mood regulation, such as serotonin and dopamine. Imbalances in these neurotransmitters have been implicated in the underlying pathophysiology of PPD [29,30]. The dysregulation of circadian rhythms may alter the release and functioning of these neurotransmitters, further contributing to the development of PPD.

In addition to neurotransmitter imbalances, circadian rhythms also play a role in modulating immune system function. Disruption of circadian rhythms can lead to immune system dysregulation and inflammation, which have been associated with PPD. The intricate interplay between circadian rhythms and the immune system suggests that disturbances in the circadian system may trigger inflammatory processes that contribute to the development of PPD [31].

Genetic factors are also thought to play a role in the susceptibility to PPD. Certain genetic variations, including variations in clock genes that regulate circadian rhythms, have been associated with an increased risk of PPD [32,33]. These genetic factors may influence an individual's sensitivity to circadian rhythm disturbances and their subsequent impact on mood and mental health.

Further research is needed to gain a deeper understanding of the underlying biological mechanisms linking circadian rhythm disturbance and PPD. Investigating these mechanisms may offer valuable insights into potential therapeutic targets for the prevention and treatment of PPD. By addressing circadian rhythm disruptions and their associated biological processes, interventions aimed at promoting better sleep, hormonal regulation, neurotransmitter balance, and immune system function may help mitigate the risk and severity of PPD.

THERAPEUTIC APPROACHES TARGETING CIRCADIAN RHYTHM IN PPD

Therapeutic approaches focusing on circadian rhythm in PPD aim to restore and regulate the disrupted circadian system, potentially alleviating depressive symptoms. Chronotherapy involves the manipulation of sleep-wake schedules and exposure to light to realign the circadian rhythm. It includes interventions such as phase advance or phase delay of sleep schedules and timed light exposure. Chronotherapy has shown positive outcomes in the treatment of depression, including in postpartum women. By adjusting the timing of sleep and light exposure, this approach aims to resynchronize the circadian system, potentially improving mood and reducing depressive symptoms in PPD [34].

Sleep interventions play a crucial role in addressing circadian rhythm disruptions in PPD. By targeting sleep disturbances and

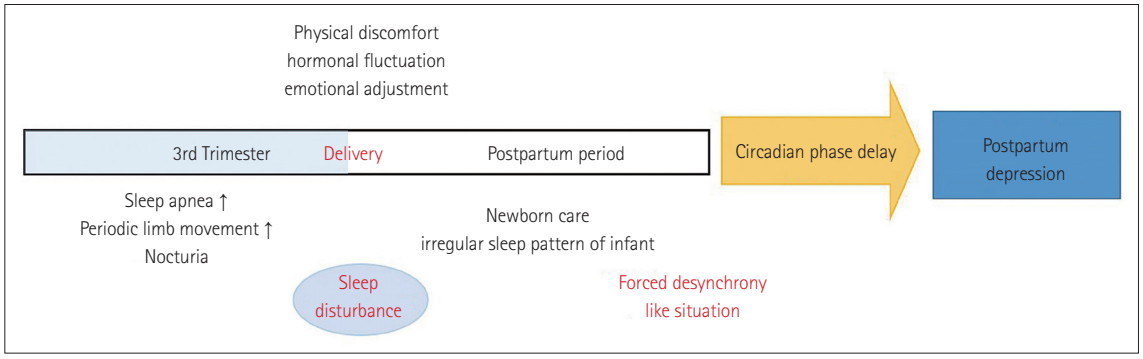

Figure 1. Causes of circadian rhythm shifts during the peripartum period and the mechanisms of development of postpartum depression. During the 3rd trimester and childbirth, various factors can lead to sleep fragmentation, sleep deprivation, and sleep disturbances. These conditions resemble forced desynchrony and can induce circadian rhythm delay, potentially resulting in postpartum depression in susceptible individuals.

improving sleep quality, these interventions can restore proper functioning of the circadian system. Behavioral sleep interventions, such as sleep hygiene education, cognitive-behavioral therapy for insomnia (CBT-I), and sleep restriction therapy, have demonstrated promise in improving sleep and reducing depressive symptoms among postpartum women. By addressing sleep issues, these interventions contribute to the restoration of circadian rhythm and potentially alleviate PPD symptoms [35].

It is important to note that further research is needed to establish the effectiveness and safety of these therapeutic approaches specifically in the context of PPD. Larger-scale studies and clinical trials are necessary to determine the optimal protocols, dosages, and long-term effects of these interventions in managing circadian rhythm disruptions and improving outcomes for women with PPD.

CONCLUSION

PPD is a prevalent mood disorder that significantly impacts the mental health and well-being of women after childbirth. Disruptions to the circadian rhythm, including sleep disturbances and altered hormonal patterns, have been implicated as potential contributors to the development and severity of PPD. Evidence suggests that circadian rhythm disturbances during the perinatal period, similar to forced desynchrony conditions, can increase the risk of mood disorders, including PPD.

Various biological mechanisms have been proposed to explain the association between circadian rhythm disturbance and PPD. These mechanisms include hormonal dysregulation, disrupted sleep-wake cycles, neurotransmitter imbalances, immune system dysregulation, and genetic factors. Further research is needed to better understand these mechanisms and their specific roles in PPD.

Therapeutic approaches targeting circadian rhythm in PPD show promise in alleviating depressive symptoms and improving outcomes. Chronotherapy, which involves adjusting sleep-wake schedules and exposure to light, aims to resynchronize the circadian system and has demonstrated positive results in treating depression, including in postpartum women. Sleep interventions, such as sleep hygiene education, CBT-I, and sleep restriction therapy, play a crucial role in restoring proper circadian functioning and improving sleep quality among postpartum women.

However, more research is required to establish the effectiveness and safety of these therapeutic approaches specifically for PPD. Larger-scale studies and clinical trials are needed to determine optimal protocols, dosages, and long-term effects. By addressing circadian rhythm disruptions, these interventions hold the potential to improve outcomes and enhance the well-being of women with PPD.

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Conflicts of Interest

The authors have no potential conflicts of interest to disclose.

Availability of Data and Material

Data sharing is not applicable to this article as no datasets were generated or analyzed during the study.

Author Contributions

Conceptualization: Ji Won Yeom, Heon-Jeong Lee. Funding acquisition: Heon-Jeong Lee. Supervision: Heon-Jeong Lee. Writing—original draft: Ji Won Yeom, Heon-Jeong Lee. Writing—review & editing: Ji Won Yeom, Heon-Jeong Lee.

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