The Role of Sleep in the Relationship Between Menstrual Cycle Phases and Depressive

Symptoms

Audrey Giltner

Department of Psychology, Colgate University

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Sleep is a fundamental biological process that plays a critical role in cognitive

functioning, emotional regulation, and overall physical health. It is essential for memory

consolidation, immune function, and metabolic balance, making it a crucial factor in overall

well-being. However, sleep patterns are highly dynamic and influenced by a wide range of

physiological, psychological, and environmental factors, including stress, lifestyle habits, and

hormonal fluctuations. One of the most prominent biological rhythms affecting sleep is the

menstrual cycle, which involves cyclical fluctuations in estrogen and progesterone levels. These

hormonal changes regulate numerous physiological processes, including body temperature,

neurotransmitter activity, and circadian rhythms, all of which impact sleep architecture and

quality. Research suggests that sleep disturbances vary across different menstrual phases, with

many individuals experiencing poorer sleep quality, increased sleep fragmentation, and

heightened sleep onset latency during the luteal phase compared to the follicular phase (Alzueta

& Baker, 2023). These disruptions may be attributed to elevated progesterone levels, which can

lead to increased core body temperature and altered melatonin secretion, both of which are

associated with difficulty falling and staying asleep.

Given the well-established bidirectional relationship between sleep and mood,

understanding how menstrual-related sleep changes contribute to emotional and psychological

well-being is crucial. Poor sleep quality, particularly during the luteal phase, has been linked to

increased irritability, mood swings, and depressive symptoms in individuals with premenstrual

syndrome (PMS) and premenstrual dysphoric disorder (PMDD) (Handy et al., 2022). This

connection underscores the importance of addressing sleep disturbances as part of

comprehensive clinical interventions for mood disorders and menstrual-related health concerns. Further research on this topic could enhance public health strategies, inform targeted treatments, and improve overall quality of life for those affected by menstrual-related sleep disturbances.

The purpose of this literature review is to examine the theoretical mechanisms linking sleep disturbances to menstrual cycle phases and depressive symptoms, summarize empirical findings, and identify gaps in the existing research. By doing so, this paper will provide a foundation for the present study, which aims to investigate whether sleep disturbances mediate the relationship between menstrual phase and depressive symptoms.

Hormonal fluctuations across the menstrual cycle have a profound impact on sleep architecture and quality. The menstrual cycle consists of two primary phases: the follicular phase (from menstruation to ovulation) and the luteal phase (from ovulation to the onset of menstruation). Estrogen and progesterone, the two dominant ovarian hormones, exhibit cyclical variations that influence sleep patterns. Estrogen has been linked to increased slow-wave sleep, reduced sleep latency, and improved sleep efficiency, whereas progesterone has sedative-like effects, which may contribute to increased daytime sleepiness but also greater sleep fragmentation (Mong & Cusmano, 2016). As a result, women often report poorer sleep quality, increased nocturnal awakenings, and greater difficulty initiating sleep during the luteal phase compared to the follicular phase (Jeon & Baek, 2023).

Beyond direct hormonal effects on sleep, the interaction between hormonal changes and the circadian system is an important factor in menstrual-related sleep disturbances. Research suggests that progesterone influences thermoregulation by increasing core body temperature during the luteal phase, which can disrupt sleep by interfering with the body's natural cooling process required for sleep onset (Baker & Driver, 2007). Additionally, estrogen and progesterone

interact with neurotransmitter systems such as serotonin and GABA, both of which play a role in sleep regulation and mood stabilization (Lovick, 2013). The decrease in progesterone levels that occurs at the end of the luteal phase may lead to withdrawal-like effects on the GABAergic system, contributing to increased anxiety and difficulty sleeping (Lin et al., 2021).

A growing body of literature has examined the relationship between menstrual phase and sleep quality, providing compelling evidence for phase-dependent sleep disruptions. A meta-analysis by Jeon and Baek (2023) reviewed studies on menstrual-related sleep disturbances and concluded that sleep is significantly poorer during the luteal phase. Their findings indicate that individuals experience increased sleep latency, more frequent nocturnal awakenings, and reduced overall sleep efficiency during this phase. Additionally, the review highlighted that individuals with premenstrual disorders, such as premenstrual syndrome (PMS) or premenstrual dysphoric disorder (PMDD), experience exacerbated sleep difficulties compared to those without these conditions.

Sleep disturbances during the luteal phase are also strongly associated with mood dysregulation. Lin et al. (2021) examined the link between sleep quality, inattention, and fatigue in individuals with PMDD and found that sleep disruptions were significantly correlated with heightened emotional instability. Their findings suggest that poor sleep contributes to cognitive impairments, such as difficulties in attention and executive functioning, further exacerbating mood symptoms. This study underscores the importance of considering sleep as a potential mediator in the relationship between menstrual phase and depressive symptoms.

Research indicates that individuals who experience significant sleep disturbances during the luteal phase are at heightened risk for mood-related symptoms, including increased irritability, anxiety, and depressive episodes (Meers & Nowakowski, 2020). These symptoms

closely align with the diagnostic criteria for premenstrual dysphoric disorder (PMDD), a severe

form of premenstrual syndrome (PMS) characterized by marked mood instability, heightened

emotional sensitivity, and significant functional impairment in daily life (Handy et al., 2022). A

study by Khazaie et al. (2016) found that university students diagnosed with PMDD exhibited

significantly poorer sleep quality, shorter total sleep time, and increased nocturnal awakenings

during the luteal phase compared to controls, reinforcing the idea that sleep disturbances may

serve as a key contributor to the severity of PMDD symptoms. Additionally, Kiesner (2009)

demonstrated that premenstrual depressive symptoms were more pronounced among individuals

who experienced significant sleep disturbances, suggesting that disrupted sleep not only coexists

with mood instability but may actively exacerbate emotional dysregulation. These findings

highlight the importance of addressing sleep disturbances in individuals with PMDD, as

improving sleep quality could potentially alleviate the severity of mood-related symptoms and

enhance overall well-being.

Further supporting these findings, a study by Rugvedh, Gundreddy, and Wandile (2023)

explored the broader physiological mechanisms underlying menstrual cycle-related sleep

changes. They found that hormonal fluctuations influence autonomic nervous system activity,

leading to variations in heart rate variability and thermoregulation, both of which affect sleep

stability. Their review highlights the potential role of circadian misalignment in exacerbating

sleep disturbances, particularly for individuals with irregular menstrual cycles. Given the

well-established link between sleep and mood, researchers have hypothesized that sleep

disturbances may act as a mediator between menstrual-related hormonal changes and depressive

symptoms. Sleep deprivation and fragmentation have been shown to increase negative affect,

reduce emotion regulation abilities, and heighten stress sensitivity (Baglioni et al., 2016).

Furthermore, disrupted sleep is a key symptom of mood disorders, including major depressive disorder (MDD) and PMDD, suggesting a shared underlying mechanism.

Despite robust evidence linking menstrual cycle phases to sleep and mood disturbances, several gaps in the literature remain. First, many studies rely heavily on self-reported sleep assessments, which are susceptible to recall bias and subjective interpretation (Jeon & Baek, 2023). While self-reports provide valuable insights into perceived sleep quality, they may not accurately capture objective sleep parameters. Future research should incorporate actigraphy or polysomnography to obtain more precise measurements of sleep disturbances across the menstrual cycle.

While existing research has established a link between sleep disruptions and mood symptoms, few studies have directly examined the mediating role of sleep disturbances in the relationship between menstrual phase and depressive symptoms. Most studies treat sleep as a secondary outcome rather than a central explanatory mechanism, focusing primarily on mood changes without fully considering how sleep disturbances may act as a bridge between hormonal fluctuations and emotional well-being. By overlooking this potential mediating pathway, research may miss critical insights into the mechanisms driving menstrual-related mood disorders. Addressing this gap is essential for developing more targeted interventions aimed at mitigating menstrual-related sleep and mood disruptions, ultimately improving both sleep quality and mental health outcomes for individuals affected by these fluctuations.

Building upon prior research, the present study aims to clarify the relationship between menstrual cycle phases, sleep quality, and depressive symptoms. Prior studies have demonstrated that sleep disturbances worsen during the luteal phase and are associated with heightened mood symptoms (Khazaie et al., 2016; Kiesner, 2009). Based on these findings, the primary hypothesis

states that sleep quality will be significantly poorer in the luteal phase compared to the follicular phase, as indicated by shorter total sleep time, increased nocturnal awakenings, and lower sleep efficiency. The secondary hypothesis posits that depressive symptoms, including increased irritability, anxiety, and low mood, will be significantly higher in the luteal phase compared to the follicular phase, consistent with prior research on premenstrual mood disturbances and PMDD symptomatology (Meers & Nowakowski, 2020; Handy et al., 2022). Finally, the mediating hypothesis suggests that sleep disturbances will mediate the relationship between menstrual cycle phase and depressive symptoms, such that poorer sleep quality in the luteal phase will predict greater depressive symptoms, partially or fully explaining this relationship. This hypothesis is informed by prior work demonstrating that disrupted sleep exacerbates mood instability and emotional dysregulation in individuals with menstrual-related mood disorders (Kiesner, 2009). By addressing limitations in past research and explicitly testing sleep as a mediating mechanism, this study will contribute to a more comprehensive understanding of menstrual-related sleep disturbances and their impact on mental health.

Methods

Participants

The study will recruit a sample of 80 to 100 college-aged women between the ages of 18 and 25. Participants will be selected based on the following inclusion criteria: regular menstrual cycles (ranging from 25 to 35 days), no use of hormonal contraceptives, and no diagnosed sleep disorders or major psychiatric conditions. Exclusion criteria will include pregnancy, lactation, or medical conditions that may influence sleep or mood (e.g., polycystic ovary syndrome, major depressive disorder). Participants will be recruited from local universities through campus flyers, email lists, and social media postings. The study will prioritize diversity in recruitment by ensuring representation from different racial, ethnic, and socioeconomic backgrounds to enhance

generalizability. College-aged women are selected as they are at an increased risk for both sleep disturbances and depressive symptoms, particularly in relation to menstrual cycle fluctuations

Study Design

The study will employ a longitudinal within-subjects design, tracking participants over the course of two full menstrual cycles. This approach allows for the examination of individual variations in sleep and depressive symptoms across different phases of the menstrual cycle rather than relying on cross-sectional snapshots. A within-subjects design minimizes variability between individuals and enhances the ability to detect meaningful patterns in sleep and mood fluctuations.

Procedure

Upon enrollment, participants will attend an initial session where they will complete baseline assessments, including demographic surveys and the Beck Depression Inventory-II (BDI-II; Beck et al., 1996). They will receive instructions on using a menstrual cycle tracking app and will be provided with an actigraphy wristband for objective sleep monitoring.

Throughout the study, participants will log their menstrual cycle phases using a validated period-tracking application. A subset of participants (n = 30) will provide salivary progesterone samples at designated points in their cycle (early follicular, ovulation, and mid-luteal phases) to verify self-reported cycle phase. Daily mood logs will be completed each evening, assessing fluctuations in depressive symptoms and subjective sleep quality.

At the conclusion of the two-month study, participants will return their actigraphy devices and complete a post-study BDI-II assessment to evaluate cumulative changes in depressive symptoms.

Measures

Sleep Assessments:

Sleep patterns will be assessed using two complementary methods:

1. **Actigraphy Wristbands:** Participants will wear actigraphy devices (e.g., Fitbit Charge 5 or Actiwatch Spectrum Plus) continuously throughout the study to objectively measure sleep duration, efficiency, and fragmentation. Actigraphy provides an accurate, non-invasive assessment of sleep patterns in naturalistic settings, reducing bias associated with self-report measures. Additionally, it enables detection of nighttime awakenings and variability in sleep efficiency across menstrual cycle phases.

2. **Pittsburgh Sleep Quality Index (PSQI):** A widely used self-report measure of sleep quality, the PSQI will be administered weekly to capture subjective perceptions of sleep patterns. This combination of objective and subjective assessments allows for a more comprehensive analysis of sleep disturbances in relation to menstrual cycle phases.

Depressive Symptoms Measurement

1. **Daily Mood Logs:** Participants will complete nightly mood logs using a standardized questionnaire designed to capture daily fluctuations in emotional well-being. They will rate their overall mood on a scale from 1 (very low) to 10 (very high) and respond to additional items assessing emotional stability, fatigue, anxiety, irritability, and stress levels. Open-ended prompts will allow participants to elaborate on significant mood changes or specific stressors encountered throughout the day. This daily tracking approach will provide granular insight into short-term variations in mood that may correlate with sleep disturbances and menstrual cycle phases.

2. **Beck Depression Inventory-II (BDI-II):** The BDI-II, a 21-item self-report inventory, will be administered at both baseline and post-study to measure depressive symptom severity. Each item is scored on a 0-3 scale, with higher total scores indicating more

severe depressive symptoms. The BDI-II assesses cognitive, affective, and somatic

symptoms of depression, such as hopelessness, loss of pleasure, and changes in sleep

patterns, making it particularly relevant for this study. Administering the BDI-II at two

time points will allow for an evaluation of cumulative depressive symptom changes

across the menstrual cycle, as well as potential moderating effects of sleep quality.

Analysis Plan

To evaluate the relationships between menstrual cycle phase, sleep quality, and

depressive symptoms, the study will utilize mixed-effects models, which account for repeated

measures within individuals over time. Cycle phase (follicular, ovulatory, luteal) will be treated

as a within-subjects factor, with sleep parameters (duration, efficiency, fragmentation) as

predictors of depressive symptoms. Additionally, a mediation analysis will assess whether sleep

disturbances mediate the relationship between menstrual cycle phase and mood symptoms. Data

will be analyzed using SPSS, with significance set at $p < .05$.

This methodological approach will provide a nuanced understanding of how menstrual

cycle fluctuations impact sleep and mood, contributing to existing research on the intersection of

sleep psychology, depression, and reproductive health.

Discussion

Potential Contributions of the Study

This study contributes to the growing body of research examining the intersection of

sleep, mood, and the menstrual cycle by incorporating objective sleep measures through

actigraphy and hormonal verification. Unlike prior research that has primarily relied on

self-reported data, this study enhances the reliability of findings by tracking sleep and mood

fluctuations across multiple menstrual cycles. Additionally, the study identifies sleep quality as a

potential mechanism underlying the link between menstrual cycle phases and depressive

symptoms, offering a novel intervention target for mood-related sleep disruptions. Understanding these patterns may allow for early detection of individuals at heightened risk for cycle-related mood disturbances and inform personalized approaches to mental health care.

Implications

Findings from this study could inform the development of cycle-based sleep hygiene interventions designed to improve sleep quality and mitigate depressive symptoms during vulnerable menstrual phases. For example, tailored cognitive-behavioral therapy for insomnia (CBT-I) could be adapted to account for hormonal fluctuations, helping individuals adjust their sleep habits in anticipation of poorer sleep quality during the luteal phase. Additionally, healthcare providers could integrate menstrual cycle tracking into sleep and mental health assessments, allowing for proactive intervention before symptoms worsen.

From a public health perspective, the results could contribute to awareness campaigns emphasizing the relationship between menstrual cycles, sleep, and mood. Such initiatives could help individuals recognize and manage cycle-related sleep disturbances, reducing their impact on daily functioning. Additionally, this research could inform workplace and educational policies, advocating for more flexible accommodations for individuals experiencing significant sleep and mood disruptions linked to their menstrual cycle. Lastly, the study's findings could support the implementation of screening programs for depressive symptoms based on menstrual cycle-related sleep patterns, improving early detection and intervention efforts.

Limitations

One key limitation of this study is the variability of menstrual cycles across individuals, which may introduce inconsistencies in tracking hormonal phase-related changes. While self-reported cycle tracking and hormonal verification improve accuracy, natural variations in

cycle length, ovulation timing, and hormone surges could influence results, making it challenging to pinpoint precise sleep and mood fluctuations. Additionally, external factors such as stress, diet, and physical activity may further contribute to cycle irregularities, potentially confounding the observed relationships. Another limitation is the exclusion of hormonal contraceptive users, which restricts the generalizability of findings. Many individuals use contraceptives that alter hormonal fluctuations and, in turn, may influence sleep patterns and mood stability differently from those with natural cycles. Since hormonal contraceptives can suppress ovulation and regulate hormone levels more consistently, their effects on sleep and depressive symptoms may differ from those observed in naturally cycling individuals. Future research should explore these differences to determine whether hormonal contraceptive use modifies the relationship between sleep, mood, and menstrual cycle phases.

Future Research Directions

Future research should examine the impact of hormonal contraceptive use on the relationship between sleep and mood, as different contraceptive methods may moderate these effects in unique ways. For example, combination oral contraceptives, progestin-only pills, and intrauterine devices (IUDs) each influence hormone levels differently, which may have varying implications for sleep architecture, REM sleep cycles, and emotional regulation. Investigating how synthetic hormones alter circadian rhythms, melatonin secretion, and overall sleep quality could provide further insight into personalized treatment approaches for individuals experiencing menstrual cycle-related sleep disturbances. Additionally, future studies should explore intervention strategies such as melatonin supplementation, light therapy, or cognitive-behavioral therapy for insomnia (CBT-I) to mitigate the negative effects of cycle-related sleep disruptions. Understanding the efficacy of these interventions across different menstrual phases may help

develop targeted therapeutic approaches for individuals at heightened risk of sleep and mood

disturbances. These findings could not only inform clinical treatment plans but also contribute to

broader public health initiatives aimed at improving sleep health and emotional well-being

throughout the menstrual cycle.

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