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Timing and variability of postpartum sleep in relation to daytime performance

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HIGHLIGHTS

- Earlier sleep midpoints were associated with better performance postpartum
- More stable sleep midpoints were associated with better performance postpartum
- Chronotype was related to sleep midpoint among postpartum women
- Sleep periods should be more thoroughly examined postpartum
- Sleep midpoints should be researched in populations without consolidated sleep

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ABSTRACT

Postpartum women have highly disturbed sleep, also known as sleep fragmentation. Fragmentation extends their total sleep period, also disrupting sleep timing. A stable and earlier sleep period among non-postpartum populations is related to better performance, physical health, and mental health. However, sleep timing has not been examined among postpartum women who are also vulnerable to daytime impairment. The study objective was to examine how the timing and regularity of sleep during the early postpartum period are related to daytime functioning across postpartum weeks 2–13. In this field-based study, 71 primiparous women wore an actigraph, a small wrist-worn device that monitors sleep and sleep timing, for the 12-week study period. Mothers self-administered a 5-min psychomotor vigilance test (PVT) each morning to evaluate the number of >500 ms response lapses. They also completed a Morningness–Eveningness scale at the beginning of the study to identify chronotype. After controlling for maternal age, earlier sleep timing was associated with significantly fewer PVT lapses at postpartum weeks 9,12; a more stable sleep midpoint was associated with significantly fewer PVT lapses at postpartum weeks 2,5–13. Earlier sleep midpoints were related to more stable sleep midpoints at postpartum week 2 and a morning-type chronotype. An earlier sleep midpoint was also associated with a reduced slope of worsening PVT lapses across weeks. Across the first 12 postpartum weeks, women with earlier or more stable sleep periods had less daytime impairment than women with later or more variable sleep midpoints. Postpartum women with earlier sleep midpoints also showed less severe decrements in performance across time, which has been attributed to cumulative impacts of sleep disturbance. These data suggest that the sleep period, in addition to sleep duration and fragmentation, should be more closely examined, particularly among vulnerable women, as it may affect the neurobehavioral performance of new mothers.

1. Introduction

Sleep disruptions can impair overall health [1], and neurobehavioral performance [2]. Postpartum mothers experience frequent nocturnal awakenings that result in fragmented sleep, a type of sleep disruption whereby the quality of sleep is reduced. While sleep fragmentation and sleep deprivation can co-occur, this is not the case among postpartum women whose total sleep time is preserved [3–5]. The fragmented sleep experienced by postpartum women appears to have similar detrimental consequences as sleep deprivation on their daytime sleepiness and functioning. Analyzing the relations between PVT and sleep, including the implications of accumulated sleep debt, was the overarching purpose of the study and those results have been published previously. Among the current study's sample, the women's total sleep time did not significantly change throughout the study, but their sleep efficiency gradually improved across weeks [5]. Interestingly, despite improvements in

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sleep efficiency across the first 12 postpartum weeks, attention lapse frequency increases across the same period [6]. While experimental studies support the notion that this effect may be due to the cumulative effects of sleep disturbance [7], it is not clear what other factors might play a role in recovery of daytime functioning during the postpartum period.

There are likely multiple behaviors that help facilitate recovery from the effects of sleep disturbance; one of these may be the timing and regularity of the nocturnal sleep period. The timing and amount of sleep are influenced by two major processes: Process S and Process C [8]. Process S is the homeostatic sleep drive and increases with time spent awake due to sleep pressure. Process C is the endogenous circadian timing system, and can be influenced by environmental time cues (zeitgebers), the strongest of which is light [9]. Processes S and C interact to determine sleep periods in a way that normally facilitates sleep during the night and wake during the day. However, in some circumstances these two processes become misaligned, commonly seen in jet lag and shift work, and can lead to consequences including impaired mood, daytime functioning, and physical health [10–12]. Process C is also strongly associated with an individuals' chronotype, or whether they are considered a morning-type or evening-type person [13,14]. An individual's chronotype correlates well with the actual timing of sleep [15]. During the postpartum period, the timing of sleep may be further influenced by (1) the infant, who is not born with an established circadian rhythm [16]; and (2) the potential buildup of sleep debt among this population [6] both of which may impact the homeostatic sleep drive. However, the timing of sleep periods or their relation to daytime functioning has not been examined among postpartum women. This is important given that this may be a source of poorer health and functioning.

Among healthy adults and clinical populations, the impact of sleep timing on mental and physical health is contradictory. In some instances, evening-types were more likely to report poor general health than morning types [17], increased depressive symptoms [18], and more psychological and somatic disorders [19]. However, morning-types are not always reported to fare any better than evening-types. Contrary to the above data, the morning "larks" (people who went to bed before 11 pm) did not differ significantly from evening "owls" (people who went to bed after 11 pm) in income, cognitive function, state of health, and mortality during a follow-up assessment [20,21]. Given the potential role of timing of sleep in health and functioning, and the known sleep-related impairments among postpartum women, assessing sleep timing among this population may give insight into their recovery from postpartum sleep disturbance.

Additionally, regularity of the nocturnal sleep period has not been assessed among postpartum women. Among healthy adults, maintaining a consistent sleep schedule is associated with shorter reaction times, better affect, and more time spent in slow wave and rapid eye movement sleep than healthy adults who maintain an irregular sleep schedule [22]. When sleep–wake schedules were experimentally regulated among a population of healthy university students with highly irregular sleep–wake habits, improvements in mood and reductions in daytime parasympathetic activity were noted [23]. This association between a stable sleep schedule and better heath and performance suggests that these relations might also account for some variance in postpartum daytime functioning.

While research exists on the many impacts of postpartum sleep disturbances [24–26] no study has assessed how the timing and regularity of sleep among postpartum women could be related to daytime functioning. The midpoint of sleep is the time halfway between sleep onset and wake time, and is more closely related to dim-light melatonin onset (DLMO; a measure of circadian phase) [27,28] and chronotype than either sleep onset or wake time [15]. No study has assessed sleep midpoint among a population that does not obtain a consolidated nocturnal sleep period, such as postpartum women. The current study examined both the timing of postpartum sleep and sleep period regularity using the sleep midpoint, and the relation of these measures to daytime functioning across the first three months postpartum. It also examined how chronotype was associated with sleep midpoint among this population. The current study tested the hypotheses that earlier and more stable sleep periods, a modifiable behavior that influences and is influenced by underlying circadian physiology, would be associated with improved daytime functioning during this period of potential vulnerability.

2. Materials and methods

The study used pre-existing data from a longitudinal field-based descriptive study of maternal postpartum sleep disturbance that was conducted in Morgantown, West Virginia and surrounding areas from 2007 to 2010 [5]. West Virginia University's Institutional Review Board approved the study and informed consent and Health Insurance Portability and Accountability Act (HIPAA) authorization were administered to all participants.

2.1. Participants

Recruitment of first-time (primiparous) healthy mothers occurred prenatally via community advertisements, obstetric and midwifery clinics, childbirth classes, and offices that administer the Women, Infant, and Children Supplemental Nutrition Program (WIC). Women were excluded from the study based on premature delivery, pregnancy with multiples, infant admission into the neonatal intensive care unit, discharge from the hospital after the standard 2 (for vaginal delivery) to 3 (for surgical delivery) days postpartum, any major medical conditions, and/or history, current diagnosis, or high risk for major depressive disorder defined as a score of >16 on the 20-item Center for Epidemiologic Studies Depression Scale [29].

2.2. Procedure

Participants contributed 12 continuous weeks of data from the beginning of the second postpartum week. Each night sleep was actigraphically-estimated and corroborated with a self-reported electronic sleep diary on a personal digital assistant (PDA). Every morning participants self-administered a 5-min psychomotor vigilance reaction time test on their PDA within 2 h after awakening. Participants were visited in their home once a week by a member of the research team to replace their actigraph and PDA.

2.3. Measures

2.3.1. Actigraphy

Nonintrusive, continuous sleep/wake monitoring was recorded using Actigraphy (Mini Mitter Actiwatch-64, Philips Respironics, Bend, Oregon). Use of the Actiwatch in detection of adult sleep–wake patterns has been validated [30–32] and previously used among postpartum women [33,34]. The Actiwatch records motion via an accelerometric sensor that uses digital integration. The device resembles a wrist watch and is worn on a strap around the woman's nondominant wrist. The highest resolution (15-s epochs) and default (medium) sensitivity setting were used to identify periods of sleep and wake within diary-defined sleep periods. Actiware Software version 5.5 (Mini Mitter Actiwatch-64, Philips Respironics, Bend, Oregon) was used to manage, analyze, and store actigraphy data. The software's algorithm scores each epoch as either sleep or wake by comparison to a wake threshold value (default settings ≥ 40 = wake). The Actiwatch allows for measurement of normative sleep patterns in the field and has been correlated with polysomnography for differentiating sleep from wake, with 91% agreement rates [35].