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Effects of a single night of postpartum sleep on childless women's daytime functioning

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HIGHLIGHTS

- Postpartum-like sleep fragmentation decreased mood and subjective sleep quality
- Postpartum-like sleep fragmentation did not alter sleep stages or melatonin levels
- Postpartum-like sleep fragmentation did not alter next-morning performance
- The effects of chronic postpartum sleep fragmentation need to be elucidated

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ABSTRACT

Study objectives: The maternal postpartum period is characterized by sleep fragmentation, which is associated with daytime impairment, mental health disturbances, and changes in melatonin patterns. In addition to sleep fragmentation, women undergo a complex set of physiological and environmental changes upon entering the postpartum period, confounding our understanding of effects of postpartum sleep disturbance. The primary study aim was to understand the basic impact of a single night of postpartum-like sleep fragmentation on sleep architecture, nocturnal melatonin levels, mood, daytime sleepiness, and neurobehavioral performance.
Measurements and results: For one week prior to entry into the laboratory, eleven healthy nulliparous women kept a stable sleep–wake schedule (verified via actigraphy). Participants contributed three consecutive nights of laboratory overnight polysomnography: (1) a habituation/sleep disorder screening night; (2) a baseline night; and (3) a sleep fragmentation night, when participants were awakened three times for ~30 min each. Self-reported sleep quality and mood (Profile of Mood States survey) both decreased significantly after sleep fragmentation compared to baseline measurements. Unexpectedly, daytime sleepiness (Multiple Sleep Latency Test) decreased significantly after sleep fragmentation. Experimental fragmentation had no significant effect on time spent in nocturnal sleep stages, urinary 6-sulfatoxymelatonin concentration, or psychomotor vigilance test performance. Participants continued to provide actigraphy data, and daily PVTs and self-reported sleep quality assessments at home for one week following sleep fragmentation; these assessments did not differ from baseline values.
Conclusions: While there were no changes in measured physiological components of a single night of postpartum-like experimental sleep fragmentation, there were decreases in self-reported measures of mood and sleep quality. Future research should examine the effects of multiple nights of modeling postpartum-like sleep fragmentation on objective measures of sleep and daytime functioning.

1. Introduction

The early maternal postpartum period is characterized by fragmented sleep [1,2], during which new mothers obtain an average of 7.2 h of total sleep time (TST), despite spending about 9 h dedicated to sleep [3]. In addition to fragmented sleep, postpartum women experience alterations in sleep architecture [4,5] and nocturnal melatonin patterns [6–8], daytime sleepiness [9], impaired neurobehavioral performance [10], and mood disturbances [11–13]. Yet, new mothers vary in the severity to which they experience these outcomes, likely because

Abbreviations: ANOVA, Analysis of Variance; aMT6, 6-sulfatoxymelatonin; ELISA, enzyme-linked immunosorbent assay; MSLT, Multiple Sleep Latency Test; POMS, Profile of Mood States survey; PSG, polysomnography; PVT, psychomotor vigilance test; SE, Sleep efficiency; TMD, total mood disturbance; TST, Total sleep time.

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of a complex process of individual physiological and environmental differences. The primary aim of the current study was to understand the relative contribution of sleep fragmentation to each of these outcomes. The current study imposed a postpartum sleep schedule based on nocturnal infant caretaking, the primary mechanism for postpartum sleep fragmentation [14,15], on childless women in a tightly controlled laboratory environment. This model allows causal testing of the effects of infant-driven postpartum sleep fragmentation independent of the physiological and environmental changes that co-exist during the typical postpartum period and also have the potential to disrupt sleep.

1.1. Postpartum physiological and environmental changes

New mothers experience physiological changes throughout pregnancy and the postpartum period that may impact their sleep and mental health above and beyond nocturnal infant demands. For instance, postpartum women undergo a host of hormonal changes as they progress through pregnancy and into the postpartum period. Steroid hormones such as estrogens, progesterone, and cortisol increase during pregnancy and abruptly decrease after childbirth [16,17]; this abrupt transition is posited to be associated with mood disturbances [18,19]. Furthermore, high cortisol levels are associated with stress and depressive symptoms [20]. Estrogens and progesterone have sleep-promoting effects [21]. Estrogens decrease sleep onset latency and nocturnal awakenings, while increasing TST and time spent in REM sleep [20]. Progesterone is sedative, decreasing wakefulness and latency to NREM sleep as well as decreasing REM sleep [20]. Finally, decreased melatonin peak values [7] and circadian phase shifts [6] have been reported during the postpartum period. These hormonal changes may contribute to postpartum sleep quality and confound the unique impact of postpartum sleep fragmentation. The current study's model of nulliparous women who do not experience these hormonal changes can, therefore, more closely approximate the basic impact of postpartum sleep fragmentation, independent of the hormonal consequences of the perinatal period.

Physiological changes during the postpartum period that may impact sleep are not limited to hormonal changes. Most new mothers report at least one negative, physical health symptom during the early postpartum period [22], such as general pain, headaches, and breast soreness [23,24]. While there is a lack of specific literature on postpartum physical pain and sleep, more than half of adults with chronic pain also experience sleep disturbances [25–27]. Further, postpartum physical health conditions are associated with emotional well-being and depressive symptoms [24], which is bidirectionally associated with sleep [21,28–30]. The participants in the current study were healthy without major medical conditions which may otherwise impact their sleep and mental health, allowing for an ideal model to test the impact of an infant-driven postpartum sleep fragmentation schedule.

Finally, the postpartum period is also characterized by adjustment to a new parenting role that includes caring for an infant as well as emotional and social changes [31]. Child-care responsibilities and lack of knowledge related to parenting are common sources of frustration and fatigue for new mothers [32]. Postpartum fatigue is indirectly associated with stress, via depressive symptoms and sleep quality [33,34]. New mothers may vary substantially in their adjustment to the postpartum period as a result of available social support. New mothers report social networks as their primary source of support [35], and social support is a recognized buffer for stressful life events and predictor of emotional and physical well-being [36]. Thus, the impact of the postpartum period on sleep and mental health is not limited to physiological changes, but also includes environmental stimuli. As nulliparous women, the current study's participants did not undergo these life changes, strengthening the use of this model to isolate the effect of infant-driven postpartum sleep fragmentation.

1.2. Effects of experimental sleep disturbance

Laboratory-based experimental sleep deprivation conducted in non-postpartum populations causes melatonin suppression [37], despite using illuminance levels lower that what is expected to suppress melatonin [38]. Further, there is evidence of a rebound in nocturnal peak melatonin values following a night of sleep deprivation [39]. These studies suggest nocturnal melatonin levels may be influenced by sleep loss, but the effects of sleep fragmentation on melatonin are unknown.

Laboratory-based experimental sleep fragmentation conducted in non-postpartum populations causes decreases in deep sleep and REM and subsequent increases in lighter stages of sleep [40,41], daytime sleepiness [41], and degraded mood [40]. However, these experiments have focused on the effects of sleep fragmentation as manifested by sleep disorders such as sleep apnea and periodic limb movement disorders, thus inducing forced awakenings every 1–2 min across the night. The sleep fragmentation postpartum women experience is unique, in that they have much longer periods of consolidated sleep, but also relatively longer periods of wakefulness [42].

1.3. Development of study protocol and hypotheses

In order to model postpartum sleep fragmentation, we chose to awaken participants three times, equally spaced throughout the night. This schedule was chosen based on data from our lab indicating women with infants 0–6 months old awaken an average of 2.9 times each night and that this is stable across this 6-month time period [42], as well as recommendations from the American Academy of Pediatrics that breastfed newborns should be fed at intervals of 2–3 h [43]. Previous literature on newborns within the first three days after birth indicate that feeding time is approximately 13.8–16 min [44,45], but that mothers spend an additional 12 min engaged with the infant in non-feeding activities [45]. Based on these cumulative data and our previous finding that mothers of infants 0–6 months spend an average of 33.9 min during each nocturnal awakening on infant caregiving [42], the protocol for the current study was 3 awakenings of ~30 min each, spaced equally throughout the night.

Prior to the current study, no study had controlled for the physiological and environmental factors associated with the postpartum period to isolate the impact of the sleep fragmentation, likely due to the difficulties of studying this population in a laboratory and the logistic and ethical barriers to changing and manipulating their routine. This study attempted to overcome these barriers and provide a basic understanding of the effects of a single night of postpartum-like sleep fragmentation by manipulating the sleep of healthy women without children to resemble what is observed during the early postpartum period. Isolating the impacts of this unique sleep fragmentation on sleep and daytime outcomes is important in order to understand the magnitude of impact interventions directed at improving postpartum sleep have in mitigating the consequences of this vulnerable period.

Based on previous sleep fragmentation studies [40,41,46] and their reported occurrences among postpartum women [4–6,9–13], it was hypothesized that modeling postpartum sleep fragmentation among nulliparous women would cause: (1) a decrease in slow wave sleep and REM sleep at the expense of increases in stages N1 and N2; (2) an increase in daytime sleepiness; (3) a decrease in subjective sleep quality; (4) a decrease in neurobehavioral performance; (5) a decrease in mood. Based on experimental sleep deprivation work [37] and reported melatonin suppression among populations experiencing sleep fragmentation (i.e., postpartum women [7] and patients with obstructive sleep apnea [47]), it was hypothesized that our protocol would cause: (6) a suppression of nocturnal 6-sulfatoxymelatonin.