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Maternal Sleep in Pregnancy and Postpartum Part I: Mental, Physical, and Interpersonal Consequences

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Abstract

Purpose of Review Sleep is a critical restorative behavior which occupies approximately one third of people's lives. Extensive data link sleep health with disease and mortality risk in the general population. During pregnancy and following childbirth, unique factors contribute to overall sleep health. In addition, there are unique implications of poor sleep during these time periods.
Recent Findings Poor maternal sleep may contribute to risk for adverse birth outcomes as well as poor maternal physical and mental health in pregnancy, postpartum, and longer term during childrearing. Moreover, the extent to which notable racial disparities in sleep contribute to disparities in adverse perinatal health outcomes remains to be fully explicated.
Summary Part I of this two-part review details these implications of poor sleep for mental health, physical health outcomes, and relationship functioning, while Part II delves into biological mechanisms as well as treatment approaches.

Keywords Sleep · Perinatal health · Birth outcomes · Racial disparities · Insomnia · Women's health · Postpartum weight retention · Interpersonal relationships · Mental health · Mood

Introduction

People spend nearly 1/3 of their lives asleep. As a critical restorative health behavior, sleep is linked with numerous mental and physical health outcomes in the general population. During pregnancy and postpartum, women experience unique challenges with relation to maintaining healthy sleep.

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In addition, there are multiple health outcomes with relevance to sleep that are unique to the perinatal period, including birth outcomes, child development, changes in interpersonal relationships, risk of postpartum weight retention, and perinatal mood disorders. Recognition of the importance of sleep in perinatal health is vital to begin to address the needs of women at this critical period. In Part I of this two-part review, we provide an overview of the importance of sleep health, unique considerations in pregnancy and postpartum, and opportunities to advance the literature.

The Importance of Sleep for Health

Measuring and Defining Sleep

Sleep is a multidimensional biobehavioral process including measures of sleep duration (e.g., hours of sleep), continuity (e.g., ease or difficulty initiating and maintaining sleep), architecture (e.g., percent of time spent in rapid-eye movement (REM) and non-REM sleep), timing (e.g., midpoint between bedtime and waketime), regularity (e.g., variability in sleep duration or timing), daytime sleepiness, and subjective sleep quality. Each of these indices measures a different aspect of

sleep and has been linked to health and functioning [1–7]. Each may be measured continuously, although epidemiological studies often query sleep duration in categorical bins [8] and some measures have established clinical cutoffs. For example, a value > 5 on the Global Sleep Quality subscale of the Pittsburgh Sleep Quality Index (PSQI) is consistent with clinically disturbed sleep [9]. Similarly, a value of > 10 on the Epworth Sleepiness Scale (ESS) indicates clinically significant sleepiness [10]. Sleep may also be characterized by clinical disorders such as insomnia, sleep apnea, and narcolepsy. And, while sleep and circadian science has tended to focus on individual dimensions of sleep, emerging evidence suggests that multivariable indices of sleep are potent predictors of health [3, 7, 11].

Sleep is measured by self-report, behavior, and polysomnography (PSG). Self-report questionnaires such as the PSQI, ESS, and Insomnia Severity Index (ISI) [12] are typically retrospective with a time frame relevant to the questionnaire (e.g., "past month" from PSQI-assessed habitual sleep quality and clinically derived ISI). In contrast, daily sleep diaries may be used to assess sleep over multiple days, typically 1 to 2 weeks in duration. Diaries may query many aspects of sleep (e.g., duration, continuity, timing, quality) and can be modified according to population and study goals. The Consensus Sleep Diary and Pittsburgh Sleep Diary are widely used in sleep and circadian science [13, 14]. Wrist actigraphy provides a behavioral index of sleep and, like sleep diaries, can be used to capture habitual sleep patterns over days and weeks. Actigraphy estimates sleep (duration, continuity, and timing) based on rest-activity patterns and compares favorably with polysomnography, although specificity can be somewhat low [15]. Polysomnography provides objective measures of sleep including traditionally assessed indices of duration, continuity, architecture, as well as power spectral analysis of the electroencephalogram, which is highly stable across nights [16]. Laboratory- and home-based studies are typically limited to two to three nights due to expense and participant burden. The choice of measurement approach depends fully on study goals and the questions being posed, although it is important to recognize that measures across modalities are not always strongly correlated [17].

Sleep and Health in the General Population

Sleep changes across the lifespan, with decreases in sleep duration, continuity, and slow-wave sleep across adulthood and increases in sleep disorders including insomnia and sleep apnea [18–20]. Sleep timing, too, is associated with normative shifts during adolescence and old age [21, 22]. Digital media such as smartphones, which many people take to bed, are also associated with decreased and disrupted sleep in adolescents and adults [23]. What is certainly evident in modern society is an epidemic of insufficient sleep. Short sleep duration, in turn, is associated with increased morbidity and mortality [2]. In response to the prevalence of insufficient sleep in Americans, the American Academy of Sleep Medicine (AASM) and the Sleep Research Society published a joint consensus statement on recommended amount of sleep for healthy adults (7 or more hours per night) [24•] and the AASM followed with recommendations for sleep in healthy children (durations vary by age; See [25•]). The adverse effects of insufficient sleep to health and functioning are beginning to be reflected in social policies such as the nascent move to later school start times and restrictions on work hours in medical residents [26, 27]. More widespread societal changes have not followed.

Sleep in Women During Pregnancy, Postpartum, and Early Childhood

Sleep disturbances are more common in women, among whom odds of insomnia are 1.4–1.6 higher than in men [28]. Sleep disturbances are further exacerbated during pregnancy. Various types of sleep disturbances are markedly more common during pregnancy than among non-pregnant women. Women report more napping, nighttime wakings, and poorer sleep quality beginning in the first trimester of pregnancy, with symptoms worsening by late pregnancy [29, 30]. In terms of clinical conditions, rates of insomnia, restless leg syndrome, snoring, and sleep apnea are all considerably higher during pregnancy [30]. Hormonal changes contribute: estrogen and progesterone substantially affect sleep architecture [31, 32]. The physical demands of pregnancy also play an important role: the developing fetus puts pressure on the lungs and bladder, affecting maternal breathing, increasing frequency of urination, and affecting overall comfort while sleeping. In addition, for many women, depressive symptoms, anxiety, and stress related to adjusting to pregnancy (particularly if unplanned), preparing for childbirth, and anticipation of lifestyle, financial, and relationship changes related to the addition of a new family member can add to mental burden which contributes to sleep difficulties [33••].

At postpartum, anxiety and mood disturbance continues to be a risk factor for poor sleep [34]. In addition, total maternal sleep duration and sleep efficiency are significantly affected by childcare demands and children's sleep schedules, including nighttime wakings [35–37]. Sleep disruption is ubiquitous in the first 3 months postpartum due to multiple wakings related to child feeding schedules [38–41]. The impact of multiple wakings is further exacerbated among women with preexisting sleep problems. In particular, women with difficulty initiating sleep may experience particularly severe disturbance because the sleep fragmentation (i.e., sleeping in several small bouts) during postpartum requires multiple occurrences of sleep initiation [42].

By 6-month postpartum, the majority of typically developing infants have established the ability to sleep for at least 8 h [43]. However, nighttime wakings are still common; a study of 80 infants ages 3, 6, 9, or 12 months found an average of 2.95 (SD = 1.32) wakings per night among 3-month olds, and 2.58 (SD = 1.56) among 12-month olds which was not statistically different [44]. Moreover, women are still in a period of significant adaptation in relation to the parenting role (i.e., changes in home responsibilities, relationships with spouse/significant other, financial stressors), conferring vulnerability to stress-induced sleep disturbances.

After the infancy stage, there is considerable variability in sleep among young children. An estimated 20–30% have some type of sleep problem [45]. Women of children with sleep and settling difficulties report greater fatigue and poorer well-being [46]. In sum, sleep health among women of childbearing age—during pregnancy, postpartum, and while raising young children—may be considerably affected by hormonal changes, physical factors (e.g., discomfort during pregnancy), psychological stress related to lifestyle changes, and lack of time due to caregiving demands. In turn, sleep health among women during this timespan has implications for maternal mental and physical health, as well as interpersonal relationship functioning.

Racial Disparities in Sleep: Relevance to Perinatal Health

According to recent data from the Centers for Disease Control (CDC), 33.2% of White adults have insufficient sleep duration (i.e., sleeping < 7 h per night), with even higher rates of 45.8% among Black adults in the USA [47]. These data are consistent with numerous epidemiological studies showing that, independent of socioeconomic status, African Americans have markedly higher rates of short sleep duration, as well as poorer subjective sleep quality, than Whites or any other racial/ethnic group [48••, 49, 50].

These racial disparities in sleep may contribute to racial disparities in perinatal health outcomes. African Americans experience approximately 1.5 times greater risk for preterm birth than Whites, which contributes to 2 times higher infant mortality rates [51, 52]. There are also remarkable racial disparities in postpartum weight retention. In the USA, African American women exhibit two to three times greater weight retention at 1-year postpartum than Whites, including twofold greater risk of retaining ≥ 10 lbs and ≥ 20 lbs [53–55]. Morever, the risk for adiposity conferred by repeated pregnancy is greater among African American women [53]. Contributing factors include pre-pregnancy BMI, total gestational weight gain, caloric intake, physical activity, and breastfeeding [56–58]. However, data on the role of sleep in this racial disparity, a key modifiable risk factor, are lacking.

Sleep and Perinatal Health

As reviewed, it is well established that short sleep contributes substantially to chronic disease, all-cause mortality, and racial disparities in health. The role of sleep in relation to maternal health during pregnancy and postpartum as well as effects on birth outcomes is increasingly being explicated. This represents a promising future direction: sleep provides a clinically modifiable target which may ultimately improve multiple interrelated perinatal health outcomes.

Sleep, Maternal Health, and Birth Outcomes

Importantly, in addition to clear effects on quality of life, poor sleep in pregnancy has been associated with adverse outcomes including risk for preterm birth, gestational diabetes (GDM), small for gestational age, and cesarean section [33••, 59–62]. In terms of maternal health, both short sleep duration (< 7 h) and frequent snoring (≥ 3 nights per week) have been associated with glucose intolerance and higher incidence of GDM, after controlling for key potential confounders [63]. While there are extensive data linking sleep health with risk for hypertensive disorders in the general population, as well as explication of underlying physiological mechanisms, the role of sleep in blood pressure regulation in pregnancy, as well as risk for gestational hypertension/pre-eclampsia is only emergent [64, 65].

Accumulating evidence demonstrates that maternal sleep has implications for birth outcomes. Among 166 women, poor sleep per self-report using the PSQI was associated with risk for preterm birth, particularly sleep in early pregnancy. Specifically, controlling for income, every one point increase on the PSQI in early pregnancy corresponded with a 25% increase in the odds of preterm birth [61]. While this is a large effect, it should be interpreted with caution; in this relatively small cohort, only 9% ($n = 15$) delivered preterm. Demonstrating similar effects in a larger sample, an epidemiological analyses of 1091 women demonstrated a significant association between both maternal snoring in late pregnancy and risk for fetal growth restriction, as well as sleep deprivation in late pregnancy (as defined by ≤ 5 h of sleep on average) and risk for preterm birth [66]. Moreover, recent retrospective data in 672 women with diagnosed insomnia or sleep apnea per medical record review showed 1.3 times greater odds of preterm birth (PTB) in cases of insomnia and 1.5 times greater odds among cases with sleep apnea as compared to 1:1 healthy matched controls [67••].

Of methodological importance, our data suggest that the effects of poor sleep on risk for shortened gestation are heightened among African American women [33••]. In a sample of African American and White women, African American women with poor sleep quality (PSQI > 5) exhibited 10.2 times ($p = 0.04$) the odds of preterm birth compared to those

with good sleep quality. In contrast, among White women, the odds were 1.6 times higher in those with poor sleep quality ($p = 0.63$). Thus, studies of sleep and adverse birth outcomes should aim for racial diversity in order to explicate the role of sleep in racial disparities in birth outcomes.

Mental Health

Sleeping difficulties can present as both a symptom and a causal contributor to perinatal mood and anxiety disorders. Supporting a prospective relationship between sleep and subsequent depressive symptoms, among 257 women assessed during pregnancy, poor sleep quality in early pregnancy as measured by the PSQI was related with depressive symptoms in late pregnancy [60]. Additional data show that among 160 women assessed during pregnancy, depressive symptoms were higher among those with sleep deficiency across time as defined by diary reporting [68]. Sleep disturbance is also related to postpartum mental health, during which time reports of insomnia and poor sleep quality are robustly correlated with symptoms of maternal depression and anxiety [34, 69]. Moreover, qualitative factors related to child sleep behaviors—such as cosleeping versus solitary arrangements—are associated with maternal depressive symptoms [70].

A growing literature seeks to explicate the role of maternal mood disorders during pregnancy and postpartum in risk for health outcomes in children, including neurodevelopment, behavioral problems, and risk for mental health conditions [71–73]. While contributing factors such as neuroendocrine mediators and differences in maternal bonding or caregiving behaviors are commonly examined, the role of maternal sleep health in these associations is infrequently assessed or considered. Similarly, numerous studies link maternal mental health—including depression and anxiety—with risk for preterm birth [74, 75]. This literature is poorly integrated with studies on sleep and birth outcomes, limiting ability to understand independent and additive effects of these exposures. Such data is needed to guide behavioral interventions.

Interpersonal Relationships

Given the well-established linkages between sleep deficiencies and dysregulated emotion, it is not surprising that problems in sleep are also predictive of interpersonal difficulties. Gunn, Hall, and Buysse [76], for example, found insomnia to be associated with reports of elevated interpersonal distress in a sample of 55 adult women. A daily diary study of 68 newlywed couples found that, following nights with longer sleep, members of the couples reported greater satisfaction with their relationship than on days that followed nights with shorter sleep [77], highlighting the self-regulatory benefits of sleep for marital satisfaction. Indeed, risks of poor sleep are evident

in the interpersonal effectiveness among business leaders, who were rated more poorly on interpersonal effectiveness by peers when the leaders experienced poor quality and quantity of sleep [78].

A relative dearth of studies has addressed the role of sleep in parenting and coparenting quality and parent–child relationships, but evidence to this effect is accruing. At least two studies have examined the role of parent sleep in qualitative aspects of parenting of adolescents. These demonstrated that poor maternal sleep was linked with poor parenting styles, as evaluated by adolescents [79], and that shorter maternal sleep was associated with more permissive parenting, again as rated by adolescents [80]. Interestingly, work examining linkages between sleep quality and quality of parenting during the transition to parenthood and in the early post-partum period, a time of heightened sleep disruption among parents, especially mothers [81••], is just beginning. In a study of coparenting quality in the early postpartum period, Daniel and Teti [82] found evidence for a path of influence in which infant night waking predicted parent night waking. Elevated parent night waking in turn predicted parental perceptions of poor sleep quality, which in turn predicted elevated depressive symptoms and then coparenting quality. This four-component pathway was identified for both mothers and fathers. Finally, in perhaps the only study to date examining sleep quality in mothers and parenting competence in the early postpartum period, Bai, Whitesell, and Teti [83] found that mothers with later bedtimes and more variable sleep durations were independently rated as less emotionally available (i.e., reduced sensitivity, structuring, and higher levels of intrusiveness and hostility) with their infants during infant bedtimes, compared to mothers who went to bed earlier and had less variable sleep durations. Mothers with shorter sleep durations also had steeper decreases in bedtime emotional availability from 1 to 6 months postpartum than mothers with longer sleep durations.

Sleep and Development in Childhood

Links between sleep quality and developmental outcomes in childhood are well established. When sleep problems are persistent across childhood, children are at risk for elevations in externalizing and internalizing behavior problems [84], problems in attention and memory [85, 86], and academic failure [87]. Over the long term, sleep problems are predictive of elevated risk for substance and alcohol misuse in adolescence [88] and depression and anxiety in adulthood [89].

The impacts of chronic sleep disturbance on the family system are also well established. Estimates of sleep problems in childhood vary but range between 10 and 52% in young children [90], and such problems can be highly disruptive of the health and well-being of the family. Indeed, when infants and young children are not sleeping well, parents invariably also do not sleep well, and family life can be placed in turmoil

[91]. Importantly, sleep problems identified in the preschool period and later are frequently rooted in dysregulated sleep in infancy [92], suggesting that family patterns that may impact the development of self-regulated sleep may be first evident very early in life.

Postpartum Weight Retention

The relationship between sleep and obesity is well established, particularly in relation to short sleep. Numerous cross-sectional studies in adults show consistent and strong relationships between shorter sleep duration and obesity as well as central adiposity [93, 94]. Prospective studies, while fewer, support these. A 2014 meta-analysis of 11 prospective studies concluded that short sleep duration was significantly associated with incidence of obesity in a prospective manner, with a pooled OR of 1.45 [95].

These findings have relevance to understanding risk for postpartum weight retention (PPWR); however, data in this regard are limited. In one study of over 500 women, short sleep duration (≤ 5 h/night per self-report) predicted greater PPWR at 3 months but not at 12 months [57]. These data were based on a single question, and only 14.5% were African American, despite higher risk among African American women for both poor sleep and high postpartum weight retention. In a study of 940 women (only 9% African American), women with short sleep duration (≤ 5 h/night) at 6-month postpartum had markedly greater odds of significant PPWR (≥ 5 kg/ 11 lbs), with an OR of 3.08 [58].

The role of sleep fragmentation at postpartum and risk for postpartum weight retention also warrants attention. Epidemiological data in elderly adults showed that sleep fragmentation predicted risk for obesity, beyond the effects of sleep duration [96]. Similarly, data from 90 overweight and obese women ages 25–65 who completed a 7-month weight-loss intervention found that those with greater sleep fragmentation showed poorer weight loss [97]. Data from animal models highlights some key neuroendocrine mechanisms that might be altered during sleep loss: chronic sleep fragmentation in mice induces decreased plasma levels in the satiety hormone leptin, with related increases in caloric intake and adipose tissue [98]. Overall, the role of sleep in postpartum weight retention is relatively unexplored, particularly with regard to implications for racial disparities in this outcome and underlying biomechanisms.

Conclusion and Future Directions

The robust effects of sleep on overall physical and mental health are increasingly being demonstrated. However, insufficient sleep as well as poor sleep quality is highly prevalent in the USA, with marked racial disparities observed. Sleep has

unique implications during the perinatal period, during which time women's bodies must adequately adjust to pregnancy as well as the transition to postpartum, fetal development is occurring, and considerable changes in family structure impact interpersonal functioning. Part II of this two-part review focuses on key biological mechanisms implicated in various health effects, as well as promising strategies for intervention.

Compliance With Ethical Standards

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