

REVIEW ARTICLES

Associations between prenatal sleep and psychological health: a systematic review

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Study Objectives: This systematic review aimed to examine the: (1) strength of associations between prenatal sleep (ie, duration, quality, and insomnia) and psychological health (ie, depression, anxiety, and stress); and (2) moderating influence of sociodemographic characteristics (ie, maternal age, gestational age/trimester, parity, marital and socioeconomic status [SES]), body mass index (BMI), and meeting sleep recommendations.

Methods: A systematic search was conducted using PubMed, PsycINFO, Web of Science, and CINHAL to identify studies with at least one sleep measure and a psychological health outcome. Effect sizes (ES) were calculated by associations between individual components of sleep and psychological health (eg, sleep quality-depression).

Results: Reviewed studies (n = 32) included 14,648 participants and yielded 219 ES. ES for anxiety/stress were combined due to insufficient data to analyze individually. Average strengths of associations for sleep duration-depression (ES = .52) and sleep duration-anxiety/stress (ES = .48), sleep quality-depression (ES = .55) and sleep quality-anxiety/stress (ES = .58), and insomnia-depression (ES = .67) ranged from medium to large. Marital status, parity, BMI, and meeting sleep recommendations moderated sleep duration-depression and sleep duration-anxiety/stress. SES, gestational age/trimester, parity, and BMI moderated sleep quality-depression and sleep quality-anxiety/stress associations.

Conclusions: Poor sleep quality and depression are prevalent during pregnancy and may negatively impact maternal and fetal outcomes. Moderating effects suggest that pregnant women of different BMI status and gestational age differ in their sleep habits and depression and anxiety/stress levels. Findings highlight the need to better understand the impact of these associations on maternal-fetal outcomes to inform interventions to improve sleep and psychological health.

Keywords: sleep, depression, anxiety, stress, pregnancy

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INTRODUCTION

Sleep duration plays an important role in an individual's overall health. The National Sleep Foundation guidelines suggest that adults get seven to nine hours of sleep per night.¹ These recommendations also suggest that adults should not go below 6 hours or above 10 hours per night due to the increased risk of morbidity and mortality.^{2,3} Although sleep duration recommendations have been set for the general population, there are no pregnancy-specific recommendations for sleep duration, quality, and insomnia. This is problematic as pregnant women are at greater risk for sleep disturbances.⁴ Prevalence data suggest that poor sleep quality ranges from 29% to 76% among pregnant women.^{5,6} Poor sleep during pregnancy is associated with increased risks of negative pregnancy outcomes, such as gestational diabetes, preeclampsia, hypertension, excessive gestational weight gain, and cesarean delivery,^{7–12} the development of negative psychological outcomes, such as depression, anxiety, and stress,^{13–15} and negative health outcomes for the baby, including, but not limited to, preterm birth and fetal growth restriction.^{16,17}

There are several proposed theoretical models to explain the relationships between sleep and health outcomes.^{18–22} For

example, Grandner and colleagues proposed a socioeconomic framework describing the relationship between short and long sleep with mortality in the general population.²⁰ According to this model, societal (eg, public policy, technology), social (eg, family, socioeconomic), and individual (eg, behavior, psychology) factors directly influence the bidirectional relationship between sleep duration and adverse health outcomes. Further, people from racial minority groups who reside in urban areas, have low education levels, are older, and practice poor health habits (ie, sedentary behaviors) are at a greater risk for short sleep duration and poor sleep and *vice versa*.^{23,24} Although this model includes multiple factors proposed to influence sleep, it is limited by primarily focusing on sleep duration, not specifically including psychological health factors related to sleep, and not being specific to pregnant women.

One pregnancy-specific model developed by Okun and colleagues illustrates the relationship between increased sleep disturbances, inflammation, poor health behaviors (eg, obesity), and adverse pregnancy outcomes.²¹ Poor health behaviors are depicted as having a bidirectional relationship with increased sleep disturbances such that poor health behaviors influence sleep disturbances and *vice versa*. Despite this

model being multifaceted and pregnancy-specific, it does not focus on the association between sleep and psychological health. Thus, we proposed a pregnancy-specific model to address these limitations and explain the bidirectional relationships between sleep and psychological health and the potential moderating influences on these associations (**Figure 1**). The available evidence in support of this conceptual framework is discussed below.

Approximately 16% of women experience minor or major depression in pregnancy, and another 5% meet the clinical criteria for major depressive disorder.²⁵ Growing evidence shows a link between depression, poor sleep quality, and insomnia.^{5,6,26,27} Mellor, Chua, and Boyce examined the association between sleep-disordered breathing and depression in pregnant women and found that those who had poor sleep quality were more depressed.²⁸ Similarly, Paavonen and colleagues reported that 28% of pregnant women with significant symptoms of insomnia had depressive symptoms, and Ko, Chang, and Chen examined sleep quality and depression during the second and third trimesters and found that those who reported depressive symptoms in both trimesters also had worse sleep quality compared to women without symptoms.^{29,30}

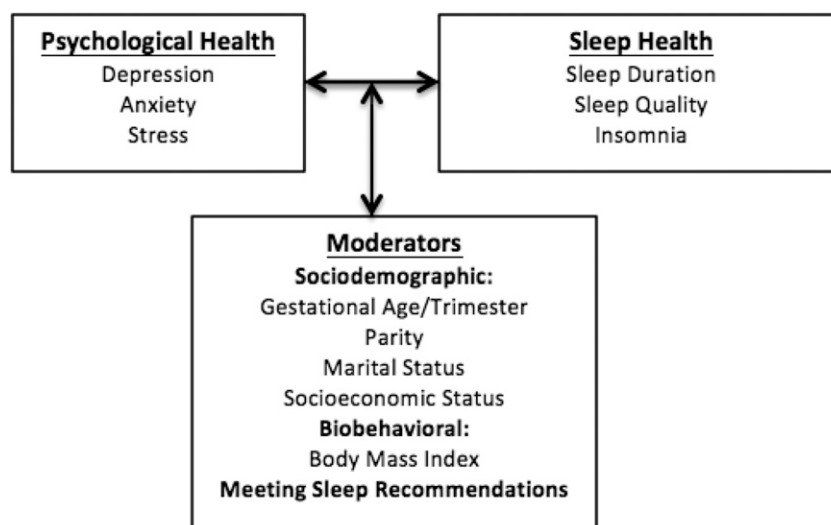
There is also evidence that body mass index (BMI) has a moderating influence on the sleep quality-depression association such that pregnant women with overweight and obesity are at higher risk for poor sleep quality and depression compared to normal weight women.^{8,31} Furthermore, Verbeek and colleagues examined the associations between socioeconomic status (ie, the social class of an individual based on education, income, and occupation) and anxiety, and depression in first trimester pregnant women.^{32,33} Low socioeconomic status was associated with anxiety and depression and had adverse effects on both psychological health outcomes during pregnancy. Okun and colleagues examined associations between socioeconomic status and sleep among 170 pregnant women between 10–20 weeks gestation and found those with low socioeconomic status had poorer sleep

quality.³⁴ Conversely, Salacz and colleagues examined psychological health outcomes in pregnant women with middle to high socioeconomic status and found anxiety levels around the average prevalence but a high level of perceived stress.³⁵

Insomnia is highly prevalent over the course of pregnancy, with symptom rates ranging from 44% to 73%.^{36,37} Okun and colleagues examined the relationship between sleep deficiency and stress and observed that those who had persistent sleep deficiency throughout the first and second trimesters reported greater levels of stress compared to women without persistent sleep deficiency.¹⁴ During pregnancy, stress is also highly prevalent, with 78% women experiencing low-to-moderate stress and 6% experiencing high stress.³⁸ Sleep efficiency (ie, time spend in bed actually asleep) has been shown to be influenced by parity, such that sleep efficiency was lower in multiparous women (ie, women who experienced more than one previous childbirth) compared to nulliparous women (ie, women who have never given birth).³⁹ However, Signal and colleagues reported that nulliparous women had less efficient sleep, more time spent awake after sleep onset, and more time spent in bed compared to multiparous women.⁴⁰

There is also a small body of evidence suggesting that the prevalence of anxiety during pregnancy ranges from 7% to 60% in pregnant women, which may also be associated with sleep disturbances.^{41–42} A recent study examined the association between anxiety and insomnia in 1,646 women in the third trimester and found that symptoms of insomnia were influenced by anxiety.²⁹ Shariat and colleagues examined the impact of gestational age on the relationship between sleep quality and anxiety in a sample of 283 women.⁴³ They found that state and trait anxiety were both significantly associated with sleep quality in each trimester, such that sleep quality decreased further along in pregnancy, and the severity of anxiety symptoms increased.⁴³ Further, marital status (eg, single or married) has been linked to anxiety and sleep quality, such that single

Figure 1—Proposed conceptual model explaining the interrelationships between sleep and psychological health during pregnancy.



Interrelationships between psychological health sleep outcomes.

pregnant women have high anxiety symptoms and poor sleep quality compared to their married counterparts.^{44,45} This is suggested, in part, due to the lack of social support from a partner.^{45,46} However, pregnancy impacts both the sleep and psychological health of the non-pregnant spouse, which may negatively impact the sleep and psychological health of the pregnant woman.²⁹ Since the spouse is having sleep and psychological health issues, this may put added stress on the pregnant woman which may influence their sleep and psychological health negatively.²⁹

Moreover, there are few systematic reviews of the literature that summarize potential moderators of the sleep-psychological health associations. Existing reviews have focused on the effect of sleep on pregnancy outcomes (eg, gestational diabetes, preeclampsia) or targeted the postpartum rather than the prenatal period.^{47–50} Few, if any, reviews have examined associations between prenatal sleep and psychological health and the influence of the possible sociodemographic (ie, maternal age, gestational age/trimester, parity, marital and socioeconomic status [SES]) and biobehavioral (ie, BMI and meeting sleep recommendations) moderators as intervention targets. In addition, guidelines and recommendations for sleep among pregnant women are limited. Due to the physiological and psychological changes that women experience during pregnancy, their sleep needs may change compared to non-pregnant women. For example, pregnant women experience more fragmented sleep due to increased awakenings to urinate or to get comfortable, which may decrease their sleep duration and quality, and negatively impact both mother and infant health.⁶

Therefore, the purpose of this systematic review was to address the limitations in the literature by examining the: (1) strength of associations between prenatal sleep duration, quality, and insomnia and psychological outcomes (ie, depression, anxiety, and stress), and (2) influence of potential sociodemographic moderators (ie, gestational age/trimester, parity, marital status, socioeconomic status), BMI, and meeting the sleep recommendations on the sleep-psychological health associations. It is hypothesized that: (1) a medium association will be observed between sleep and psychological outcomes, and (2) sociodemographic characteristics (gestational age/trimester, parity, marital status, socioeconomic status), BMI, and meeting sleep recommendations will moderate the strength of association between sleep and psychological outcomes.^{14,43,51–55}

METHODS

A systematic review and meta-analysis of articles was conducted to examine associations between prenatal sleep and psychological health determinants. The review was prepared according to PRISMA statement guidelines.^{56,57} Methods for data analyses and assessing risk of bias were also identified, and results were reported systematically.

Search strategy

Electronic searches of Medline/PubMed, PsychINFO, CINAHL Complete, ProQuest Dissertations & Thesis A&I, and Web of

Science from July 1, 1968 (ie, date of first study conducted examining sleep in pregnancy⁵⁸ to January 15, 2018 were conducted to identify relevant peer-reviewed articles and primary studies. Search strategies were based on the terms “sleep,” “pregnancy,” and “mental and psychological health” and were limited to human participants (full list available from first author upon request). Search strategies for each database were reviewed and approved by a health science research librarian to ensure proper search terms and procedures were used.⁵⁹ Reference lists of included articles were hand searched to identify additional articles and primary studies that were missed during electronic database searches.

Data extraction: study selection

Article titles and abstracts were reviewed by the first and last authors. Articles were excluded based on title/abstract review if they did not include: (1) expectant mothers (ie, women who are currently pregnant), (2) at least one measure of sleep (ie, the Pittsburgh Sleep Quality Index; PSQI), or (3) at least one psychosocial measure (ie, measured depression [Edinburgh Postnatal Depression Scale]). The full text of remaining articles were further reviewed to determine if they met additional inclusion criteria. Studies were eligible for inclusion in this review if they: (1) were written in English, (2) conducted with expectant mothers (ie, women who are currently pregnant), (3) contained at least one measure of sleep (ie, the Pittsburgh Sleep Quality Index; PSQI), (4) contained at least one psychological measure (ie, measured depression [Edinburgh Postnatal Depression Scale], anxiety [State-Trait Anxiety Inventory], and/or stress [Perceived Stress Scale]), (5) included participants with or without a confirmed clinical psychological disorder diagnosis, and (6) were cross-sectional, longitudinal, or intervention studies. Studies were excluded if they: (1) had a sample of nonexpectant mothers (mixed samples were used as long as results were reported separately for expectant and nonexpectant mothers), (2) included participants with a sleep disorder diagnosis (eg, obstructive sleep apnea, restless leg syndrome, narcolepsy), (3) review articles, (4) duplicate samples, (5) articles that did not include measures of sleep, depression, anxiety, and/or stress, and (6) did not include statistical data to compute effect sizes. The Joanna Briggs Institute Critical Appraisal tool for Cross Sectional Studies was used for critical appraisal of bias for each individual study.⁶⁰

Coding procedures

Specific participant characteristics coded were: number of participants, maternal age (in years), socioeconomic status (ie, the social class of an individual based on education, income, and occupation and calculated based on Kuppaswamy's socioeconomic scale),^{33,61} marital status, height, weight, BMI category, gestational age at measurement timepoint (in weeks), trimester at measurement timepoint, and parity. Specific study characteristics coded were: author, year, publication format, journal, study type (ie, correlational, experimental, longitudinal, intervention), mode of data collection (ie, in-person, by mail, online), sample size, relevant data (ie, means and standard deviations, ranges, *P* values), measures of sleep

and psychological outcomes, response rate, and the interrelationships of sleep and psychological outcomes (ie, Pearson correlations, odds ratios). As a result of the search strategy and study selection, 32 studies based on 14,648 participants yielded 219 number of effect sizes were retained. The PRISMA flow chart summarizing study selection is shown in **Figure 2**.

Statistical analyses

Effect sizes (ES) were calculated to examine the strength of associations between prenatal sleep (duration, quality, and insomnia) and psychological health outcomes, including depression, anxiety, and stress (*Purpose 1*). To obtain an unbiased estimate of the ES, ES were corrected using the following equation:

$$1 - \frac{3}{4 \times n - 3} \text{.}^{62}$$

Weighted mean ES were then calculated using the equation:

$$\text{weighted mean ES} = \frac{\frac{ES}{\text{variance}}}{\frac{1}{\text{variance}}}$$

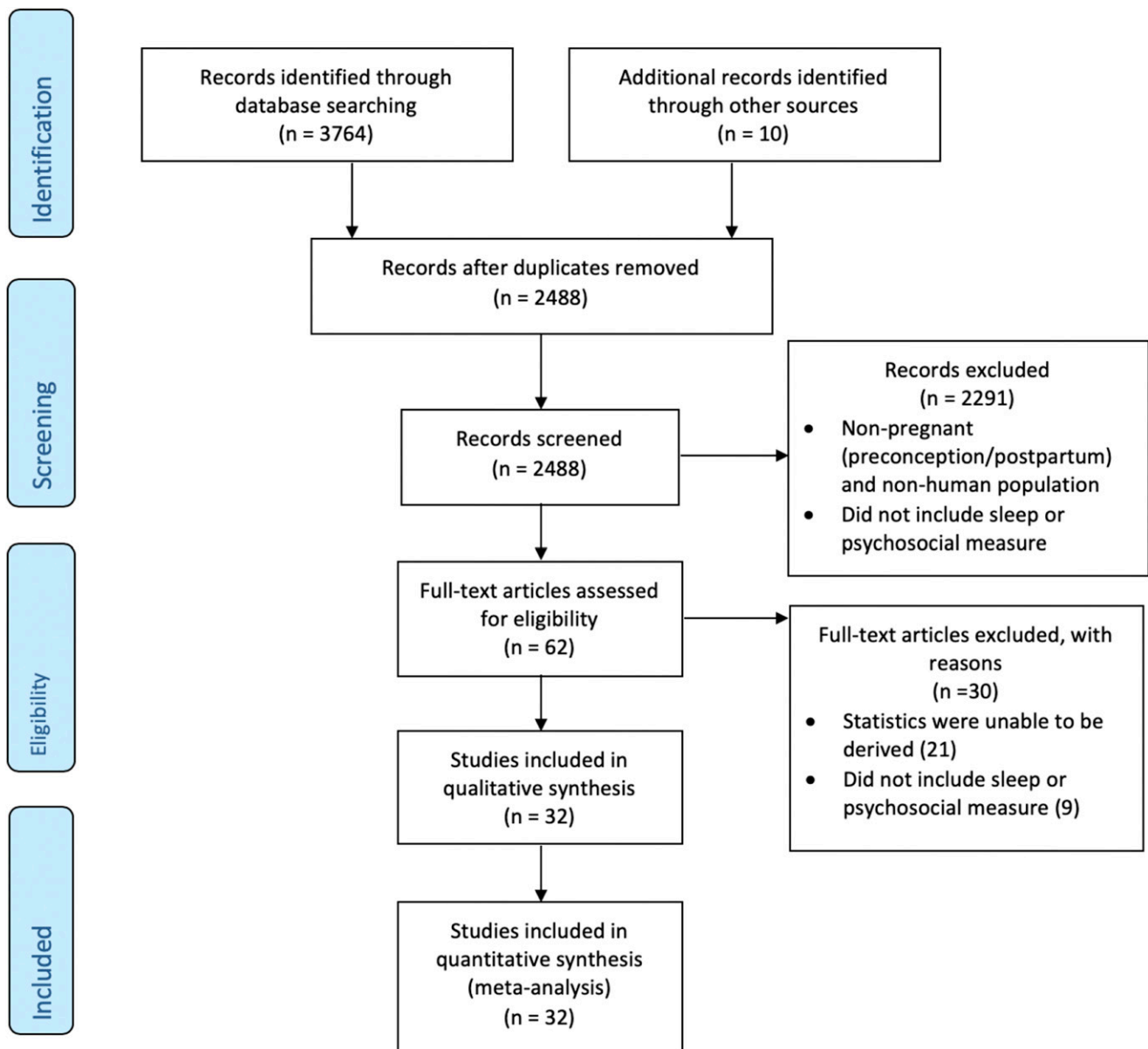
where:

$$\text{variance} = \frac{(1 - r_i \times r_i) \times (1 - r_i \times r_i)}{n - 1}$$

and r_i is the i th correlation.⁶³

Weighting ES allows for those ES with smaller variances to receive a larger weight than those with larger variances. Cohen’s *d* ES were then calculated with values of 0.20, 0.50, and 0.80 representing small, medium, and large effects, respectively.⁶⁴

Figure 2—PRISMA search flow diagram.



Flow diagram of study selection.

Average ES were calculated for each association between specific sleep variables (duration, quality, and insomnia) and depression, anxiety/stress.

A variety of scales were used to measure the sleep and psychological health outcomes (**Table 2**). To examine the moderating influences on the ES (*Purpose 2*), one-way analyses of variance were conducted with Benjamini-Hochberg false discovery rate procedures to adjust for multiple comparisons for the following moderators: socio-demographic characteristics (gestational age/trimester, parity, marital status, socioeconomic status), BMI, and meeting sleep recommendations.⁶⁵ Gestational age/trimester was based on typical gestational weeks associated with each trimester: (1) first trimester (gestational age range 1–13 weeks), (2) second trimester (gestational age range 14–27 weeks), and (3) third trimester (gestational age range 28–40 weeks).⁶⁶ Parity was divided into: (1) nulliparous (never carried a pregnancy beyond 20 weeks gestation), (2) primiparous (1 previous birth), and (3) multiparous (> 1 previous birth).³⁸ Marital status was categorized based on the United States Census Bureau marital status classifications as: (1) single, (2) partnered, and (3) currently married.⁶⁷ Socioeconomic status was based on calculations from the Kuppaswamy socioeconomic scale categorized as: (1) lower-class, (2) middle-class, and (3) upper-class.⁶¹ BMI was divided into three groups: (1) normal weight (BMI 18.9–24.9 kg/m²), (2) overweight (BMI 25–29.9 kg/m²), and (3) obese (BMI ≥ 30.0 kg/m²).⁶⁸ Meeting sleep recommendations was divided into three groups: (1) < 7 hours, (2) 7–9 hours, and > 9 hours.¹ Data was analyzed using SPSS 25 (IBM Corp., Armonk, New York).

Assessment of heterogeneity and bias

To examine the homogeneity of ES, the I² index was calculated on a scale from 0 to 100, representing the ratio of variance among point estimates that can be attributed to heterogeneity.⁶⁹ Heterogeneity thresholds are 25% for low, 50% for medium, and 75% for high.⁶⁹ Funnel plots and Egger regression analysis were completed using workbooks from Suurmond and colleagues⁷⁰ to determine if any publication bias was present.⁷¹ To account for studies that were unpublished, not located, or studies with null effects, a fail-safe *n*, using Hedges and Olkin formula with a trivial criterion value of 0.15, was calculated for each ES sleep-depression, sleep-anxiety, and sleep-stress association.⁶³

RESULTS

Participant and study characteristics

A list of all selected studies is provided in the supplemental material. **Table S1** in the supplemental material includes descriptions of selected studies. All studies included pregnant women (*n* = 32, 100%) with *n* = 14,648 participants across studies, were conducted between 2016–2017 (*n* = 16, 50%), 2011–2015 (*n* = 9, 28.2%), and 2006–2010 (*n* = 7, 21.8%) and were published (*n* = 31, 96.9%). Only 34.4% of studies reported a response rate; the average response rate across studies was 85.3%. A total of 3,774 articles were collected,

2,488 (65.9%) remained after removing duplicates; 62 (2.5%) full-text articles were assessed and 32 (51.6%) reviewed. **Table S2** in the supplemental material summarizes study measures and ES. The majority of articles were removed due to insufficient data for target variables (70.0%) and due to not including a sleep or psychological measure (30.0%). Not all studies assessed all three of the specific psychological measures; studies measured depression symptoms alone (*n* = 12, 37.5%), depression and anxiety symptoms, and depression, anxiety and stress (*n*'s = 7, %'s = 21.9%), and depression and stress, anxiety alone and stress alone (*n*'s = 2, %'s = 6.3%). Due to insufficient data for anxiety and stress, we averaged these ES together (eg, ES reported as “sleep duration-anxiety/stress”). The majority of the studies reported sleep quality using the Pittsburgh Sleep Quality Index Global score (*n* = 18, 56.3%) but also reported self-report sleep duration (*n* = 16, 47.5%), sleep quality (*n* = 11, 34.4%), and insomnia (*n* = 5, 15.6%). Additional participant and study details can be found in **Table 1** and **Table 2**.

Average ES and heterogeneity scores for associations between sleep duration, sleep quality, and insomnia and depression, anxiety, and stress can be found in **Table 3** and **Table 4**. Random effect models were used to determine overall effects of the various associations and was selected due to the difference of sample sizes among studies and the usage of different measures for sleep and psychological health.⁷² Average ES for all individual associations ranged from small (ES = .33) to large (ES = .92). I² test for heterogeneity indicated high amounts of heterogeneity for all associations. Funnel plots illustrated no asymmetry (or no publication bias) except for sleep duration-depression and sleep duration-anxiety/stress, and sleep quality-anxiety/stress (**Figure 3** and **Figure 4**). Average ES for the Pittsburgh Sleep Quality Index sleep quality item score-anxiety/stress and insomnia-anxiety/stress associations were unable to be computed due to insufficient data (ie, less than 2 studies with data to compute ES). Higher scores for sleep (duration, quality, insomnia) and depression/anxiety/stress indicated poorer sleep and greater symptomatology. Thus, shorter sleep duration, poorer sleep quality, and the presence of insomnia, were positively associated with higher depression/anxiety/stress suggesting with worse psychological health symptomatology, there may be decreases in sleep duration and quality, and insomnia may be present.

Moderation analyses

Table S3, **Table S4**, **Table S5**, **Table S6**, and **Table S7** in the supplemental material display the ES means and standard deviations, and the moderating effects of gestational age/trimester, parity, marital status, socioeconomic status, BMI, and meeting the sleep duration guidelines on the strength of the sleep-depression/anxiety/stress associations. Specifically, the strength of sleep duration-depression and sleep duration-anxiety/stress associations were significantly stronger in married women compared to single and/or partnered women and stronger in normal weight women compared to overweight and/or obese women. The strength of the PSQI sleep duration-depression association was examined and was stronger in multiparous women compared to nulliparous women, and the sleep log reported duration-depression association was stronger

Table 1—Participant characteristics.

Characteristic		No. of Studies	No. of Participants	Proportion	Mean (Range)	Studies Reported
Age, years	25–30	30	14,231	39.1%	29.9 ± 1.9 (26–33)	93.8%
	> 30			60.9%		
Parity	Nulliparous	24	11,547	50.2%	Nulliparous	75.0%
	Primiparous			31.4%		
	Multiparous			18.4%		
Marital status	Single	23	12,664	0.95%	Married	71.9%
	Partnered			12.95%		
	Married			86.10%		
Gestational age	First trimester	23	11,411	21.0%	21.4 ± 7.4 weeks	71.9%
	Second trimester			63.6%		
	Third trimester			15.4%		
Socioeconomic status	Lower-class	16	7,792	26.8%	Middle-class	50.0%
	Middle-class			50.9%		
	Upper-class			22.3%		
BMI/BMI range	Normal weight	13	7,051	75.83%	Normal weight	40.5%
	Overweight			19.20%		
	Obese			4.97%		

BMI = body mass index.

in women meeting the sleep duration guidelines compared to women who slept > 9 h/night. The sleep quality collapsed across all sleep quality measures-anxiety/stress association was stronger in women in the first trimester compared to women in the second and third trimesters. The PSQI Global quality score-anxiety/stress association was stronger in multiparous women compared to primiparous women and women in upper-class status compared to women in middle-class status.

DISCUSSION

The goals of this review were to examine the: (1) strength of associations between sleep (ie, quality, duration, and insomnia) and psychological outcomes (ie, depression, anxiety/stress) during pregnancy; and (2) influence of potential moderators (sociodemographic: gestational age/trimester, parity, marital status, socioeconomic status; biobehavioral: BMI; meeting sleep recommendations) on these associations. Overall, strengths of all the individual sleep-psychological health associations ranged from small to large such that shorter sleep duration, poor sleep quality, and insomnia were associated with greater depression, anxiety/stress. Specifically, the strength of the sleep quality-depression association was the strongest, illustrating that poor sleep quality and depression are prevalent during pregnancy and could negatively impact maternal and fetal outcomes (eg, gestational diabetes, preterm birth). In addition, BMI had the strongest moderating influence on the sleep duration-depression association, and gestational age/trimester had the strongest moderating influence on the sleep quality-anxiety/stress association. These findings suggest that pregnant women of different BMI status and gestational age differ in their sleep habits and

depression/anxiety/stress levels which can potentially influence the sleep-psychological health and in turn, maternal-fetal outcomes. These study findings suggest BMI and gestational age/trimester, as well as parity, marital status and SES, may play a crucial role in the sleep-psychological health associations and maternal-fetal outcomes and should be targeted in future research. More details on these findings are described below.

As hypothesized, the average strengths of the sleep-psychological health associations were medium to large, indicating that sleep was associated with depression/anxiety/stress with variation in the strengths of associations. Specifically, the sleep quality-depression association was the strongest followed by insomnia-depression, sleep quality-anxiety/stress, and sleep duration-depression, and -anxiety/stress suggesting that the sleep quality-depression association may be stronger and more stable compared to the other associations. The strength of the sleep quality-depression association indicates that poor sleep quality was associated with greater depression and *vice versa*. These findings are consistent with previous literature suggesting that with poorer sleep, shorter sleep duration, and insomnia, depression and anxiety increased and *vice versa*.^{29,73} Since the sleep quality-depression association was the strongest, by targeting this relationship, there may be improvements in the other components of sleep and psychological health during pregnancy.

However, these findings may be a result of the varying number of ES sizes between the three psychological health variables (n for depression = 116, n for anxiety/stress = 103). Despite the variation of strengths and limited number of ES, these findings ultimately suggest that the relationships between sleep and depression and anxiety/stress are prevalent during pregnancy. Due to the risk of negative health outcomes

Table 2—Study characteristics.

Scale	n	Studies Used
EPDS	13	46.4%
BDI	6	21.4%
CESD	3	10.7%
DASS-21 (depression subscale)	3	10.7%
PHQ-9 (depression)	2	7.1%
SDS	1	3.6%
ZSRDS	1	3.6%
GHQ-28 (depression)	1	3.6%
HADS (depression subscale)	1	3.6%
STAI	5	31.3%
DASS-21 (anxiety subscale)	4	22.2%
PSWQ	2	11.1%
BAI	1	6.3%
SAS	1	6.3%
GHQ-28 (anxiety subscale)	1	6.3%
GAD-7	1	6.3%
PRAQ-R2	1	6.3%
HADS (anxiety subscale)	1	6.3%
DASS-21 (stress subscale)	4	40%
PSS	3	30%
PSRS	1	10%
Allostatic load	1	10%
Norepinephrine	1	10%
Cortisol	1	10%
PSQI	24	75%
ISI	3	9.4%
Sleep logs	2	6.3%
SHPS	2	6.3%
BIS (daytime impairment)	1	3.1%
VSH	1	3.1%
Mindell's Sleep Questionnaire	1	3.1%
AIS	1	3.1%
BNSQ	1	3.1%
BRIAN (sleep scale)	1	3.1%
Actigraphy	3	9.4%

AIS = Athens Insomnia Scale, BAI = Beck Anxiety Inventory, BDI = Beck Depression Inventory, BIS = Bergen Insomnia Scale, BNSQ = Basic Nordic Sleep Questionnaire, BRIAN = Biological Rhythms Interview of Assessment in Neuropsychiatry, CESD = Center for Epidemiological Studies Depression Scale, DASS-21 = Depression, Anxiety, and Stress Scale-21 Items, EPDS = Edinburgh Postnatal Depression Scale, GAD-7 = Generalized Anxiety Disorder-7, GHQ-28 = General Health Questionnaire, HADS = Hospital Anxiety and Depression Scale, ISI = Insomnia Severity Index, PHQ-9 = Patient Health Questionnaire, PRAQ-R2 = Pregnancy-related anxiety questionnaire, PSQI = Pittsburgh Sleep Quality Index, PSRS = Pregnancy Stress Rating Scale, PSS = Perceived Stress Scale, PSWQ = Penn State Worry Questionnaire, SAS = self-rating anxiety scale, SDS = self-rating depression scale, SHPS = Sleep Hygiene Practice Scale, STAI = State/Trait Anxiety Inventory, VSH = Verran and Snyder-Halpern Sleep Scale, ZSRDS = Zung Self-Rating Depression Scale.

associated with poor psychological health symptoms, there is an important need for more research to better understand these interrelationships.

Secondly as hypothesized, the strength of the various sleep-psychological health associations were moderated by various participant characteristics. Specifically, the PSQI global quality score-depression association was stronger in women of upper-class status compared to those of lower-class status suggesting women of upper-class status experience poorer sleep quality and increased depression. There were no significant differences between lower-class and middle/upper-class status. Similarly, the strength of the PSQI global quality score-anxiety/stress association was stronger in women of upper-class status compared to women of middle-class status. These findings are interesting since the majority of existing evidence suggests that issues pertaining to sleep and psychological health individually are more prevalent in women of lower-class status.^{34,74} However, higher levels of anxiety/stress during pregnancy have been found in pregnant women.³⁵ Since the findings regarding the influence of socioeconomic status level within this review are conflicting with the existing evidence and since research in this area is in its infancy, more research is needed to understand the specific needs and issues of pregnant women in each socioeconomic status level. Researchers may be able to provide tailored education and strategies to help pregnant women cope and deal with any pressures they feel from providing for their families, multiple work responsibilities, and their pending labor, delivery, and adjusting to life with a newborn.

The strength of the PSQI global quality score-anxiety/stress association was also stronger in multiparous women compared to primiparous women, suggesting that poor sleep and increases in anxiety/stress are prevalent in women with children compared to those who have given birth once previously. Polo-Kantola and colleagues examined sleep quality in 78 pregnant women and found that multiparous women had difficulty falling asleep and poorer sleep quality and anxiety.^{75,76} These current findings may be attributed to the added responsibilities and stressors associated with having multiple children at home, and any lingering anxiety due to previously difficult labor and birth experiences.⁷⁶ Existing evidence examining the influence of parity is limited, which suggests a need for future research in this area.

The sleep quality-anxiety/stress association was stronger in women in their first trimester compared to women in their second and third trimesters, suggesting that at the beginning of pregnancy, sleep quality is poor and there is an increase in anxiety/stress compared to the second and third trimesters. These findings are similar to those of Lee et al who found anxiety was more prevalent in the first trimester compared to the second and third trimesters.⁵⁵ These findings suggest that the first trimester may be the best time to target improving sleep and psychological health for a lasting effect throughout pregnancy since women are more amenable to receiving intervention content on these topics during this time. For example, by intervening early on negative sleep practices, improving coping techniques, and providing the education and skills needed to prepare for the later stages of pregnancy, increases in anxiety, stress, and sleep issues may be reduced throughout later pregnancy and potentially into postpartum.

Table 3—Effect size and statistics for the associations among self-reported sleep components and self-reported depression.

Association	N ES	M ES	SD	I ²	τ ²	Intercept	SE	CI
Sleep duration (PSQI) and depression	4	.330	.179	–	–	–	–	–
Sleep duration and depression	7	.657	.221	–	–	–	–	–
Sleep duration (collapsed across all) and depression	11	.494	.200	86.63%	0.02	–8.14*	2.25	–13.15 to –3.13
Sleep quality (PSQI item) and depression	7	.769	.283	–	–	–	–	–
Sleep quality (PSQI global score) and depression	40	.924	.360	–	–	–	–	–
Sleep quality and depression	6	.861	.052	–	–	–	–	–
Sleep quality (collapsed across all) and depression	53	.851	.232	94.65%	0.08	1.52	3.72	–5.93 to 8.97
Insomnia and depression	5	.665	.340	91.38%	0.20	–61.21	29.09	–141.99 to 19.57

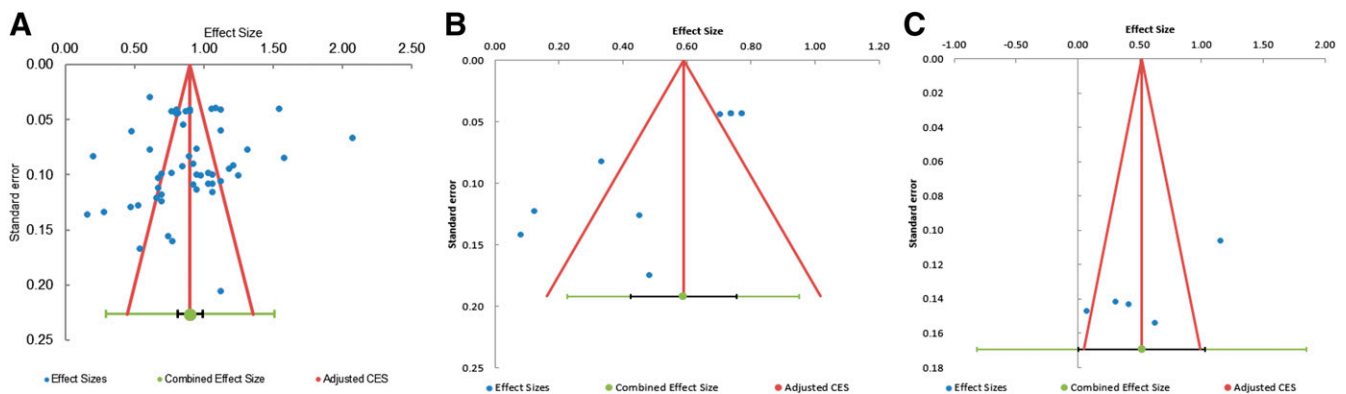
*P < .05. CI = confidence interval, M ES = mean effect size, N ES = effect size number, PSQI = Pittsburg Sleep Quality Index, SD = standard deviation, SE = standard error.

Table 4—Effect size and statistics for the associations among sleep quality, sleep duration, and insomnia and self-reported anxiety/stress.

Association	N ES	M ES	SD	I ²	τ ²	Intercept	SE	CI
Sleep duration and anxiety/stress	12	.483	.313	95.3%	.06	–17.71*	4.67	–27.98 to –7.44
Sleep quality (PSQI global score) and anxiety/stress	36	.644	.327	–	–	–	–	–
Sleep quality (collapsed across all) and anxiety/stress	61	.584	.389	98.0%	0.21	–21.96*	7.30	–36.55 to –7.37

*P < .05. CI = confidence interval, M ES = mean effect size, N ES = effect size number, PSQI = Pittsburg Sleep Quality Index, SD = standard deviation, SE = standard error.

Figure 3—Funnel plots of effect sizes.

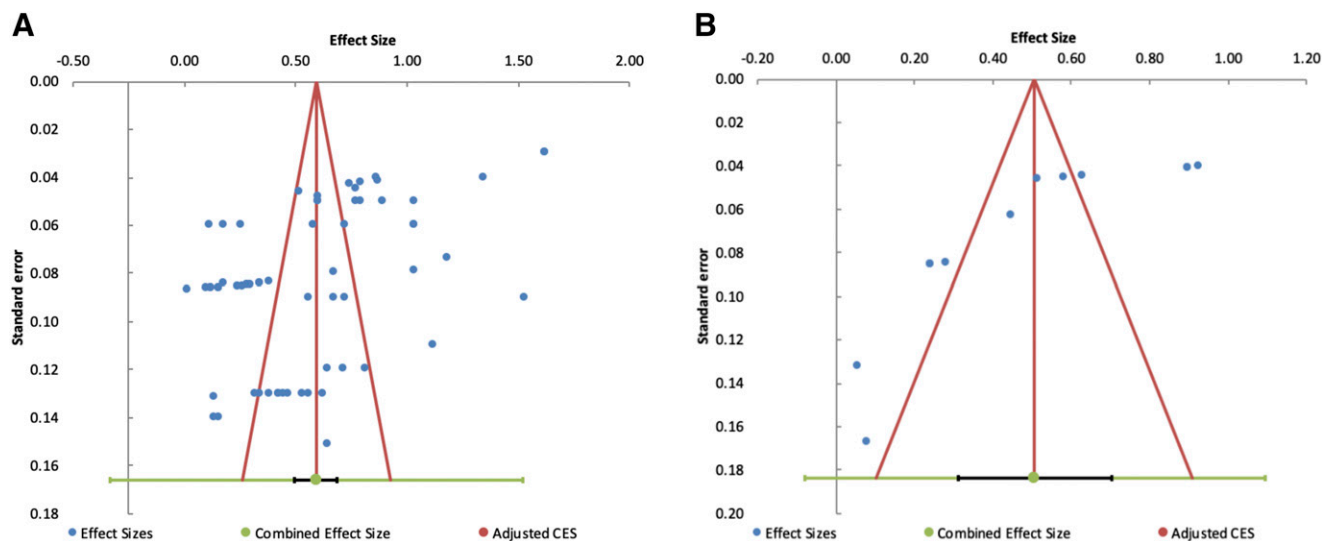


(A) sleep quality-depression, (B) sleep duration-depression, and (C) insomnia-depression associations. CES = Combined Effect Size.

The strengths of the sleep duration-depression and sleep duration-anxiety/stress associations were stronger in women who were married compared to those who were partnered and/or single. These findings are in contrast to those of Naud and colleagues who found that single motherhood was significantly associated with poor sleep quality and could be due to lack of social support.⁴⁵ However, despite having spousal support, issues within the marriage and spousal sleep habits may negatively influence the sleep and psychological health of

pregnant women. Spousal sleep habits were not reported in the reviewed studies and should be examined in future research. This will allow for a better understanding of what spousal sleep behaviors can be modified to improve the sleep of the expectant mothers and, in turn, the spouse. Also, since there was a limited number of studies that examined the sleep-psychological health associations in single pregnant women, studies should target single pregnant women in order to understand how single motherhood impacts sleep and psychological health.

Figure 4—Funnel plots of effect sizes.



(A) sleep quality-anxiety/stress and (B) sleep duration-anxiety/stress associations. CES = Combined Effect Size.

In contrast to the hypothesis and past researchers' conclusions,^{53,77} the sleep duration-depression and sleep duration-anxiety/stress associations were stronger in normal weight women compared to women with overweight/obesity. Although it is well-known that pregnant women with overweight/obesity have poorer sleep quality, shorter sleep duration, and higher risk for negative psychological health than normal weight women, these findings suggest that when normal weight women had poorer sleep quality and shorter sleep duration, there was also an increase in depression and anxiety/stress. These findings also suggest that normal weight pregnant women may need as much assistance with improving their sleep and psychological health as those with overweight/obesity. For example, all pregnant women are at risk for pregnancy-related sleep apnea which may increase the chances of snoring, disturbed sleep, and negative pregnancy outcomes.⁷⁸ Thus, it is important to identify strategies to reduce sleep apnea and related sleep disturbances in all pregnant women regardless of their pre-pregnancy weight status to promote healthy pregnancies.

Lastly, it was hypothesized that meeting sleep recommendations (7–9 h/night) would be associated with lower levels of depression. However, the sleep duration-depression association was stronger in women who slept 7–9 h/night compared to women who slept > 9 h/night, which did not agree with the hypothesis. However, these findings are limited in that it cannot be inferred that sleeping 7–9 h/night is the same as having good quality sleep such that women may be meeting the duration recommendations but as pregnancy progresses their quality of sleep may be worsening. For example, a woman could sleep 8 hours but may not feel fully rested regardless of sleeping the recommended duration. This suggests sleep duration and quality should be considered together when developing sleep recommendations during pregnancy.

Limitations

This study included strengths such as producing a thorough synthesis and review of the evidence, providing important insight

into the relationships and potential moderating effects between sleep and psychological health, and suggesting recommendations for researchers and clinicians. Despite these strengths, this study is not without its limitations. First, many of the studies reviewed used measures of depression and anxiety but did not include measures of stress, resulting in a limited number of ES. In addition, most sleep studies relied on the PSQI to assess sleep, which is limited by its self-reported nature, and lacked objective measures of sleep. Due to inconsistencies across actigraphy variables and insufficient ES, these studies (n = 2) were excluded and important sleep variables (ie, number of daytime naps and nap duration) could not be examined. More research using objective measures, in combination with consistent self-reported measures of sleep, is needed to obtain more accurate values of sleep outcomes by reducing the variability and error when self-reporting variables such as duration. Additionally, the number of ES for various sleep variable and psychological health outcome (ie, sleep-anxiety and sleep-stress, individually) associations were limited so conclusions were unable to be drawn and moderation analyses were unable to be performed. More research is needed to understand these relationships and what factors may impact these associations. Some findings of this review were in conflict with existing evidence (ie, socioeconomic status) in regard to moderation analyses, which need to be examined further in order to obtain a comprehensive understanding of the needs of pregnant women when it comes to sleep and psychological health. Also, pregnancy spacing was one factor that may explain the conflicting findings and influence these associations was not coded due to insufficient data (ie, studies did not report on pregnancy spacing). This area needs further research in order to understand how multiple pregnancies and the time in-between may impact sleep and psychological health. Lastly, additional biobehavioral factors (ie, gestational weight gain, physical activity) were to be examined but due to insufficient data, they were excluded. These variables are important during pregnancy and need to be examined and included in future research studies.

Also, the majority of the studies reviewed were observational/cross-sectional and were only conducted between 2016–2017. This research area is in its infancy and there is a need to conduct longitudinal and intervention studies. This will allow for the better understanding of the changes that occur throughout pregnancy in relation to sleep and psychological health, the potential moderating effects of other participant characteristics, and the impact of behavior modification on sleep and/or psychological health during pregnancy. Lastly, there was some evidence of publication bias found for the sleep duration-depression and sleep duration-anxiety/stress and sleep quality-anxiety/stress associations. The potential reasons for this publication bias may be due to the use of various measures to examine depression/anxiety/stress and sleep as well as the majority of the studies only reporting significant findings.

CONCLUSIONS

To our knowledge, this is one of the first systematic reviews to examine associations between sleep and psychological health, and the influence of potential moderators on those relationships. In summary, we found that poor sleep quality and depression are prevalent during pregnancy and moderating effects suggest that pregnant women of different BMI status and gestational age differ in their sleep habits and levels of depression, anxiety, and stress. These findings are significant because they can provide the evidence-base for future studies focusing on prenatal sleep and psychological health. To improve upon the gaps in the current literature, researchers aiming to study prenatal sleep and psychological health may want to consider including measures of multiple components of sleep (eg, sleep quality, total sleep time, naptime duration, etc.) and moderator variables such as gestational age/trimester, parity, BMI, marital status, and socioeconomic status.

ABBREVIATIONS

BMI, body mass index
 ES, effect sizes
 PSQI, Pittsburgh Sleep Quality Index
 SES, socioeconomic status

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