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Sleep and Women's Health

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Abstract

Sex differences in sleep begin at a very early age and women report poorer sleep quality and have higher risk for insomnia than do men. Sleep may be affected by variation in reproductive hormones, stress, depression, aging, life/role transitions, and other factors. The menstrual cycle is associated with changes in circadian rhythms and sleep architecture. Menstruating women (even without significant menstrual-related complaints) often report poorer sleep quality and greater sleep disturbance during the premenstrual week compared to other times of her menstrual cycle. In addition to these sleep disturbances, women with severe premenstrual syndrome often report more disturbing dreams, sleepiness, fatigue, decreased alertness and concentration during the premenstrual phase. Sleep disturbances are also commonly reported during pregnancy and increase in frequency and duration as the pregnancy progresses. The precipitous decline in hormones and unpredictable sleep patterns of the newborn contribute to and/or exacerbate poor sleep and daytime sleepiness during the early postpartum period. Insomnia is also among the most common health complaints that are reported by perimenopausal women. Women are particularly vulnerable to developing insomnia disorder during these times of reproductive hormonal change. In this review, we present a discussion on the most relevant and recent publications on sleep across the woman's lifespan, including changes in sleep related to menstruation, pregnancy, postpartum, and the menopausal transition. Treatment for sleep disturbances and insomnia disorder and special considerations for treating women will also be discussed.

Keywords

Sleep; Insomnia; Women; Pregnancy; Postpartum; Menopause

Introduction

Research has shown that women report more sleep difficulties[1,2] and are at greater risk for a diagnosis of insomnia compared to men[3,4]. In the National Sleep Foundation's 2007 poll, 30% of pregnant women and 42% of postpartum women reported rarely getting a good

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night's sleep, compared with 15% among all women. Additionally, 25% of perimenopausal women and 30% of postmenopausal women reported getting a good night's sleep only a few nights per month or less[5,6]. In general, there is a higher prevalence of insomnia, restless leg syndrome, and dissatisfaction with sleep in women. In contrast, objective measures of sleep, measured by actigraphy and polysomnography (PSG), have demonstrated shorter sleep onset latency, increased sleep efficiency and total sleep time in women compared to men[7–9]. Yet, a meta-analysis of sex differences of sleep behaviors in older adults (aged 58+) revealed no sex differences in total sleep time[10]. Although sleep disturbances and insomnia disorder are widespread in the general population, each tends to occur more frequently in women, particularly during times of hormonal fluctuation. In addition to sex differences found in complaint of sleep disturbances and prevalence of sleep disorders, sex differences may also exist when treating men versus women. For example, in 2013 the U.S. Food and Drug Administration (FDA) required the manufacturers of Ambien to lower the recommended dose of zolpidem for women from 10 mg to 5 mg for immediate-release products and from 12.5 mg to 6.25 mg for extended-release products due to the risk of next-morning impairment and motor vehicle accidents. Women appear to be more susceptible to this risk because they eliminate zolpidem from their bodies more slowly than men. Zolpidem is the first drug in the U.S. to have different recommended doses for women versus men, but it seems likely pharmacokinetic sex differences would lead to differences in rates of absorption, metabolism, and excretion of other medications as well. Other biopsychosocial factors, such as discomfort during pregnancy, breastfeeding and infant/child care during the postpartum period, and potential ongoing nocturnal vasomotor symptoms (hot flashes and night sweats) during peri- and postmenopause, may complicate insomnia treatment and require special treatment considerations for sleep disturbances in women.

The Menstrual Cycle and Menstrual Cycle Disorders

The menstrual cycle of healthy women is characterized by cyclic changes in production of estradiol, progesterone, lutenizing hormone, follicle stimulating hormone, prolactin, and growth hormone. Reproductive hormones not only regulate reproductive function during the menstrual cycle, but also influence sleep and circadian rhythms. Negative menstrual symptoms are most commonly experienced by women during the last few days of the cycle, as progesterone and estrogen levels decline[11]. Premenstrual Syndrome (PMS) and Premenstrual Dysphoric Disorder (PMDD) are characterized by emotional, behavioral, and physical symptoms that occur in the premenstrual phase of the menstrual cycle, with resolution at the onset of menses or shortly thereafter. Many women of reproductive age experience some premenstrual symptoms, but 3–8% of women have clinically relevant premenstrual symptoms that they perceive as distressing and that affect daily function and meet diagnostic criteria[6,12,13]. Women with PMS/PMDD typically report sleep-related complaints such as insomnia, frequent awakenings, non-restorative sleep, unpleasant dreams or nightmares, and poor sleep quality associated with their symptoms; and daytime disturbances such as sleepiness, fatigue, decreased alertness, and an inability to concentrate during the during the premenstrual week and during the first few days of menstruation[14–19]. Women who experience severe premenstrual syndrome report significant declines in sleep quality in association with their symptoms during the late luteal phase compared with early

follicular phase of their cycle[20,21]. These corresponding changes, however, were not found in PSG sleep[22–24]. Recently, actigraphic sleep was examined in participants from the Study of Women's Health Across the Nations (SWAN) and investigators found that among later reproductive-age women, sleep efficiency declines across the menstrual cycle with the most pronounced decline in the last week of the menstrual cycle[25]. Another recent study demonstrated that a steeper rate of rise in progesterone levels from follicular phase through mid-luteal phase was associated with greater PSG wake after sleep onset and sleep fragmentation in the late luteal phase[26]. Sleep studies across the menstrual cycle have been limited by small sample sizes, heterogeneous cycle lengths, lack of ovulation timing controls, and oral contraceptive use. Due to these methodological issues and the limited nature of these studies, much remains unknown about premenstrual sleep.

Most women with PMDD seeking psychiatric help for this disorder present with symptoms of premenstrual depression, anxiety, and/or irritability. A number of treatment strategies currently exist that target these symptoms and appear beneficial in treating them[27]. The selective serotonin reuptake inhibitors (SSRIs) fluoxetine and sertraline have been approved by the U.S. FDA for the treatment of PMDD. Fluoxetine[28–31], sertraline[32], and clomipramine[33,34] appear to be highly effective for treatment of depression, however little data is available on the safety and efficacy of using SSRIs to treat sleep disturbance and insomnia in PMS and PMDD. Nonpharmacological interventions for insomnia, such as Cognitive Behavioral Therapy for Insomnia (CBTI), have not been empirically examined for premenstural insomnia. CBTI is a brief, structured, skill-focused psychotherapy aimed at changing maladaptive cognitions (i.e. thoughts and beliefs) and behaviors contributing to insomnia. The weight of evidence supporting CBTI, summarized in several meta-analyses[35–37], led to its recognition as a first-line treatment for insomnia by the NIH Consensus Statement[38]. Improvements following CBTI are equivalent to those achieved during acute treatment with hypnotic medications[39,40] and its effects are more durable after treatment discontinuation[39]. Although efficacy has been demonstrated for adults with insomnia, it remains unclear if it is efficacious for women with PMS/PMDD and if special treatment considerations should be made (e.g., targeting other PMS symptoms such as menstrual pain[41] or using CBTI skills intermittently during late luteal phase of a women's menstrual cycle, as it is done to treat mood symptoms[42–44], when symptoms are likely to be the most problematic).

Pregnancy

Pregnancy brings about significant fluctuations in hormones that affect the sleep-wake cycle and cause physiologic changes that lead to sleep disturbance. In addition to the hormonal changes, pregnancy itself causes a multitude of anatomic and physiologic changes; which are essential to maintain the pregnancy, but can also contribute to sleep problems. Common physical symptoms, such as anxiety, urinary frequency, backache, fetal movement, general abdominal discomfort, breast tenderness, leg cramps, heart burn, and reflux cause sleep disturbance during pregnancy. Complaints of sleep disturbance during pregnancy generally start at the onset of pregnancy and increase in frequency and duration as the pregnancy progresses due to pregnancy-related anatomic, physiologic, and hormonal changes[45,46]. During the first trimester women tend to sleep longer and experience greater daytime

sleepiness. Cross sectional and longitudinal studies that use subjective (self-report) and objective (PSG) measures of sleep have consistently documented increased wake after sleep onset and decreased sleep quality during the first trimester relative to pre-pregnancy[47,48]. During the second trimester, daytime sleepiness improves. During the third trimester there is an increase in sleep disruptions with typically 3–5 awakenings per night, more daily naps[49], diminished daytime alertness, more disturbed dreams[50], and approximately 21% report disturbed sleep at levels consistent with a diagnosis of insomnia disorder[47,51]. Decreased sleep efficiency, increased wake after sleep onset, increased total sleep time (decreased by third trimester), increased stage 1 and 2 sleep, and decreased REM sleep (during late pregnancy) have been noted by PSG recordings[52–55]. Poor and insufficient sleep during pregnancy are also associated with increased circulating levels of inflammatory markers involved in poor health[56–60] and adverse pregnancy outcomes, including intrauterine growth restriction and preterm delivery[61–67]. During the third trimester of pregnancy, insufficient and poor sleep may place women at increased risk for prolonged labor and cesarean deliveries[6869,70] and for having an infant small for gestational age[71].

For most women, sleep disruptions are caused by factors related to pregnancy, such as frequent need for urination during pregnancy[51]. Some women, however, have difficulties initiating sleep and/or returning to sleep, which may be unrelated to perinatal factors. When sleep disturbances are substantial (occur for 3+ nights per week for a period of 3+ months) and are associated with clinically significant distress or impairment of performance or other aspects of functioning, a diagnosis of insomnia disorder diagnosis is warranted. The prevalence of sleep disturbance among perinatal women is as high as 58%[72–74], and a probable diagnosis of perinatal insomnia is estimated at 10%[75]. Daytime coping strategies such as napping, spending more time in bed, or increasing caffeine intake can perpetuate sleep difficulties. The presence of insomnia has a significant impact on quality of life and daytime functioning and its management is imperative.

Pharmacologic treatments, including sedative-hypnotics, benzodiazepines, and remelteon for insomnia during pregnancy are typically avoided because of the potential for adverse effects such as low birth weight, preterm deliveries, and cesarean sections in pregnancy[76,7778]. Over-the-counter antihistimines and herbal and nutritional substances may be associated with fewer risks, but there have been fewer studies of their safety in pregnant women and their use is not recommended[79].

Concerns regarding use of sleep medication during pregnancy and lactation make non-pharmacological treatment options for insomnia particularly attractive. Nonpharmalogical treatments such as CBTI should be the initial therapy. Current randomized clinical trials are under way to examine the efficacy and special considerations of CBTI during pregnancy. Additionally, studies of other nonpharmacological treatments options such as yoga[80,81], acupuncture[8283], yoga combined with mindfulness[84], and exercise[85] have been shown to be safe and effective treatments.

Postpartum

Sleep disturbance during the postpartum period and its effects on maternal role functioning and mother-infant interactions are not well understood. Both self-report and actigraphy studies have demonstrated that nearly 30% of mothers have disturbed sleep after the birth of their baby. The precipitous drop in hormone levels after the birth and unpredictable infant sleep patterns can affect a new mother's sleep. Longitudinal studies have documented that the first six months postpartum are associated with a significant increase in wake after sleep onset and a decrease in sleep efficiency compared to the last trimester of pregnancy[46,55,74,86,87]. Fatigue and lack of energy remain high from pregnancy into postpartum period through the first year after delivery. Sleep begins to normalize around 3–6 months postpartum, around the time when infants begin distinguishing between day and night and sleep for longer periods of time during the night. Other factors such as the mother's age, type of delivery, type of infant feeding, infant temperament, return-to-work issues, prior birth experience, number of other children at home, and availability of nighttime support from the partner or other family member can have an impact on quality and quantity of sleep in new mothers. Many women compensate for their sleep disruptions by spending more time napping during the early postpartum period[88].

Negative effects of poor and insufficient sleep have been observed during the postpartum period. Mothers with poorer sleep (lower self-reported sleep quality and a higher number of night waking resulting from infant awakenings) perceived their infants as having lower mood and as being more distressed and tearful[89]. Moreover, insufficient sleep and more time tending to the infant at night predicted poorer maternal-infant attachment. Several studies have documented the relationship between sleep disturbance and subsequent reports of depressive symptoms at a later time among perinatal women (later in pregnancy[9091,92] or in the early postpartum[91,9394–96]). The association between poor sleep and subsequent depressive symptoms also holds when sleep disturbance is experienced during the early postpartum period and postpartum depression develops at a later postpartum time[97,9899].

Interventions to improve maternal sleep and fatigue are limited, perhaps because of the universal nature of the experience and the belief that disturbed sleep is an unavoidable part of motherhood. In general, pharmacological interventions are seldom used in postpartum women who are breastfeeding. Even for women who are not breastfeeding, many choose not to take sedatives or other pharmacological options due to the need to have a more flexible sleep schedule for infant care. Therefore, behavioral interventions are the primary treatment options. Two pilot studies provide preliminary evidence for the efficacy of CBTI for postpartum insomnia and both studies demonstrated that the benefits of CBTI extended beyond improvement in sleep to other domains. One study provided five CBTI sessions, between the second and seventh postpartum weeks, to women who stopped smoking during pregnancy and found a significant decrease in time awake in the middle of the night and a significant increase in nocturnal (as well as per 24-hour) sleep time. Importantly, compared to women who did not receive the sleep intervention, those who did undergo CBTI had lower average daily cigarettes smoked and higher percent cigarette-free days[100]. The second study provided CBTI to women with postpartum depression who also had disturbed sleep and reported pre to post treatment improvement in insomnia severity, sleep quality, sleep

efficiency (% time asleep relative to time in bed), mood, and daytime fatigue[101]. Studies of other nonpharmacological treatments such as reflexology[102], massage,[103] and exercise[104] have shown these options to be safe alternative treatments for postpartum women.

Menopause

Menopause is a natural process that occurs in women's lives as part of normal aging. Menopause is defined as the cessation of menstruation due to degeneration of ovaries and follicles accompanied by changing ovarian hormone levels (estrogen and progesterone). The World Health Organization[105] characterizes menopause as the permanent cessation of menstrual periods that occurs naturally or is induced by surgery, chemotherapy, or radiation. More recently menopause has been categorized in stages such as menopausal transition (defined by standardized criteria[106] as variable cycle length seven days different from the normal cycle or >2 skipped cycles and an interval of amenorrhea of 2–12 months) or postmenopausal (defined as >12 months since last menstrual period). Menopause occurs between 50 and 52 years of age for Western women, but the range can vary based on race and ethnicity as well as lifestyle factors[107]. The worldwide population of 470 million postmenopausal women is expected to increase, as 1.5 million women enter menopause each year, reaching a total of 1.2 billion by the year 2030[105]. Most women now live long enough to become menopausal and can expect to live at least another 30 years beyond their final menstrual period.

Many women go through the menopausal transition with few or no symptoms, while a small percentage of women suffer from symptoms severe enough to interfere with their ability to function effectively at home, work, or school. Common complaints include hot flashes, night sweats, insomnia, mood changes, fatigue, and excessive daytime sleepiness. In the 2005 NIH State-of-the-Science Conference panel report on menopause-related symptoms, sleep disturbance was identified as a core symptom of menopause[108]. The prevalence of insomnia, defined as disturbed sleep associated with distress or impairment, is estimated at 38–60% in peri- and postmenopausal women[109–111]. Troubled sleep was reported by 54–58% of women between 40 and 60 years of age in the Ohio Midlife Women's study[112]. The Wisconsin Sleep Cohort found that perimenopausal women and postmenopausal women were twice as likely to be dissatisfied with their sleep as premenopausal women[113]. The Study of Women's Health Across the Nation (SWAN) has shown that difficulty sleeping is reported by 38% of women between 40 and 55 years of age, with higher levels among late perimenopausal (45.4%) and surgical postmenopausal (47.6%) women[110].

We are unable to find an estimate of prevalence on nocturnal hot flashes/night sweats; however, it is generally believed that hot flashes occur in 60 to 80% of women during the menopausal transition[114] and persist for 4 to 5 years on average[115,116]. When hot flashes occur during the night, they frequently awaken women from sleep; although not every nocturnal flash is associated with an awakening. Women with nocturnal flashes may also experience awakenings that are unrelated to a vasomotor event. Indeed, insomnia can occur during menopause independent of nocturnal flashes. Although self-reported nocturnal flashes correlate with poor subjective sleep quality, such association is less clear when objective sleep measures are used[113,117,118]. There is only limited and contradictory

evidence supporting an association between nocturnal flashes and sleep disturbance when both variables were measured objectively[113,117–123].

The most common pharmacological treatments for menopausal insomnia include hormone replacement therapy (HRT), hypnotics and sedatives, and antidepressants. HRT is the primary treatment for menopausal symptoms, particularly vasomotor symptoms. The efficacy of HRT for sleep and mood disturbances remains unclear, with some studies finding positive results[124–129] and others finding no benefit[130–132]. Hypnotics and sedatives such as Zalepon (Sonata), zolpidem (Ambien)[133], and eszopiclone (Lunesta)[128,134] have been shown to be effective in short-term use for acute, initial insomnia treatment in menopausal women. However, tolerance, withdrawal, dependence, and rebound depression at discontinuation may occur when drugs are used for longer than two weeks[135]. Another psychopharmacological option is ramelteon, a selective melatonin receptor agonist, which has shown some efficacy[136]. Antidepressant use has been effective in treating sleep disturbance in those with comorbid depression[137–140]. Using antidepressants to treat sleep disruption in those without major depression, however, is not recommended[141]. Herbal and dietary supplements such as black cohosh[142], omega-3[143], valerian[144], and isoflavens[145,146] have gained popularity for the treatment of menopausal symptoms; however few studies have examined their direct effect on insomnia symptoms.

Hormonal fluctuation and vasomotor symptoms such as night sweats may be the initial cause of insomnia symptoms, but physiological arousals, behavioral conditioning, and misguided coping attempts appear to prolong insomnia[147]. CBTI targets these behaviors and has been shown to be efficacious for the treatment of chronic insomnia in randomized trials of adults[40] and in older adults[148]. It may be beneficial for insomnia syndrome in menopausal women, however, to date, no randomized clinical trials have been conducted to examine efficacy of CBTI in menopausal women or special treatment considerations in this population. Preliminary data[149] do demonstrate promising results for using CBTI for sleep disruptions affected by menopause. Other nonpharmacological options such as acupuncture[150,151], mindfulness[152], reflexology[153], exercise[154], and yoga[155] have also shown some promise, however more evidence is needed to confirm their therapeutic benefits.

Conclusion

Sleep disturbances and disorders are common across a woman’s lifespan. Important biological events, often mediated by hormones and physiological changes, such as menstruation, pregnancy, and menopause commonly impact and often cause dissatisfaction with sleep. Given the fact that the negative impacts of poor sleep extend beyond tiredness and fatigue but also impair daytime functioning and mood, identification and treatment of these disorders is vital to a woman’s quality of life. Women looking to treat their sleep problems have many options from pharmacological help from drugs such as sedatives and hypnotics to HRT for those with menopause-related insomnia. Behavioral treatments such as CBTI offer longer-lasting improvements in sleep without the side-effects that are often accompanied by medications.

Despite advancing research in sleep and women's health, there are several areas that deserve more focused research. Recently, there has been an increased interest on the menstrual cycle's impact on the sleep cycle. While it is known that the hormones are linked to sleep and that the variability across the menstrual cycle causes changes in sleep quality, there are few studies that have explored treatment options in women with PMS and PMDD and significant sleep concerns. Additionally, though CBTI has been shown to be efficacious in treating chronic insomnia within various populations, including adult men and women and older adults, and among comorbid conditions like chronic pain and major depression, there is still a paucity of literature examining the efficacy of CBTI among women suffering from insomnia during times of reproductive change and special treatment considerations that may need to be taken into account. Future studies should include full-scale randomized trials of CBTI for women experiencing during the perinatal and perimenopausal periods. Treatment of sleep disturbances in women may have direct effects on quality of life as well as effects on mental and physical health.

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References

1. Akerstedt T, Knutsson A, Westerholm P, Theorell T, Alfredsson L, Kecklund G. Sleep disturbances, work stress and work hours: a cross-sectional study. J Psychosom Res. 2002 Sep; 53(3):741–748. [PubMed: 12217447]
2. Lindberg E, Janson C, Gislason T, Bjornsson E, Hetta J, Boman G. Sleep disturbances in a young adult population: can gender differences be explained by differences in psychological status? Sleep. 1997 Jun; 20(6):381–387. [PubMed: 9302720]
3. Jaussent I, Dauvilliers Y, Ancelin ML, et al. Insomnia symptoms in older adults: associated factors and gender differences. Am J Geriatr Psychiatry. 2011 Jan; 19(1):88–97. [PubMed: 20808113]
4. Singareddy R, Vgontzas AN, Fernandez-Mendoza J, et al. Risk factors for incident chronic insomnia: a general population prospective study. Sleep Med. 2012 Apr; 13(4):346–353. [PubMed: 22425576]
5. Baker FC, Wolfson AR, Lee KA. Association of sociodemographic, lifestyle, and health factors with sleep quality and daytime sleepiness in women: findings from the 2007 National Sleep Foundation "Sleep in America Poll". J Womens Health (Larchmt). 2009 Jun; 18(6):841–849. [PubMed: 19514826]
6. Ferguson KA, Ono T, Lowe AA, Ryan CF, Fleetham JA. The relationship between obesity and craniofacial structure in obstructive sleep apnea. Chest. 1995 Aug; 108(2):375–381. [PubMed: 7634870]
7. Carrier J, Land S, Buysse DJ, Kupfer DJ, Monk TH. The effects of age and gender on sleep EEG power spectral density in the middle years of life (ages 20–60 years old). Psychophysiology. 2001 Mar; 38(2):232–242. [PubMed: 11347869]
8. Bixler EO, Papaliaga MN, Vgontzas AN, et al. Women sleep objectively better than men and the sleep of young women is more resilient to external stressors: effects of age and menopause. J Sleep Res. 2009 Jun; 18(2):221–228. [PubMed: 19302341]
9. Jean-Louis G, Mendlowicz MV, Von Gizycki H, Zizi F, Nunes J. Assessment of physical activity and sleep by actigraphy: examination of gender differences. J Womens Health Gend Based Med. 1999 Oct; 8(8):1113–1117. [PubMed: 10565670]

10. Rediehs MH, Reis JS, Creason NS. Sleep in old age: focus on gender differences. Sleep. 1990 Oct; 13(5):410–424. [PubMed: 2287853]
11. Driver HS, Baker FC. Menstrual factors in sleep. Sleep Med Rev. 1998 Nov; 2(4):213–229. [PubMed: 15310493]
12. Halbreich U, Borenstein J, Pearlstein T, Kahn LS. The prevalence, impairment, impact, and burden of premenstrual dysphoric disorder (PMS/PMDD). Psychoneuroendocrinology. 2003 Aug; 28(Suppl 3):1–23.
13. Halbreich U, Backstrom T, Eriksson E, et al. Clinical diagnostic criteria for premenstrual syndrome and guidelines for their quantification for research studies. Gynecological endocrinology : the official journal of the International Society of Gynecological Endocrinology. 2007 Mar; 23(3):123–130. [PubMed: 17454164]
14. Baker FC, Driver HS. Self-reported sleep across the menstrual cycle in young, healthy women. J Psychosom Res. 2004 Feb; 56(2):239–243. [PubMed: 15016584]
15. Cohen LS, Soares CN, Otto MW, Sweeney BH, Liberman RF, Harlow BL. Prevalence predictors of premenstrual dysphoric disorder (PMDD) in older premenopausal women. The Harvard Study of Moods and Cycles. J Affect Disord. 2002 Jul; 70(2):125–132. [PubMed: 12117624]
16. Hachul H, Andersen ML, Bittencourt LR, Santos-Silva R, Conway SG, Tufik S. Does the reproductive cycle influence sleep patterns in women with sleep complaints? Climacteric. 2010 Dec; 13(6):594–603. [PubMed: 20001564]
17. Lamarche LJ, Driver HS, Wiebe S, Crawford L, JM DEK. Nocturnal sleep, daytime sleepiness, and napping among women with significant emotional/behavioral premenstrual symptoms. J Sleep Res. 2007 Sep; 16(3):262–268. [PubMed: 17716275]
18. Smith MJ, Schmidt PJ, Rubinow DR. Operationalizing DSM-IV criteria for PMDD: selecting symptomatic and asymptomatic cycles for research. J Psychiatr Res. 2003 Jan-Feb;37(1):75–83. [PubMed: 12482472]
19. Woosley JA, Lichstein KL. Dysmenorrhea, the menstrual cycle, and sleep. Behavioral medicine (Washington, D.C.). 2014; 40(1):14–21.
20. Lee KA, Baker FC, Newton KM, Ancoli-Israel S. The Influence of reproductive status and age on women's sleep. J Womens Health (Larchmt). 2008 Sep; 17(7):1209–1214. [PubMed: 18774898]
21. Moline ML, Broch L, Zak R. Sleep in women across the life cycle from adulthood through menopause. The Medical clinics of North America. 2004 May; 88(3):705–736. ix. [PubMed: 15087212]
22. Baker FC, Kahan TL, Trinder J, Colrain IM. Sleep quality and the seep electroencephalogram in women with severe premenstrual syndrome. Sleep. 2007; 30(10):1283–1291. [PubMed: 17969462]
23. Baker FC, Sassoon SA, Kahan T, et al. Perceived poor sleep quality in the absence of polysomnographic sleep disturbance in women with severe premenstrual syndrome. J Sleep Res. 2012 Oct; 21(5):535–545. [PubMed: 22417163]
24. Parry BL, Mostofi N, LeVeau B, et al. Sleep EEG studies during early and late partial sleep deprivation in premenstrual dysphoric disorder and normal control subjects. Psychiatry Res. 1999 Feb 22; 85(2):127–143. [PubMed: 10220004]
25. Zheng H, Harlow SD, Kravitz HM, et al. Actigraphy-defined measures of sleep and movement across the menstrual cycle in midlife menstruating women: Study of Women's Health Across the Nation Sleep Study. Menopause. 2014 May.19
26. Sharkey KM, Crawford SL, Kim S, Joffe H. Objective sleep interruption and reproductive hormone dynamics in the menstrual cycle. Sleep Med. 2014 Jun; 15(6):688–693. [PubMed: 24841109]
27. Altshuler LL, Hendrick V, Parry B. Pharmacological management of premenstrual disorder. Harv Rev Psychiatry. 1995 Jan-Feb;2(5):233–245. [PubMed: 9384908]
28. Menkes DB, Taghavi E, Mason PA, Spears GF, Howard RC. Fluoxetine treatment of severe premenstrual syndrome. Bmj. 1992 Aug 8; 305(6849):346–347. [PubMed: 1392887]
29. Steiner M, Steinberg S, Stewart D, et al. Fluoxetine in the treatment of premenstrual dysphoria. Canadian Fluoxetine/Premenstrual Dysphoria Collaborative Study Group. N Engl J Med. 1995 Jun 8; 332(23):1529–1534. [PubMed: 7739706]

30. Stone AB, Pearlstein TB, Brown WA. Fluoxetine in the treatment of late luteal phase dysphoric disorder. J Clin Psychiatry. 1991 Jul; 52(7):290–293. [PubMed: 2071558]
31. Wood SH, Mortola JF, Chan YF, Moossazadeh F, Yen SS. Treatment of premenstrual syndrome with fluoxetine: a double-blind, placebo-controlled, crossover study. Obstet Gynecol. 1992 Sep; 80(3 Pt 1):339–344. [PubMed: 1495689]
32. Yonkers KA, Halbreich U, Freeman E, et al. Symptomatic improvement of premenstrual dysphoric disorder with sertraline treatment. A randomized controlled trial. Sertraline Premenstrual Dysphoric Collaborative Study Group. Jama. 1997 Sep 24; 278(12):983–988. [PubMed: 9307345]
33. Sundblad C, Modigh K, Andersch B, Eriksson E. Clomipramine effectively reduces premenstrual irritability and dysphoria: a placebo-controlled trial. Acta Psychiatr Scand. 1992 Jan; 85(1):39–47. [PubMed: 1546547]
34. Sundblad C, Hedberg MA, Eriksson E. Clomipramine administered during the luteal phase reduces the symptoms of premenstrual syndrome: a placebo-controlled trial. Neuropsychopharmacology. 1993 Sep; 9(2):133–145. [PubMed: 8216696]
35. Morin CM, Culbert JP, Schwartz SM. Nonpharmacological interventions for insomnia: a meta-analysis of treatment efficacy. Am J Psychiatry. 1994 Aug; 151(8):1172–1180. [PubMed: 8037252]
36. Murtagh DR, Greenwood KM. Identifying effective psychological treatments for insomnia: a meta-analysis. J Consult Clin Psychol. 1995 Feb; 63(1):79–89. [PubMed: 7896994]
37. Smith MT, Perlis ML, Park A, et al. Comparative meta-analysis of pharmacotherapy and behavior therapy for persistent insomnia. Am J Psychiatry. 2002 Jan; 159(1):5–11. [PubMed: 11772681]
38. NIH. National Institutes of Health State of the Science Conference statement on Manifestations and Management of Chronic Insomnia in Adults. Jun 13–15.2005 Sleep. 2005 Sep; 28(9):1049–1057. [PubMed: 16268373]
39. Morin CM, Colecchi C, Stone J, Sood R, Brink D. Behavioral and pharmacological therapies for late-life insomnia: a randomized controlled trial. Jama. 1999 Mar 17; 281(11):991–999. [PubMed: 10086433]
40. Edinger JD, Wohlgemuth WK, Radtke RA, Marsh GR, Quillian RE. Cognitive behavioral therapy for treatment of chronic primary insomnia: a randomized controlled trial. Jama. 2001 Apr 11; 285(14):1856–1864. [PubMed: 11308399]
41. Araujo P, Hachul H, Santos-Silva R, Bittencourt LR, Tufik S, Andersen ML. Sleep pattern in women with menstrual pain. Sleep Med. 2011 Dec; 12(10):1028–1030. [PubMed: 22030206]
42. Freeman EW, Rickels K, Sondheimer SJ, Polansky M, Xiao S. Continuous or intermittent dosing with sertraline for patients with severe premenstrual syndrome or premenstrual dysphoric disorder. Am J Psychiatry. 2004 Feb; 161(2):343–351. [PubMed: 14754784]
43. Halbreich U, Bergeron R, Yonkers KA, Freeman E, Stout AL, Cohen L. Efficacy of intermittent, luteal phase sertraline treatment of premenstrual dysphoric disorder. Obstet Gynecol. 2002 Dec; 100(6):1219–1229. [PubMed: 12468166]
44. Kornstein SG, Pearlstein TB, Fayyad R, Farfel GM, Gillespie JA. Low-dose sertraline in the treatment of moderate-to-severe premenstrual syndrome: efficacy of 3 dosing strategies. J Clin Psychiatry. 2006 Oct; 67(10):1624–1632. [PubMed: 17107257]
45. Little SE, McNamara CJ, Miller RC. Sleep changes in normal pregnancy. Obstet Gynecol. 2014 May.123(Suppl 1):153S. [PubMed: 24770043]
46. Hertz G, Fast A, Feinsilver SH, Albertario CL, Schulman H, Fein AM. Sleep in normal late pregnancy. Sleep. 1992 Jun; 15(3):246–251. [PubMed: 1621025]
47. Hedman C, Pohjasvaara T, Tolonen U, Suhonen-Malm AS, Myllyla VV. Effects of pregnancy on mothers' sleep. Sleep Med. 2002 Jan; 3(1):37–42. [PubMed: 14592252]
48. Santiago JR, Nolledo MS, Kinzler W, Santiago TV. Sleep and sleep disorders in pregnancy. Ann Intern Med. 2001 Mar 6; 134(5):396–408. [PubMed: 11242500]
49. Tsai SY, Lin JW, Kuo LT, Thomas KA. Daily sleep and fatigue characteristics in nulliparous women during the third trimester of pregnancy. Sleep. 2012 Feb; 35(2):257–262. [PubMed: 22294816]

50. Lara-Carrasco J, Simard V, Saint-Onge K, Lamoureux-Tremblay V, Nielsen T. Disturbed dreaming during the third trimester of pregnancy. Sleep Med. 2014 Jun; 15(6):694–700. [PubMed: 24780135]
51. Baratte-Beebe KR, Lee K. Sources of midsleep awakenings in childbearing women. Clinical nursing research. 1999 Nov; 8(4):386–397. [PubMed: 10855105]
52. Kizilirmak A, Timur S, Kartal B. Insomnia in pregnancy and factors related to insomnia. The Scientific World Journal. 2012; 2012:197093.
53. Driver HS, Shapiro CM. A longitudinal study of sleep stages in young women during pregnancy and postpartum. Sleep. 1992 Oct; 15(5):449–453. [PubMed: 1455129]
54. Pien GW, Schwab RJ. Sleep disorders during pregnancy. Sleep. 2004 Nov 1; 27(7):1405–1417. [PubMed: 15586794]
55. Lee KA, Zaffke ME, McEnany G. Parity and sleep patterns during and after pregnancy. Obstet Gynecol. 2000 Jan; 95(1):14–18. [PubMed: 10636494]
56. von Kanel R, Dimsdale JE, Ancoli-Israel S, et al. Poor sleep is associated with higher plasma proinflammatory cytokine interleukin-6 and procoagulant marker fibrin D-dimer in older caregivers of people with Alzheimer's disease. J Am Geriatr Soc. 2006 Mar; 54(3):431–437. [PubMed: 16551309]
57. Vgontzas AN, Zoumakis E, Bixler EO, et al. Adverse effects of modest sleep restriction on sleepiness, performance, and inflammatory cytokines. J Clin Endocrinol Metab. 2004 May; 89(5): 2119–2126. [PubMed: 15126529]
58. McDade TW, Hawkley LC, Cacioppo JT. Psychosocial and behavioral predictors of inflammation in middle-aged and older adults: the Chicago health, aging, and social relations study. Psychosom Med. 2006 May-Jun;68(3):376–381. [PubMed: 16738067]
59. Meier-Ewert HK, Ridker PM, Rifai N, et al. Effect of sleep loss on C-reactive protein, an inflammatory marker of cardiovascular risk. J Am Coll Cardiol. 2004 Feb 18; 43(4):678–683. [PubMed: 14975482]
60. Irwin MR, Wang M, Campomayor CO, Collado-Hidalgo A, Cole S. Sleep deprivation and activation of morning levels of cellular and genomic markers of inflammation. Arch Intern Med. 2006 Sep 18; 166(16):1756–1762. [PubMed: 16983055]
61. Dudley, D. Cytokines in preterm and term parturition. In: Hill, J., editor. Cytokines in Human Reproduction. New York, NY: John Wiley & Sons, Inc; 2000. p. 171-202.
62. Holst RM, Mattsby-Baltzer I, Wennerholm UB, Hagberg H, Jacobsson B. Interleukin-6 and interleukin-8 in cervical fluid in a population of Swedish women in preterm labor: relationship to microbial invasion of the amniotic fluid, intra-amniotic inflammation, and preterm delivery. Acta Obstet Gynecol Scand. 2005 Jun; 84(6):551–557. [PubMed: 15901266]
63. Menon R, Merialdi M, Lombardi SJ, Fortunato SJ. Differences in the placental membrane cytokine response: a possible explanation for the racial disparity in preterm birth. Am J Reprod Immunol. 2006 Aug; 56(2):112–118. [PubMed: 16836613]
64. Vogel I, Thorsen P, Curry A, Sandager P, Uldbjerg N. Biomarkers for the prediction of preterm delivery. Acta Obstet Gynecol Scand. 2005 Jun; 84(6):516–525. [PubMed: 15901257]
65. Bartha JL, Romero-Carmona R, Comino-Delgado R. Inflammatory cytokines in intrauterine growth retardation. Acta Obstet Gynecol Scand. 2003 Dec; 82(12):1099–1102. [PubMed: 14616253]
66. Holcberg G, Huleihel M, Sapir O, et al. Increased production of tumor necrosis factor-alpha TNF-alpha by IUGR human placentae. Eur J Obstet Gynecol Reprod Biol. 2001 Jan; 94(1):69–72. [PubMed: 11134828]
67. Romero R, Espinoza J, Goncalves LF, Kusanovic JP, Friel LA, Nien JK. Inflammation in preterm and term labour and delivery. Semin Fetal Neonatal Med. 2006 Oct; 11(5):317–326. [PubMed: 16839830]
68. Lee KA, Gay CL. Sleep in late pregnancy predicts length of labor and type of delivery. Am J Obstet Gynecol. 2004 Dec; 191(6):2041–2046. [PubMed: 15592289]
69. Okun ML, Roberts JM, Marsland AL, Hall M. How disturbed sleep may be a risk factor for adverse pregnancy outcomes. Obstetrical & gynecological survey. 2009 Apr; 64(4):273–280. [PubMed: 19296861]

70. Okun ML, Luther JF, Wisniewski SR, Sit D, Prairie BA, Wisner KL. Disturbed sleep, a novel risk factor for preterm birth? J Womens Health (Larchmt). 2012 Jan; 21(1):54–60. [PubMed: 21967121]
71. Chang J, Chien L, Duntley S, Pien G. Sleep duration during pregnancy and maternal and fetal outcomes: a pilot study using actigraphy. Sleep. 2011; 34(A317)
72. Dorheim SK, Bondevik GT, Eberhard-Gran M, Bjorvatn B. Sleep and depression in postpartum women: a population-based study. Sleep. 2009 Jul; 32(7):847–855. [PubMed: 19639747]
73. Swanson LM, Pickett SM, Flynn H, Armitage R. Relationships among depression, anxiety, and insomnia symptoms in perinatal women seeking mental health treatment. J Womens Health (Larchmt). Apr; 20(4):553–558. [PubMed: 21417746]
74. Mindell JA, Jacobson BJ. Sleep disturbances during pregnancy. J Obstet Gynecol Neonatal Nurs. 2000 Nov-Dec;29(6):590–597.
75. Manber R, Steidtmann D, Chambers AS, Ganger W, Horwitz S, Connelly CD. Factors associated with clinically significant insomnia among pregnant low-income Latinas. J Womens Health (Larchmt). 2013 Aug; 22(8):694–701. [PubMed: 23863074]
76. Wang LH, Lin HC, Lin CC, Chen YH, Lin HC. Increased risk of adverse pregnancy outcomes in women receiving zolpidem during pregnancy. Clinical pharmacology and therapeutics. 2010 Sep; 88(3):369–374. [PubMed: 20686480]
77. Ibrahim S, Foldvary-Schaefer N. Sleep disorders in pregnancy: implications, evaluation, and treatment. Neurologic clinics. 2012 Aug; 30(3):925–936. [PubMed: 22840797]
78. Zammit G. Comparative tolerability of newer agents for insomnia. Drug. safety : an international journal of medical toxicology and drug experience. 2009; 32(9):735–748.
79. Schutte-Rodin S, Broch L, Buysse D, Dorsey C, Sateia M. Clinical guideline for the evaluation and management of chronic insomnia in adults. J Clin Sleep Med. 2008 Oct 15; 4(5):487–504. [PubMed: 18853708]
80. Field T, Diego M, Delgado J, Medina L. Tai chi/yoga reduces prenatal depression, anxiety and sleep disturbances. Complementary therapies in clinical practice. 2013 Feb; 19(1):6–10. [PubMed: 23337557]
81. Field T, Diego M, Hernandez-Reif M, Figueiredo B, Schanberg S, Kuhn C. Sleep disturbances in depressed pregnant women and their newborns. Infant behavior & development. 2007 Feb; 30(1): 127–133. [PubMed: 17292785]
82. da Silva JB, Nakamura MU, Cordeiro JA, Kulay LJ. Acupuncture for insomnia in pregnancy--a prospective, quasi-randomised, controlled study. Acupuncture in medicine : journal of the British Medical Acupuncture Society. 2005 Jun; 23(2):47–51. [PubMed: 16025784]
83. Manber R, Schnyer RN, Lyell D, et al. Acupuncture for depression during pregnancy: a randomized controlled trial. Obstet Gynecol. 2010 Mar; 115(3):511–520. [PubMed: 20177281]
84. Beddoe AE, Lee KA, Weiss SJ, Kennedy HP, Yang CP. Effects of mindful yoga on sleep in pregnant women: a pilot study. Biological research for nursing. 2010 Apr; 11(4):363–370. [PubMed: 20338897]
85. Miller EH. Women and insomnia. Clin Cornerstone. 2004; 6(Suppl 1B):S8–S18. [PubMed: 15457811]
86. Montgomery-Downs HE, Insana SP, Clegg-Kraynok MM, Mancini LM. Normative longitudinal maternal sleep: the first 4 postpartum months. Am J Obstet Gynecol. 2010 Nov; 203(5):465, e461–e467. [PubMed: 20719289]
87. Brunner DP, Munch M, Biedermann K, Huch R, Huch A, Borbely AA. Changes in sleep and sleep electroencephalogram during pregnancy. Sleep. 1994 Oct; 17(7):576–582. [PubMed: 7846455]
88. Swain AM, O'Hara MW, Starr KR, Gorman LL. A prospective study of sleep, mood, and cognitive function in postpartum and nonpostpartum women. Obstet Gynecol. 1997 Sep; 90(3): 381–386. [PubMed: 9277648]
89. Tikotzky L, Chambers AS, Gaylor E, Manber R. Maternal sleep and depressive symptoms: links with infant Negative Affectivity. Infant Behav Dev. 2010 Dec; 33(4):605–612. [PubMed: 20723998]

90. Skouteris H, Germano C, Wertheim EH, Paxton SJ, Milgrom J. Sleep quality and depression during pregnancy: a prospective study. J Sleep Res. 2008 Jun; 17(2):217–220. [PubMed: 18482110]

91. Park EM, Meltzer-Brody S, Stickgold R. Poor sleep maintenance and subjective sleep quality are associated with postpartum maternal depression symptom severity. Arch Womens Ment Health. 2013 Dec; 16(6):539–547. [PubMed: 23733081]

92. Kamysheva E, Skouteris H, Wertheim EH, Paxton SJ, Milgrom J. A prospective investigation of the relationships among sleep quality, physical symptoms, and depressive symptoms during pregnancy. J Affect Disord. 2010 Jun; 123(1–3):317–320. [PubMed: 19822370]

93. Dorheim SK, Bjorvatn B, Eberhard-Gran M. Can insomnia in pregnancy predict postpartum depression? A longitudinal, population-based study. PloS one. 2014; 9(4):e94674. [PubMed: 24732691]

94. Wolfson AR, Crowley SJ, Anwer U, Bassett JL. Changes in sleep patterns and depressive symptoms in first-time mothers: last trimester to 1-year postpartum. Behav Sleep Med. 2003; 1(1): 54–67. [PubMed: 15600137]

95. Bei B, Milgrom J, Ericksen J, Trinder J. Subjective perception of sleep, but not its objective quality, is associated with immediate postpartum mood disturbances in healthy women. Sleep. 2010 Apr; 33(4):531–538. [PubMed: 20394323]

96. Wilkie G, Shapiro CM. Sleep deprivation and the postnatal blues. J Psychosom Res. 1992 May; 36(4):309–316. [PubMed: 1593506]

97. Doering J, Szabo A. Sleep quality and depression symptoms in disadvantaged postpartum women. Sleep. 2011; 34:A319.

98. Okun ML, Luther J, Prather AA, Perel JM, Wisniewski S, Wisner KL. Changes in sleep quality, but not hormones predict time to postpartum depression recurrence. J Affect Disord. May; 130(3): 378–384. [PubMed: 20708275]

99. Tsai SY, Thomas KA. Sleep disturbances and depressive symptoms in healthy postpartum women: a pilot study. Res Nurs Health. 2012 Jun; 35(3):314–323. [PubMed: 22431157]

100. Stone K. Effects of a behavioral sleep intervention on postpartum sleep. Sleep. 2011; 34:A320.

101. Swanson L, Arnedt J, Adams J, Armitage R, Flynn H. An open pilot of cognitive behavioral therapy for insomnia in women with postpartum depression. Sleep. 2011; 34:A319.

102. Li CY, Chen SC, Li CY, Gau ML, Huang CM. Randomised controlled trial of the effectiveness of using foot reflexology to improve quality of sleep amongst Taiwanese postpartum women. Midwifery. 2011 Apr; 27(2):181–186. [PubMed: 19577829]

103. Ko YL, Lee HJ. Randomised controlled trial of the effectiveness of using back massage to improve sleep quality among Taiwanese insomnia postpartumwomen. Midwifery. 2014 Jan; 30(1):60–64. [PubMed: 23410501]

104. Ashrafinia F, Mirmohammadali M, Rajabi H, et al. The effects of Pilates exercise on sleep quality in postpartum women. Journal of bodywork and movement therapies. 2014 Apr; 18(2):190–199. [PubMed: 24725785]

105. WHO. Research on the menopause in the 1990s. 1996

106. Soules MR, Sherman S, Parrott E, et al. Executive summary: Stages of Reproductive Aging Workshop (STRAW). Climacteric. 2001 Dec; 4(4):267–272. [PubMed: 11770182]

107. Gold EB. The timing of the age at which natural menopause occurs. Obstet Gynecol Clin North Am. 2011 Sep; 38(3):425–440. [PubMed: 21961711]

108. NIH. National Institutes of Health State-of-the-Science Conference statement: management of menopause-related symptoms. Ann Intern Med. 2005 Jun 21; 142(12 Pt 1):1003–1013. [PubMed: 15968015]

109. Kravitz HM, Ganz PA, Bromberger J, Powell LH, Sutton-Tyrrell K, Meyer PM. Sleep difficulty in women at midlife: a community survey of sleep and the menopausal transition. Menopause. 2003 Jan-Feb;10(1):19–28. [PubMed: 12544673]

110. Kravitz HM, Zhao X, Bromberger JT, et al. Sleep disturbance during the menopausal transition in a multi-ethnic community sample of women. Sleep. 2008 Jul; 31(7):979–990. [PubMed: 18652093]

111. NIH. State-of-the Science Conference statement. Management of menopause-related symptoms. Ann Intern Med. 2005; 142(12):1003–1013. [PubMed: 15968015]
112. Glazer G, Zeller R, Delumba L, et al. The Ohio Midlife Women's Study. Health Care Women Int. 2002 Sep-Nov;23(6–7):612–630. [PubMed: 12418983]
113. Young T, Rabago D, Zgierska A, Austin D, Laurel F. Objective and subjective sleep quality in premenopausal, perimenopausal, and postmenopausal women in the Wisconsin Sleep Cohort Study. Sleep. 2003 Sep 15; 26(6):667–672. [PubMed: 14572118]
114. Gold EB, Sternfeld B, Kelsey JL, et al. Relation of demographic and lifestyle factors to symptoms in a multi-racial/ethnic population of women 40–55 years of age. Am J Epidemiol. 2000 Sep 1; 152(5):463–473. [PubMed: 10981461]
115. Col NF, Guthrie JR, Politi M, Dennerstein L. Duration of vasomotor symptoms in middle-aged women: a longitudinal study. Menopause. 2009 May-Jun;16(3):453–457. [PubMed: 19188852]
116. Politi MC, Schleinitz MD, Col NF. Revisiting the duration of vasomotor symptoms of menopause: a meta-analysis. J Gen Intern Med. 2008 Sep; 23(9):1507–1513. [PubMed: 18521690]
117. Shaver J, Giblin E, Lentz M, Lee K. Sleep patterns and stability in perimenopausal women. Sleep. 1988 Dec; 11(6):556–561. [PubMed: 3148991]
118. Ensrud KE, Stone KL, Blackwell TL, et al. Frequency and severity of hot flashes and sleep disturbance in postmenopausal women with hot flashes. Menopause. 2009 Mar-Apr;16(2):286–292. [PubMed: 19002015]
119. Savard J, Davidson JR, Ivers H, et al. The association between nocturnal hot flashes and sleep in breast cancer survivors. J Pain Symptom Manage. 2004 Jun; 27(6):513–522. [PubMed: 15165649]
120. Freedman RR, Roehrs TA. Lack of sleep disturbance from menopausal hot flashes. Fertil Steril. 2004 Jul; 82(1):138–144. [PubMed: 15237002]
121. Erlik Y, Tataryn IV, Meldrum DR, Lomax P, Bajorek JG, Judd HL. Association of waking episodes with menopausal hot flushes. Jama. 1981 May 1; 245(17):1741–1744. [PubMed: 7218488]
122. Freedman RR, Benton MD, Genik RJ 2nd, Graydon FX. Cortical activation during menopausal hot flashes. Fertil Steril. 2006 Mar; 85(3):674–678. [PubMed: 16500337]
123. Woodward S, Freedman RR. The thermoregulatory effects of menopausal hot flashes on sleep. Sleep. 1994 Sep; 17(6):497–501. [PubMed: 7809562]
124. Blum M, Zacharovitch D, Pery J, Gilerowitch M. Estrogen replacement therapy (ERT) by a special regimen in the years following menopause. Clin Exp Obstet Gynecol. 1989; 16(1):9–11. [PubMed: 2713995]
125. Terauchi M, Obayashi S, Akiyoshi M, Kato K, Matsushima E, Kubota T. Insomnia in Japanese peri- and postmenopausal women. Climacteric. 2010 Oct; 13(5):479–486. [PubMed: 19886814]
126. Schiff I, Regestein Q, Tulchinsky D, Ryan KJ. Effects of estrogens on sleep and psychological state of hypogonadal women. Jama. 1979 Nov 30; 242(22):2405–2404. [PubMed: 226735]
127. Scharf MB, McDannold MD, Stover R, Zaretsky N, Berkowitz DV. Effects of estrogen replacement therapy on rates of cyclic alternating patterns and hot-flush events during sleep in postmenopausal women: a pilot study. Clin Ther. 1997 Mar-Apr;19(2):304–311. [PubMed: 9152569]
128. Joffe H, Petrillo L, Viguera A, et al. Eszopiclone improves insomnia and depressive and anxious symptoms in perimenopausal and postmenopausal women with hot flashes: a randomized, double-blinded, placebo-controlled crossover trial. Am J Obstet Gynecol. 2010 Feb; 202(2):171, e171–e171, e111. [PubMed: 20035910]
129. Schussler P, Kluge M, Yassouridis A, et al. Progesterone reduces wakefulness in sleep EEG and has no effect on cognition in healthy postmenopausal women. Psychoneuroendocrinology. 2008 Sep; 33(8):1124–1131. [PubMed: 18676087]
130. Bliwise NG. Factors related to sleep quality in healthy elderly women. Psychology and aging. 1992 Mar; 7(1):83–88. [PubMed: 1558709]

131. Pickett CK, Regensteiner JG, Woodard WD, Hagerman DD, Weil JV, Moore LG. Progestin and estrogen reduce sleep-disordered breathing in postmenopausal women. Journal of applied physiology (Bethesda, Md.: 1985). 1989 Apr; 66(4):1656–1661.

132. Hachul H, Bittencourt LR, Andersen ML, Haidar MA, Baracat EC, Tufik S. Effects of hormone therapy with estrogen and/or progesterone on sleep pattern in postmenopausal women. Int J Gynaecol Obstet. 2008 Dec; 103(3):207–212. [PubMed: 18812241]

133. Dorsey CM, Lee KA, Scharf MB. Effect of zolpidem on sleep in women with perimenopausal and postmenopausal insomnia: a 4-week, randomized, multicenter, double-blind, placebo-controlled study. Clin Ther. 2004 Oct; 26(10):1578–1586. [PubMed: 15598474]

134. Soares CN, Joffe H, Rubens R, Caron J, Roth T, Cohen L. Eszopiclone in patients with insomnia during perimenopause and early postmenopause: a randomized controlled trial. Obstet Gynecol. 2006 Dec; 108(6):1402–1410. [PubMed: 17138773]

135. Voshaar RC, van Balkom AJ, Zitman FG. Zolpidem is not superior to temazepam with respect to rebound insomnia: a controlled study. Eur Neuropsychopharmacol. 2004 Aug; 14(4):301–306. [PubMed: 15163440]

136. Dobkin RD, Menza M, Bienfait KL, Allen LA, Marin H, Gara MA. Ramelteon for the treatment of insomnia in menopausal women. Menopause international. 2009 Mar; 15(1):13–18. [PubMed: 19237617]

137. Zanardi R, Rossini D, Magri L, Malaguti A, Colombo C, Smeraldi E. Response to SSRIs and role of the hormonal therapy in post-menopausal depression. Eur Neuropsychopharmacol. 2007 May-Jun;17(6–7):400–405. [PubMed: 17196795]

138. Soares CN, Arsenio H, Joffe H, et al. Escitalopram versus ethinyl estradiol and norethindrone acetate for symptomatic peri- and postmenopausal women: impact on depression, vasomotor symptoms, sleep, and quality of life. Menopause. 2006 Sep-Oct;13(5):780–786. [PubMed: 16894334]

139. Joffe H, Soares CN, Petrillo LF, et al. Treatment of depression and menopause-related symptoms with the serotonin-norepinephrine reuptake inhibitor duloxetine. J Clin Psychiatry. 2007 Jun; 68(6):943–950. [PubMed: 17592922]

140. Archer DF, Seidman L, Constantine GD, Pickar JH, Olivier S. A double-blind, randomly assigned, placebo-controlled study of desvenlafaxine efficacy and safety for the treatment of vasomotor symptoms associated with menopause. Am J Obstet Gynecol. 2009 Feb; 200(2):172, e171–e110. [PubMed: 19110224]

141. Nowakowski S, Meliska CJ, Martinez LF, Parry BL. Sleep and menopause. Curr Neurol Neurosci Rep. 2009 Mar; 9(2):165–172. [PubMed: 19268040]

142. Vermes G, Banhidy F, Acs N. The effects of remifemin on subjective symptoms of menopause. Advances in therapy. 2005 Mar-Apr;22(2):148–154. [PubMed: 16020404]

143. Cohen LS, Joffe H, Guthrie KA, et al. Efficacy of omega-3 for vasomotor symptoms treatment: a randomized controlled trial. Menopause. 2014 Apr; 21(4):347–354. [PubMed: 23982113]

144. Taavoni S, Nazem Ekbatani N, Haghani H. Valerian/lemon balm use for sleep disorders during menopause. Complementary therapies in clinical practice. 2013 Nov; 19(4):193–196. [PubMed: 24199972]

145. Agosta C, Atlante M, Benvenuti C. Randomized controlled study on clinical efficacy of isoflavones plus Lactobacillus sporogenes, associated or not with a natural anxiolytic agent in menopause. Minerva ginecologica. 2011 Feb; 63(1):11–17. [PubMed: 21311416]

146. Hachul H, Brandao LC, D'Almeida V, Bittencourt LR, Baracat EC, Tufik S. Isoflavones decrease insomnia in postmenopause. Menopause. 2011 Feb; 18(2):178–184. [PubMed: 20729765]

147. Krystal AD, Edinger J, Wohlgemuth W, Marsh GR. Sleep in peri-menopausal and post-menopausal women. Sleep Med Rev. 1998 Nov; 2(4):243–253. [PubMed: 15310495]

148. Sivertsen B, Omvik S, Pallesen S, et al. Cognitive behavioral therapy vs zopiclone for treatment of chronic primary insomnia in older adults: a randomized controlled trial. Jama. 2006 Jun 28; 295(24):2851–2858. [PubMed: 16804151]

149. Nowakowski S, Dowdle CL, Suh S, Siebern A, Manber R. Examination of cognitive behavioral therapy for insomnia in perimenopausal women. Sleep. 2012; 35(Supp):A243.

150. Borud EK, Alraek T, White A, et al. The Acupuncture on Hot Flushes Among Menopausal Women (ACUFLASH) study, a randomized controlled trial. Menopause. 2009 May-Jun;16(3): 484–493. [PubMed: 19423996]

151. Huang MI, Nir Y, Chen B, Schnyer R, Manber R. A randomized controlled pilot study of acupuncture for postmenopausal hot flashes: effect on nocturnal hot flashes and sleep quality. Fertil Steril. 2006 Sep; 86(3):700–710. [PubMed: 16952511]

152. Carmody JF, Crawford S, Salmoirago-Blotcher E, Leung K, Churchill L, Olendzki N. Mindfulness training for coping with hot flashes: results of a randomized trial. Menopause. 2011 Jun; 18(6):611–620. [PubMed: 21372745]

153. Asltoghiri M, Ghodsi Z. The effects of Reflexology on sleep disorder in menopausal women. Procedia - Social and Behavioral Sciences. 2012; 31(0):242–246.

154. Mansikkamaki K, Raitanen J, Nygard CH, et al. Sleep quality and aerobic training among menopausal women--a randomized controlled trial. Maturitas. 2012 Aug; 72(4):339–345. [PubMed: 22673453]

155. Afonso RF, Hachul H, Kozasa EH, et al. Yoga decreases insomnia in postmenopausal women: a randomized clinical trial. Menopause. 2012 Feb; 19(2):186–193. [PubMed: 22048261]

Table 1

Menses and Sleep

Study author	Study of	Population	Group design and sample size	Study length/ Assessment points	Attrition rates	Follow up	Outcome measure	Results
Intervention Studies								
Freeman et al. (2004)	Continuous vs. Intermittent Sertraline Treatment	Women with severe PMS	Randomized, double-blind; Continuous (n=56) Intermittent (luteal phase) (n=56) Placebo (n=55)	3 months	29%	No	Daily Symptom Rating Form, & Patient Global Ratings of Functioning	Intermittent dosing does not differ from continuous. Both sertraline groups improved significantly.
Halbreich et al. (2002)	Luteal Phase Sertraline Treatment for PMDD	Women with PMDD	Randomized, ouble-blind; Luteal Phase 50–100 mg (n=142) Placebo (n=139)	3 cycles	21%	No	Clinical Global Impression Severity & Improvement (CGI), DRSP	Intermittent luteal-phase sertraline is effective and well tolerated.
Kornstein et al. (2006)	Sertraline for PMS	Women with PMS	Randomized, Single Blind; Sertraline 25 mg (n=98) Sertraline 50 mg (n=97) Placebo (n=101)	4 menstrual cycles	27%	No	Daily Symptom Report (DSR), CGI, Quality of life questionnaire, Social Adjustment Scale (SAS)	Intermittent luteal-phase low dose sertraline produced significant symptom improvement. Continuous and symptom-onset dosing also effective, particularly at lower dose.
Menkes et al. (1992)	Fluoxetine for PMS	Women with PMS	Double-blind, crossover, N=37; Fluoxetine 20 mg Placebo	3 cycles followed by crossover	24%	No	Premenstrual Assessment Form	Fluoxetine an effective treatment for severe PMS.
Steiner et al. (1995)	Fluoxetine for PMDD	Women with Late Luteal Phase Dysphoric Disorder (LLPDD)	Randomized, double-blind; Fluoxetine 20mg (n=102) 60 mg (n=106) Placebo (n=105)	8 cycles	56%	No	Visual-Analogue Scales (VAS) for tension, irritability, & dysphoria	Fluoxetine useful in treatment of PMDD. Lower dosing clinically effective and reduced side effects.
Stone et al. (1991)	Fluoxetine	Women with LLPDD	Randomized; Fluoxetine 20 mg (n=10) Placebo (n=10)	4 menstrual cycles (2 all placebo, 2 randomized)	0%	No	Self-report of symptoms	9 of 10 fluoxetine subjects responded to treatment. Symptoms ↓ in all 10 LLPDD diagnostic categories in fluoxetine group.

Study author	Study of	Population	Group design and sample size	Study length/ Assessment points	Attrition rates	Follow up	Outcome measure	Results
Sundblad et al. (1993)	Clomipramine for PMS	Non-depressed women with premenstrual irritability & LLPDD	Clomipramine (n=15) Placebo (n=14)	3 cycles	24%	No	VAS for irritability, depressed mood	Low doses of clomipramine effective for PMS. Lag between onset of medication and effect shorter for PMS than for anxiety/depression.
Sundblad et al. (1992)	Clomipramine for PMDD	Nondepressed women with premenstrual irritability & LLPDD	Randomized; Clomipramine (n=20) Placebo (n=20)	3 cycles	27%	No	VAS for Premenstrual irritability	Low doses of clomipramine effective in reducing premenstrual irritability and dysphoria.
Wood et al. (1992)	Fluoxetine for PMS	Women with severe & persistent PMS	Randomized, double- blind, crossover; N=8 Fluoxetine Placebo	6 months	0%	No	Calendar of Premenstrual Experiences, Beck Depression Inventory (BDI), Profile of Mood States	Fluoxetine associated with ↓ in PMS symptoms including ↓ in behavioral, physical, and anxiety/depression scores.
Yonkers et al. (1997)	Sertraline for PMDD	Women with PMDD	Randomized, double-blind; Sertraline (n=121) Placebo (n=122)	3 cycles	18%	No	DRSP, HRSD, CGI, & SAS	Sertraline ↓ PMDD symptoms, improved functional impairment.
Observational Studies								
Araujo et al. (2011)	Sleep patterns & menstrual pain	Menstruating women aged 25–48	Ancillary; N= 24	1 night	N/A	No	PSG, Women's Questionnaire, Pre/Post sleep questionnaires	Menstrual pain, use of pain medication did not alter sleep patterns.
Baker et al. (2012)	Sleep quality in women with severe PMS	Premenopausal women	Severe PMS (n=18) Minimal Symptoms (n=18)	1 night in Midfollicular phase, 1 night in late luteal phase	N/A	No	PSG, Perceived Stress Scale, Profile of Mood States, Sleep Diary, anxiety & depression scales	Poorer subjective sleep quality reported when symptomatic in the late-luteal phase. No corresponding changes in objective sleep quality.
Baker et al. (2007)	Sleep quality, Composition in severe PMS	Women aged 18–40	PMS/PMDD (n=9) Asymptomatic Control (n=12)	1 night in Midfollicular phase, 1 night in late- luteal phase	28%	No	PSG, BDI-II, rofile of Mood States, Sleep Diary	Women with severe PMS reported significantly poorer sleep quality during the late luteal phase.
Baker & Driver (2004)	Sleep across Menstrual cycle	Healthy Ovulating Women (mean age 21)	N=40	1 menstrual cycle	35%	No	Sleep Diary	↓ sleep quality over the 3 premenstrual days and 4 days during menstruation
Cohen et al. (2002)	Prevalence & Predictors of PMDD	Older Premenopausal Women (36–44)	N=513	1 menstrual cycle	N/A	No	Moos Remenstrual Inventory, Daily Record of Severity	PMDD associated with ↓ education, history of depression, current cigarette smoking. Women not working

Study author	Study of	Population	Group design and sample size	Study length/ Assessment points	Attrition rates	Follow up	Outcome measure	Results
							of Problems (DRSP)	outside the home less likely to meet criteria for PMDD.
Hachul et al. (2010)	Sleep across Menstrual cycle	Women with Sleep complaints	N=931	1 night	N/A	No	PSG, Sleep Questionnaire, Gynecological Questionnaire	Irregular menstrual cycle associated with sleep difficulties.
Lamarche et al. (2007)	Sleep & Significant Emotional Premenstrual symptoms	Women aged 20–37	Significant Emotional Premenstrual Symptoms (n=10) Minimal symptoms (n=9)	1 night in Follicular phase & 2 nights in late-luteal phase	N/A	No	PSG, Stanford Sleepiness Scale (SSS), Subjective Alertness Scale	Women with significant symptoms sleepier and less alert during the late-luteal phase.
Parry et al. (1999)	Sleep deprivation & PMDD	Premenstrual women with PMDD	Randomized, cross-over trial; PMDD (n=23) Normal Comparison (n=18)	3 months	N/A	No	PSG, Hamilton Rating Scale for Depression (HRSD), BDI, Atypical & Mania Rating Scores	↑ REM latencies, ↓ REM in luteal phase. PMDD subjects had no sleep architecture changes like those in depression. Sleep deprivation may correct circadian rhythm disturbances in PMDD.
Sharkey et al. (2014)	Sleep Disturbance across the menstrual cycle	Healthy Premenopausal women (18–45)	N=27	1 menstrual cycle	1%	No	PSG, Progesterone, Estradiol, Estrone, WASO	The steeper rate of rise in progesterone from follicular through mid-luteal phase associated with ↑ WASO.
Woosley & Lichstein (2014)	Dysmenorrhea, the menstrual cycle, & sleep	Women aged 18–24	N=89	5 weeks	N/A	No	ISI, ICSD-2, Sleep Diary, Brief Pain Inventory (BPI)	Insomnia severity associated with dysmenorrhea severity. ↑ SOL, ↓ sleep efficiency in severe dysmenorrhea.
Zheng et al. (2014)	Sleep across Menstrual cycle	Late-reproductive-age, Menstruating women	N=163	1 menstrual cycle	N/A	No	Actigraphy	Sleep efficiency ↓ gradually across menstrual cycle, more pronounced in premenstrual period.

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Table 2

Pregnancy and Sleep

First author	Study of	Population	Study design and initial sample size	Study length/Assessment Points	Attrition rates	Follow up	Outcome measure	Results
Intervention Studies								
Beddoe (2010)	Mindful yoga	Pregnant women	N=15	7 weeks	N/A	No	Actigraphy, General Sleep Disturbance Scale (GSDS)	Initiating yoga in 2nd trimester associated with ↓ awakenings, ↓ time awake, and ↓ perceived sleep disturbance. Beginning in 3rd associated with poorer sleep over time.
Chang (2011)	Sleep in pregnancy & maternal, fetal outcomes	Pregnancy women	Pilot; N=31	1 week at each time point: 5–20 weeks, 21-28 weeks, 30–36 weeks	0%	No	Actigraphy, socio-Demographic questionnaires, medical records	Each additional hour of sleep per day in late pregnancy ↓ odds of small for gestational age, one hour ↑in mid pregnancy ↓ the odds of preeclampsia. Each hour ↑ in sleep per day in early pregnancy associated with ↓ weight gain.
da Silva (2005)	Acupuncture	Pregnant women	Quasi-randomized; Acupuncture (n=17) Sleep Hygiene (n=13)	8 weeks	27%	No	Numerical rating scale of insomnia	Acupuncture ↓ insomnia ratings.
Field (2013)	Tai chi/yoga	Pregnant women	Tai Chi/Yoga (n=46) Control (n=46)	1 group session per week, 12 weeks	11%	No	Center for Epidemiologic Studies Depression Scale (CES-D), STAI	Tai chi/yoga ↓ depression, negative affect, and somatic/vegetative symptoms, ↓ anxiety and sleep disturbance scores.
Manber (2010)	Acupuncture For Depression	Pregnant women with Major Depression	Randomized; Depression-Specific Acupuncture (n=52) Acupuncture (control, n=49) Massage (control, n=49)	8 weeks	23%	No	HRSD	Depression-specific acupuncture ↓ symptom severity, showed greater response rate.
Observational Studies								
Baratte-Beebe & Lee (1999)	Sources of awakenings	Pregnant women	Longitudinal, Secondary Analysis (n=25)	Preconception, 1st, 2nd & 3rd trimesters	N/A	No	Sleep diary	↑ in awakenings pre-conception through 3rd trimester. Need to urinate the primary source of awakening in 1st & 3rd trimesters. Parity &

First author	Study of	Population	Study design and initial sample size	Study length/Assessment Points	Attrition rates	Follow up	Outcome measure	Results
								environment impact awakenings.
Driver & Shapiro (1992)	Sleep stages Across pregnancy	Primiparous pregnant women	Longitudinal, N=5	Between 8 & 16 weeks, Then bimonthly	N/A	1 month postpartum	PSG	No reduction in stage 4 sleep. Slow-wave sleep ↑ at 27–39. REM sleep time ↓ in last 2 months and WASO ↑.
Field (2007)	Sleep Disturbances & depression in pregnancy & newborns	Pregnant women & their newborns	Depressed (n=83) Non-depressed (n=170)	20–24 weeks, 30–35 weeks, infants observed at birth	N/A	No	SCID, CES-D, STAI, Sleep scale, VAS of pain perception	Depressed women: ↑ sleep disturbances, depression, anxiety, & anger in 2nd & 3rd trimesters. ↑ norepinephrine & cortisol. Newborns: ↑ sleep disturbances, ↓ deep sleep, ↑ disorganized sleep, more active/fussy.
Hedman (2002)	Sleep	Pregnant women	N=325	3 mo. pre-conception, 1st, 2nd, 3rd trimesters, & 3 months postpartum	62.9%	No	Basic Nordic Sleep Questionnaire (BNSQ), 5-point scale by Partinen & Gislason	TST ↑ in 1st trimester, ↓ there after. Sleep shortest in 3 months postpartum. ↓ sleep in late pregnancy over age 30. Sleep in all more restless, fragmentary.
Hertz (1992)	Sleep	Pregnant women in 3rd trimester	Pregnant (n=12) Age-matched controls (n=10)	1 night in pregnancy, 1 night 3–5 Months postpartum	30%	No	PSG, SSS	Late pregnancy: ↑ WASO, ↓ sleep efficiency, ↓ REM, and ↑ stage 1 sleep. Postpartum: ↓ WASO, and ↑ sleep efficiency; slight ↑ REM.
Kizilirmak (2012)	Insomnia	Pregnant women	Cross sectional, N=486	N/A	N/A	No	Women's Health Initiative Insomnia Rating Scale, BDI	52.2% insomnia prevalence. ↑ risk of insomnia in 3rd trimester, for those aged 20 and over, and for those with depression.
Lara-Carrasco et al., (2014)	Dreaming in pregnancy	3rd Trimester Nulliparous pregnant women	Prospective, Nulliparous 3rd trimester pregnant (n=57) Non-pregnant control (n=59)	14 days	0%	No	STAI, EPDS, Beck Depression Inventory- Short form (BDI-SF), Sleep Disorders Questionnaire, Sleep Diary	No difference in dream recall. Pregnant women ↑bad dreams, ↓ sleep quality, ↑ awakenings, ↑ recall of bad dreams, nightmares.
Lee (2004)	Sleep & labor type	Pregnant women in 9th month of pregnancy	N=131	48 hours	N/A	N/A	Actigraphy, Sleep Diary, GSDS, VAS for fatigue	< 6 hr/a night sleep, severely disturbed sleep associated with longer labors, C-Sections. Fatigue unrelated to labor outcomes.
Lee (2000)	Parity & sleep patterns	Pregnant women	Planning to Conceive within 1 year (n=45)	2 nights Preconception, 1st, 2nd & 3rd	12 did not Conceive & were not included in	No	PSG	↑ TST by 11–12 weeks, ↓ deep sleep, ↑ awakenings. By the 3rd month postpartum sleep

First author	Study of	Population	Study design and initial sample size	Study length/Assessment Points	Attrition rates	Follow up	Outcome measure	Results
			Those who Conceived (n=33) Postpartum (n=29)	trimesters	the 2nd group			characteristics improved, but sleep efficiency ↓.
Little (2014)	Sleep Changes in Pregnancy	Pregnant women	N=9	7 nights Each trimester	0%	No	Actigraphy	WASO and awakenings ↑ as pregnancy progressed. SOL ↓ as pregnancy progressed, but not significantly. No difference in TST.
Manber (2013)	Insomnia in pregnancy	Pregnant, low-income Latinas	Cross sectional, N=1289	One-time questionnaire	N/A	No	ISI, EPDS	Correlates of insomnia: ↑ EPDS scores, completing measures in English, and income. ↑ insomnia in those with EPDS scores ≥9.
Mindell (2000)	Sleep Disturbances in pregnancy	Pregnant women	Cross sectional; 8–12 weeks (n=37) 18–22 (n=28) 25–28 (n=24) 35–38 (n=38)	One-time questionnaire	Each Woman Participated only one time	No	Self-reported sleep, Epworth Sleepiness Scale (ESS)	Common sleep disturbances: frequent awakenings, difficulty falling asleep, sleep apnea symptoms. Few differences in sleep patterns across pregnancy, however, women in late pregnancy slept and napped more.
Swanson (2011)	Anxiety, depression, & insomnia	Perinatal women in outpatient psychiatric treatment	Archival; N=257	N/A	N/A	No	ISI, EPDS, Penn State Worry Questionnaire (PSWQ)	Women with clinically significant ISI scores had ↑ odds for reporting depression and anxiety.
Tsai et al., (2012)	Sleep, Depressive symptoms, & perception of fatigue	3rd Trimester, nulliparous, Taiwanese, pregnant women	Prospective; N=38	7 days	12%	No	Actigraphy, Sleep Diary, PSQI, CES-D	Most napped during the day. Antecedent night sleep duration inverse association with fatigue. More depressive symptoms predicted more severe daytime fatigue.
Wang (2010)	Zolpidem	Pregnant women	Population-based; Zolpidem (n=2,497) No Zolpidem (n=12,485)	N/A	N/A	N/A	N/A	Adverse outcomes: low-birth-weight, preterm deliveries, small-for-gestational-age infants, congenital anomalies, C-sections.

Table 3

Postpartum and Sleep

Study author	Observational Or Treatment Study	Population	Group design and sample size	Study Length/ Assessment Points	Attrition rates	Follow up	Outcome measure	Results
Intervention Studies								
Ashrafinia et al. (2014)	Pilates exercise	Primigravada Postpartum women	Pilates (n=40) Control (n=40)	8 weeks	0%	No	PSQI	Pilates group showed improvement in subjective sleep quality, SOL, daytime dysfunction and PSQI score.
Ko & Lee (2014)	Back massage	Postpartum women	Randomized; Back Massage (n=31) Control (n=31)	5 days	1%	No	PSQI	Back massage in the postnatal period significantly improved the sleep quality.
Li et al. (2011)	Foot reflexology	Postpartum women reporting poor sleep quality	Randomized; Foot Reflexology (n=34) Control (n=34)	5 days	0%	No	PSQI	Foot reflexology in postnatal period significantly improved the sleep quality.
Swanson et al. 2013	CBT for Insomnia	Postpartum women with insomnia & depression	Pilot; N=12	5 weeks	N/A	No	Sleep diary	Statistically significant improvements in sleep efficiency and total wake time, mood, insomnia severity, sleep quality, and fatigue.
Observational Studies								
Bei et al. (2010)	Disrupted sleep & mood disturbance	Healthy women at low risk for postpartum depression	N=44	3rd trimester & 1 week postpartum	0%	No	PSQI, Actigraphy, depression & anxiety scales, Affect Schedule	Perception of poor sleep and conscious awareness of its impact during wake might be more related to immediate postpartum mood disturbances than actual sleep quality and quantity.
Dorheim et al. 2014	Insomnia in pregnancy & postpartum depression	Perinatal women	Longitudinal, population-based; N=2088	Weeks 17 & 32 & 8 Weeks postpartum	55%	No	Bergen Insomnia Scale, EPDS	After delivery women slept ↓ at night, had ↑ awakenings, but improved insomnia scores. Insomnia in pregnancy may be marker for postpartum depression in women with previous depression.
Dorheim et al. (2009)	Postpartum sleep & depression	Postpartum women	Population-based, Cross-sectional; N=2830	One-time Assessment at 7 weeks	N/A	No	PSQI, EPDS	Depression, previous sleep problems, being primiparous, not exclusively breastfeeding, or having a younger or male infant associated with poor postpartum sleep quality.
Montgomery-Downs et al. (2010)	Sleep during 4 months postpartum	Postpartum women	Longitudinal; 2–13 weeks (n=50)	7–12 weeks	N/A	No	Actigraphy	Though postpartum mothers' TST was ↑ in initial postpartum months, sleep was fragmented and inefficient.

Study author	Observational Or Treatment Study	Population	Group design and sample size	Study Length/ Assessment Points	Attrition rates	Follow up	Outcome measure	Results
			9–16 weeks (n= 24)					
Okun et al. (2011)	Sleep quality & hormones postpartum	Pregnant women with history of MDD/PPMD (not depressed in Current pregnancy)	N=56	First 17 Weeks postpartum	0%	No	PSQI, HRSD, Estradiol, Prolactin, Cortisol, IL-6	Poor sleep quality in 17 weeks post-delivery ↑ risk for recurrent PPMD in women with history of depression. Changes in the hormonal milieu not associated with recurrence.
Park al. (2013)	Sleep variables & postpartum depression	Healthy Primiparous women	N=25	3rd trimester (1 week), 2, 6, 10, & 14 weeks postpartum	0%	No	Actigraphy, Sleep diary, EPDS	Sleep fragmentation, efficiency, and WASO correlated with EPDS scores postpartum.
Swain et al. (1997)	Sleep patterns, mood states, cognitive functioning	Primiparous mothers	Primiparous (n=53) Non-Postpartum Controls (n=30)	First 3 Weeks postpartum	30%	No	Sleep diary, VAS for mood, Cognitive & psychomotor tests	Postpartum women reported ↑ awakenings, ↑ WASO , and ↑ naps, but overall sleep time was similar to control.
Tikotzky et al. (2010)	Maternal sleep & depression & infant affectivity	Women 6 Months postpartum	N=69	1 week	N/A	No	HRSD, Sleep diary, Infant Behavior Questionnaire-Revised (IBQ-R)	Maternal depression severity a predictor of IBQ-R Distress & Falling Reactivity scales. Poor maternal sleep a predictor of the IBQ-R Sadness scale.
Tsai & Thomas (2012)	Sleep Disturbances & depressive symptoms	Healthy Primiparous Postpartum women	N=22	1 week	15%	No	Actigraphy, GSDS, EPDS	Variable sleep duration from night to night and awakening too early correlated with ↑ depressive symptoms.
Wilkie & Shapiro (1992)	Sleep disruption & postnatal blues	Perinatal women	N=63	10 days	21%	No	Sleep Diary, Stein Questionnaire, VAS for mood states	Nighttime labor, history of sleep disruption in late pregnancy may be associated with postnatal blues.
Wolfson et al. (2003)	Sleep patterns & depressive Symptoms	First-time others	N=56	3rd trimester, Postpartum: 2–4 & 12-16 weeks, & 12–15 months	32%	No	Sleep Diary, CES-D	Differences in rise time, time awake due to disruptions, & naps at 2–4 weeks. Depressive symptoms ↑ at 2–4 weeks. Women with depressive symptoms at 2–4 weeks had ↑ TST, later rise times, more naps in late pregnancy.

Table 4

Menopause and Sleep

Study author	Study of	Population	Group design and initial sample size	Study length/ Assessment points	Attrition rates	Follow up	Outcome measure	Results
Intervention Studies								
Afonso et al. (2012)	Yoga	Postmenopausal women	Randomized; Yoga (n=15) Passive Stretching (n=14) Control (n=15)	16 weeks	0%	No	ISI	↓ insomnia scores for both groups
Agosta et al. (2011)	Magnolia bark + isoflavones, & lactobacilli	Menopausal women	Randomized; Isoflavones, lactobacillus, calcium & vitamin D3 (n=300) Magnolia bark + Estromineral Serena (n=334)	0, 4, 8, 12 weeks	N/A	No	Self-report of Menopausal symptoms	↓ menopausal symptoms for both groups. Magnolia bark + Estromineral serena more active on insomnia & mood.
Archer et al. (2009)	Desvenlafaxine	Postmenopausal women with vasomotor symptoms	Randomized; Desvenlafaxine 100mg (n=153) 150mg (n=152) Placebo (n=153)	12 weeks + 1 week taper period	13%	1 week after taper period	HF diary	↓ hot flashes (HF), HF severity, and nighttime awakenings.
Asltoghiri et al. (2012)	Reflexology	Postmenopausal women	Randomized; Reflexology (n=53) Non-specific foot massage (n=47)	21 days	10%	No	PSQI	↓ sleep disorder symptoms.
Borud et al. (2009)	Acupuncture	Postmenopausal women with vasomotor symptoms	Randomized; Acupuncture (n=134) Control (n=133)	12 weeks	7%	No	HF diary	↓ HF frequency ↑ hours of sleep

Study author	Study of	Population	Group design and initial sample size	Study length/ Assessment points	Attrition rates	Follow up	Outcome measure	Results
Carmody et al. (2011)	Mindfulness-Based Stress Reduction (MBSR)	Late Perimenopausal & early Postmenopausal women with vasomotor symptoms	Randomized; MBSR (n=57) Control (n=53)	8 weeks	9.3%	Follow-ups at weeks 12, 16, 20	HF diary, Depression/ Anxiety/Quality of life measures	↓ HF bother. Significant difference in perceived sleep quality but within subject differences not significant
Cohen et al. (2014)	Omega-3 Supplements	Peri- & Postmenopausal women with vasomotor symptoms	Randomized; Oral omega-3 (n=177) Placebo (n=178)	12 weeks	1%	No	ISI and PSQI	No significant differences in vasomotor or sleep variables
Dobkin et al. (2009)	Ramelteon (Rozeram)	Peri- & Postmenopausal women with sleep latency insomnia	Open label pilot; Ramelteon 8mg (n=20)	6 weeks	30%	No	Sleep diary	Ramelteon effective in improving subjective reports of SOL, TST, and sleep quality.
Dorsey et al. (2004)	Zolpidem (Ambien)	Peri- & Postmenopausal women with insomnia	Randomized; Zolpidem 10mg (n=68) Placebo (n=73)	4 weeks	11%	No	Subjective sleep reports	Zolpidem ↑ TST, ↓ WASO, and ↓number of awakenings.
Hacul et al. (2011)	Isoflavones (soy)	Postmenopausal women with sleep disturbance	Randomized; Oral Isoflavones (80mg; n=19) Placebo (n=19)	16 weeks	2%	No	PSG	Isoflavones ↑ sleep efficiency, ↓ intensity and number of HF, and ↓ subjective insomnia.
Hachul et al. (2008)	Estrogen and/or progesterone replacement therapy	Postmenopausal women	Randomized; Conjugated Equine Estrogens 0.625 mg (n=14) Placebo (n=19) All received Medroxyprogesterone acetate 5 mg in addition to previous tx after 12 weeks	24 weeks	0%	No	Standardized questionnaire of sleep quality; PSG, ESS	Estrogen + progesterone more effective than estrogen alone in ↓PLM, HF, and bruxism. ↓ breathing irregularities, arousals, anxiety and memory impairment in both groups following progesterone treatment. Hormone therapy did not significantly affect sleep quality.

Study author	Study of	Population	Group design and initial sample size	Study length/ Assessment points	Attrition rates	Follow up	Outcome measure	Results
Huang (2006)	Acupuncture	Postmenopausal women with HF	Pilot; Randomized; Active Acupuncture (n=12) Placebo Acupuncture (n=17)	7 weeks; 2 20-min treatments a week first 2 weeks, 1 a week thereafter	24%	1-month follow up	HF diary & PSQI	Nocturnal HF severity reduced, but not significantly, however correlations between improvements in PSQI and reductions in nocturnal HF severity and frequency significant.
Joffe et al. (2010)	Eszopiclone	Peri- & Postmenopausal women with HF & depression and/or anxiety symptoms	Randomized, double blind, crossover; Eszopiclone 3 mg Placebo; N=59	11 weeks	22%	No	ISI, Sleep diary, depression/ anxiety/quality of life measures	Eszopiclone improved all sleep parameters, depressive symptoms, anxiety symptoms, quality of life, and nighttime (but not daytime) HF.
Joffe et al. (2007)	Duloxetine	Postmenopausal women with Major Depressive Disorder	Pilot; Oral Duloxetine (60–120mg; n=20)	8 weeks	25%	No	Montgomery-Asberg Depression Rating Scale (MADRS), PSQI	Significant improvements in epression, vasomotor, anxiety, and pain.
Mansikkamaki et al. (2012)	Sleep quality & aerobic activity	Sedentary Menopausal women	Randomized; Aerobic Training 4x/week (n=88) Control (n=88)	6 months	13%	No	Daily subjective sleep reports	Sleep quality improved significantly. Hot flushes related to sleep ↓.
Nowakowski et al. (2012)	CBT for Insomnia	Perimenopausal women	Archival; Group CBT for Insomnia (n=44) Control (n=63)	7 sessions, 1 a week for 5 weeks, then biweekly for 4 weeks.	N/A	N/A	ISI, BDI, Dysfunctional Beliefs & Attitudes about Sleep Scale	Significant ↓ in ISI and BDI. Women who perceive their sleep as disrupted by menopausal symptoms may benefit from CBT for Insomnia.
Pickett et al. (1989)	Progesterone & estrogen Replacement therapy	Postmenopausal women	Combined oral estrogen & progesterone	7 days	0%	No	PSG	No differences before and after administration of hormones.
Scharf et al. (1997)	Estrogen Replacement therapy	Postmenopausal women with hot flushes	N=7; Placebo baseline then estrogen 0.625 mg	5 weeks	0%	No	SSS, Subjective sleep assessment, HF log	↓in number of hot flushes and number of hot flushes associated with awakenings. Sleep efficiency ↑.

Study author	Study of	Population	Group design and initial sample size	Study length/ Assessment points	Attrition rates	Follow up	Outcome measure	Results
Schiff et al. (1979)	Estrogen Replacement therapy	Hypogonadal women	Double-blind, crossover, N=16; Estrogen 0.625 mg Placebo	128 days, 10 total nights in sleep lab	N/A	No	PSG, Clyde Mood Scale, Gottschalk-Gleser Test	↓ number of vasomotor flushes, mean sleep latency. ↑ REM. Positive correlation between psychological intactness and SOL.
Schuessler et al. (2008)	Progesterone Replacement therapy	Postmenopausal women	Randomized, double-blind, crossover, N=10; Oral Micronized Progesterone 300 mg Placebo	2 treatment intervals of 21 days separated by 2 weeks washout	0%	No	PSG, St. Mary's Hospital Sleep Questionnaire, HF diary, Cognitive performance tests	Progesterone ↓ intermittent time awake. ↑ REM sleep in first third of night, no effect on cognitive performance
Sivertsen et al. (2006)	CBT vs. Zopiclone	Older adults	Randomized, double-blind; CBT (n=18) Zopiclone 7.5 mg (n=16) Placebo (n=12)	6 weeks	21%	6 months	PSG, Sleep Diary	CBT was superior to zopiclone in short- and long-term management of insomnia. CBT ↑ sleep efficiency and slow-wave sleep, and ↓ awakenings.
Soares et al. (2006)	Eszopiclone (Lunesta)	Peri- or early Postmenopausal women with insomnia	Randomized; Eszopiclone 3mg (n=201) Placebo (n=209)	4 weeks	12.4%	No	ISI	58% of those treated with Eszopiclone ↓ ISI score to "non-significant clinical insomnia"
Soares et al. (2006)	Escitalopram (Lexapro) vs. estrogen & progesterone	Peri- & Postmenopausal women with depressive disorders & menopause related symptoms	Randomized; Escitalopram 10–20mg (n=20) Ethinyl estradiol 5 microg + norethindrone acetate 1 mg (n=20)	8 weeks	20%	No	MADRS, Greene Climacteric Scale, CGI, sleep & quality of life scales	Escitalopram more efficacious for treatment of depression. Improved sleep, HF, and quality of life.
Taavoni et al. (2013)	Valerian/ Lemon balm	Postmenopausal women	Triple blind; Valerian officinalis 160 mg + lemon balm 80 mg (n=50) Placebo (n=50)	Not reported	Not Reported	1 month follow up	PSQI	↓ levels of sleep disorders.

Study author	Study of	Population	Group design and initial sample size	Study length/ Assessment points	Attrition rates	Follow up	Outcome measure	Results
Vermes et al. (2005)	Remifemin	Women aged 40–65 not on Estrogen therapy	N=2016	0, 4, 8, & 12 weeks	7.5%	No	Kupperman Menopause Index	Remifemin ↓ menopausal symptoms. Most favorable changes in HF, sweating, insomnia, and anxiety.
Voshaar et al. (2004)	Zolpidem & Rebound insomnia	Aged 18–65 with insomnia diagnosis	Randomized; Zolpidem 10 mg (n=74) Temazepam 20 mg (n=85)	6 weeks	29%	No	Sleep diary, sleep questionnaire, STAI, CGI, Physician-rated tremor, sweating, agitation	Both improved TST and SOL No differences in rebound insomnia, efficacy, or safety.
Zanardi et al. (2007)	SSRIs with or Without Hormone therapy (HT)	Postmenopausal women with depression	Prospective; SSRIs + HT (n=47) SSRIs, no HT (n=123)	7 weeks	8%	No	HRSD, CGI, Serum levels of gonadotropins & sex hormones	HT appeared to improve the antidepressant response to SSRIs.
Observational Studies								
Bliwise et al. (1992)	Factors related to sleep quality	Elderly women	“Good sleepers” (n=22) “Poor sleepers” (n=16)	N/A	N/A	No	PSG	Using estrogen did not differentiate good from poor sleepers.
Col et al. (2009)	Duration of Vasomotor symptoms	Healthy women	Longitudinal; N=438	13 years	33%	N/A	Somatic & Vasomotor Symptom checklist, Health behavior assessments	Mean duration of bothersome symptoms was estimated at5.2 years. The only factor associated with duration of HF was exercise (↑ exercise associated with ↓ symptom duration).
Ensrud et al. (2009)	Relationship Between frequency and severity of HF and insomnia	Postmenopausal women with HF	N=217; (Actigraphy subcohort: n=112)	One time Questionnaire (+1 week for subcohort)	N/A	N/A	HF diary, ISI, Actigraphy	ISI score associated with ↑ frequency moderate/ severe HF. ↑ frequency of moderate/severe HF independently associated with ↑ nighttime wakefulness and ↑number of long wake episodes, but not sleep efficiency, TST, or SOL.
Erlik et al. (1981)	Relationship between HF and waking episodes	Postmenopausal women with HF	Postmenopausal, severe HF (n=9) Asymptomatic Premenopausal (n=5)	3 nights	0%	No	PSG, finger temperature, skin resistance	Significant correlation between HF and waking episodes. Estrogen ↓ HF and waking symptoms.

Study author	Study of	Population	Group design and initial sample size	Study length/ Assessment points	Attrition rates	Follow up	Outcome measure	Results
Freedman et al. (2006)	To determine regions of brain activation associated with HF	Postmenopausal women	Symptomatic Postmenopausal (n=12) Asymptomatic Eumenorrheic (n=8)	Up to 12 10-min scans	N/A	No	fMRI	Activation of insular cortex associated with the "rush of heat" of HF. Thermo-regulation represented in a distributed cortico-subcortical network rather than a single localized structure.
Freedman & Roehrs (2004)	Determine if HF produce Disordered sleep	Menopausal women with HF	Symptomatic Postmenopausal (n=12) Asymptomatic Postmenopausal (n=8) Premenopausal (n=11)	3 nights	N/A	No	PSG, Sternal skin conductance, Sleep Latency Test, Post sleep questionnaire, Fatigue Assessment Inventory, Divided attention task, Psychomotor Vigilance Task	No significant group differences on sleep stage measure. No evidence that HF produce sleep disturbance in symptomatic postmenopausal women.
Glazer et al. (2002)	Predictors, moderators, and outcome variables associated with the transition to midlife	Midlife women aged 40–60	N=160	0, 9, and 18 months	20%	No	Hobfall Conservation of Resources tool, coping scale, menopause symptom/attitude scales, health behavior profile, anxiety/depression measures	Anxiety predictors: loss of resources, coping effective-ness, education. Depression predictors: loss of resources, education. Health promoting activities predicted by attitude toward menopause, coping effectiveness. Stress a better predictor of negative outcomes than menopause.
Gold et al. (2000)	Factors related to menopausal and other symptoms	Women aged 40–55	Cross Sectional survey, N=16,065	N/A	N/A	N/A	Self-report of symptoms	Peri- or postmenopausal women reported the most symptoms. Lifestyle, menstrual status, race/ ethnicity, socioeconomic status (SES), & BMI affect symptoms.
Kravitz et al. (2003)	Sleep difficulty	Women aged 40–55	Cross sectional, N=12,603	N/A	N/A	N/A	Symptom questionnaire	Menopausal status associated with difficulty sleeping, ethnicity, vasomotor & psychological symptoms, self-perceived health, health behaviors, arthritis, education.
Kravitz et al. (2008)	Sleep disturbance	Women aged 42–52	Longitudinal, N=3.302	7 annual assessments	27.2%	No	Self-report of sleep	Progression through menopausal transition associated with self-reported sleep disturbances.
Savard et al. (2004)	Sleep & nocturnal HF	Breast cancer survivors	N=24	3 nights at each of 4 time points	N/A	N/A	PSG, Skin conductance, Self-report of HF	10-min periods around HF had more wake time and more stage changes to lighter sleep. Nights with HF had ↑ wake time, ↓ Stage 2 sleep, and ↑ REM latency.

Study author	Study of	Population	Group design and initial sample size	Study length/ Assessment points	Attrition rates	Follow up	Outcome measure	Results
Terauchi et al. (2010)	Insomnia in menopause	Peri- & Postmenopausal Japanese women	Archival; N=1451	N/A	N/A	N/A	Health-related Quality of Life (HR-QOL)	Insomnia more correlated with depressed mood than vasomotor symptoms. Hormone therapy & nightly hypnotics improved insomnia, 'as needed' hypnotics did not.
Woodward et al. (1994)	Thermo-Regulatory effects of HF on sleep	Postmenopasual women with HF	Postmenopausal with HF (n=12) Postmenopausal without HF (n=7)	24 hours	N/A	No	PSG, Ambulatory recordings of HF	HF associated with ↑ Stage 4 sleep and ↓ first REM period. HF 2 hours prior to sleep onset correlated with slow-wave sleep.
Young et al. (2003)	Sleep quality Across menopause	Pre-, peri-, & Postmenopausal women	Population-based; N=589	N/A	N/A	No	PSG, Self-report of sleep	Menopause not associated with sleep quality. Peri- & postmenospausal women more dissatisfied with sleep, but menopause not a strong predictor of sleep disorder.