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CBT-I and women's health: Sex as a biological variable

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Introduction

Several studies have demonstrated 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 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 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] 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, they tend to occur more frequently in women, particularly during times of hormonal fluctuation. In addition to sex differences found in the complaint of sleep disturbances and prevalence of insomnia, sex differences also exist for the treatment of sleep complaints. 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

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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] (see Figure 1).

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.[6,12-14] Women with PMS/PMDD typically report sleeprelated 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.[15-24] 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.[25-27] Changes in progesterone and estrogen, rather than absolute levels, in the late-luteal phase may be an important consideration in determining factors associated with sleep quality. 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 (SE) and total sleep time (TST) declines across the menstrual cycle with the most pronounced decline in the last week of the menstrual cycle.[28] These corresponding changes, however, were not found in PSG sleep.[29-31] Another 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 (WASO) and sleep fragmentation in the late luteal phase.[32] 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.[33] The selective serotonin reuptake inhibitors (SSRIs) fluoxetine and sertraline have been approved by the U.S. FDA for the treatment of PMDD. Fluoxetine,[34-37] sertraline,[38] and clomipramine[39,40] 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. The evidence for nonpharmacological treatments, such as cognitive behavioral therapy for insomnia (CBT-I) have been summarized in several meta-analyses,[41-43] which led to its recognition as a first-line treatment for insomnia by the NIH Consensus Statement[44] and the American College of Physicians.[45] However, the efficacy of CBT-I in improving sleep and menstural symptoms has not been examined. It remains unclear if CBT-I 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[46] or using CBT-I skills intermittently during late luteal phase of a women's menstrual cycle, as it is done to treat mood symptoms,[47-49] 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 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.[50,51] 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.[52,53] 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,[54] diminished daytime alertness, more disturbed dreams,[55] and approximately 21% report disturbed sleep at levels consistent with a diagnosis of insomnia disorder.[52,56] (Fig 2). 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.[57-60] Poor and insufficient sleep during pregnancy are also associated with increased circulating levels of inflammatory markers involved in poor health[61-65] and adverse pregnancy outcomes, including intrauterine growth restriction and preterm delivery.[66-72] During the third trimester of pregnancy, insufficient and poor sleep may place women at increased risk for prolonged labor and cesarean deliveries[7374,75] and for having an infant small for gestational age.[76]

For most women, sleep disruptions are caused by factors related to pregnancy, such as frequent need for urination during pregnancy.[56] 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. Insomnia may be experienced as a continuation or exacerbation of insomnia disorder that predates pregnancy or it may develop during pregnancy. The prevalence of sleep disturbance among perinatal women is as high as 58%[77-79] and a probable diagnosis of perinatal insomnia is estimated at 10%.[80] 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.

Pharmacological treatment for insomnia during pregnancy is typically avoided because of the potential for adverse effects such as low birth weight, preterm deliveries, and cesarean sections in pregnancy.[81-8485] Concerns regarding use of sleep medication during pregnancy and lactation make non-pharmacological treatment options for insomnia particularly attractive. CBT-I is a promising intervention for insomnia during pregnancy. A recent study of 187 pregnant women recruited from a low-risk maternity clinic and trade show, revealed that pregnant women preferred CBT-I over pharmacotherapy or acupuncture for treatment of insomnia.[86] Preliminary evidence in an open-pilot trial of 13 pregnant women with insomnia revealed improvements in diary and actigraphy-assessed sleep onset latency, sleep efficiency, and total sleep time.[87] In addition, symptoms of depression, pregnancy-specific anxiety, and fatigue also improved following treatment.[87] In this trial, CBT-I consisted of five weekly 90-minute group sessions and was adapted for pregnant women using the ORBIT model[88] from a treatment protocol that was previously validated for oncology patients with comorbid insomnia.[89] The final CBT-I session included a booklet on how to maintain gains in the postpartum period and how to foster optimal infant sleep.[90] Future studies could examine CBT-I tailored further for pregnancy symptoms (e.g., overcoming fatigue, strategies to reduce pain/discomfort during pregnancy, minimizing sleep disruption due to urinary frequency at night, increased stress management/relaxation, challenging maladaptive thoughts related to pregnancy and impending labor and delivery, and role transition).

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.[51,60,79,91,92] Fatigue and lack of energy remain high from pregnancy into the postpartum period through the first year after delivery. Sleep begins to normalize around 3-6 months postpartum, around the time when infants begin to establish their own circadian rhythm, distinguishing between day and night, and sleep for longer periods of time during the night. Some women may also react to infant waking with catastrophic predictions about the

consequences of these disruptions that, in turn, lead to hyperarousal and prolonged wakefulness even after the baby is content and asleep. The response to sleep disruption with distress and urgency to get back to sleep inevitably increase arousal and reduce the likelihood of returning to sleep easily. 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 and going to bed earlier than pre-pregnancy habitual bedtime.[93]Sleep disruptions that may have begun with pregnancy or postpartum related stressors develop into an insomnia disorder, maintained by maladaptive compensatory behaviors[94] and conditioned hyperarousal.

Negative effects of poor and insufficient sleep during the postpartum period are also associated with mood disturbance and interfere with bonding. 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.[95] 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[9697,98] or in the early postpartum[97,99, 100-102]). 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·[103,104105]

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 CBT-I for postpartum insomnia and both studies demonstrated that the benefits of CBT-I extended beyond improvement in sleep to other domains. One study provided five CBT-I 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 CBT-I had lower average daily cigarettes smoked and higher percent cigarette-free days.[106] The second study provided CBT-I 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.[107] In addition, several RCTs have evaluated interventions promoting infant sleep by providing education and training on infant sleep strategies to limit the development of unwanted sleep associations, increase the infant's ability to self soothe, and recommend environmental modifications to consolidate infant sleep at night. These trails demonstrated longer and more

consolidated sleep periods compared to infants in control conditions.[108-110] Future studies examining CBT-I across pregnancy and into the postpartum period and combining interventions for maternal and infant sleep are still needed. Future studies and interventions could also include the impact of partners or significant others to enhance support for maternal sleep and nighttime parenting responsibilities.

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[111] 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[112] 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). (Fig. 3). 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.[113] 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.[111] 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.[114] The prevalence of insomnia, defined as disturbed sleep associated with distress or impairment, is estimated at 38-60% in peri- and postmenopausal women.[115-117] Troubled sleep was reported by 54-58% of women between 40 and 60 years of age in the Ohio Midlife Women's study.[118] The Wisconsin Sleep Cohort found that perimenopausal women and postmenopausal women were twice as likely to be dissatisfied with their sleep as premenopausal women.[119] 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.[116]

The prevalence on nocturnal hot flashes/night sweats is generally believed to occur in 60 to 80% of women during the menopausal transition[120] and persist for 4 to 5 years on average.[121,122] 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.[119,123,124] There is only limited and contradictory evidence supporting an association between nocturnal flashes and sleep disturbance when both variables were measured objectively.[119,123–129] This may be, in part, due to the stage of sleep hot flashes are occurring. When taking sleep stage into account, several studies have demonstrated a relatively low incidence hot flashes during REM sleep, which has been postulated to be due to the inhibition of thermoregulatory responses during REM sleep.[130] Contradictory evidence may also be due to how investigators characterized hot flashes associated with awakenings and the duration of the window for detecting an awakening before or after the hot flash occurred.

Vasomotor symptoms, including nocturnal hot flashes and night sweats, may be a precipitating factor in the development of insomnia, but physiological arousals, behavioral conditioning, and misguided coping attempts appear to prolong insomnia.[131] CBT-I targets these behaviors and has been shown to be efficacious for the treatment of chronic insomnia in randomized trials of older adults[132] and for midlife women.[133-135] Telephone-delivered CBT-I has recently been evaluated for insomnia during the menopausal transition in a randomized clinical trial of perimenopausal and postmenopausal women with insomnia symptoms as well as daily hot flashes.[135,136] Compared with a menopause education control condition, 8 weeks of telephone-delivered CBT-I led to a greater reduction in insomnia symptoms, with improvements maintained at 6 months posttreatment.[135] Another randomized clinical trial of 150 postmenopausal women with insomnia were randomized to one of three conditions: face-to-face CBT-I, sleep restriction only, or sleep hygiene education control. The investigators found that the participants treated with CBT-I had a decrease in the insomnia severity index by 7.7 point, sleep restriction by 6.5 points, and sleep hygiene control by 1.1 points. Participants who received CBT-I were generally more likely to remit than participants who received sleep restriction alone.[134] These studies have examined traditional CBT-I or sleep restriction component of CBT-I in midlife women.

By focusing on distress following the hot flash experience, the principles of CBT can also be used to reduce suffering from hot flashes. Psychological factors, such as reaction to stress, appear to play a role; with past findings that higher levels of perceived control and lower distress were associated with fewer hot flashes.[137-139] Women who perceive greater control over their reactions to hot flashes tend to regard their flashes as less problematic and report fewer hot flashes[138] This suggests that addressing reactions to hot flashes and providing strategies for coping with hot flashes could reduce distress associated with hot flashes. Indeed, several studies have provided empirical support demonstrating CBT as an effective strategy for coping with hot flashes and other menopausal symptoms.[140-147] Future studies combining CBT for insomnia and hot flashes could prove to be beneficial for women bothered by multiple symptoms during menopause, including insomnia and hot flashes.

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. (see Figure 4).

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. Nonpharmacological treatments, such as CBT-I, offer longer-lasting improvements for insomnia 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. In studies examining sex differences, the menstrual phase should be considered and documented. 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 insomnia treatment options in women with PMS and PMDD and the interaction of sleep and mood disturbances and menstrual pain. There are a greater number of published studies examining CBT-I in perinatal and perimenopausal women. However, few studies have tailored CBT-I to multiple symptoms women may be experiencing. In addition, the high prevalence of women experiencing insomnia during times of reproductive hormonal change relative to the low number of trained providers able to effectively deliver CBT-I remains unbalanced.[148] Thus, future research should focus on dissemination and implementation of CBT-I in order to improve access to care, with particular attention on utilizing health technologies to reach more patients. Examining the effectiveness of CBT-I and its downstream effects on immune functioning, chronic health conditions, and recovery is also greatly needed.

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Synopsis: Differences in sleep for men and women begin at a very early age, with women reporting poorer sleep and having a higher risk for insomnia compared to men. Women are particularly vulnerable to developing insomnia during times of reproductive hormonal change. Sleep across the woman's lifespan and special treatment considerations for using cognitive behavioral therapy for insomnia (CBT-I) in women will be addressed in this review.

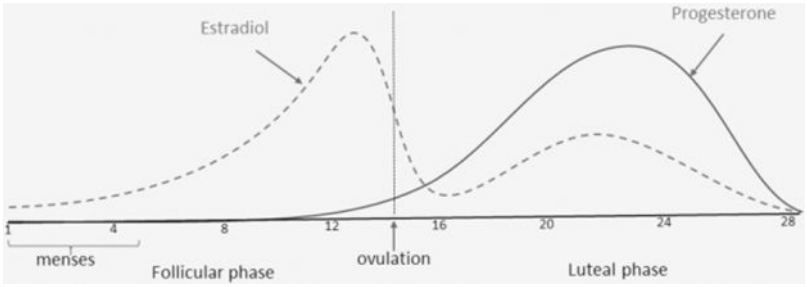

Figure 1.

Changes in estradiol and progesterone across a typical 28-day ovulatory menstrual cycle, where day 1 represents the first day of bleeding. From Baker, FC, Lee KA. Menstrual Cycle Effects on Sleep. Sleep Med Clin 13 (2018) 283-94; with permission.

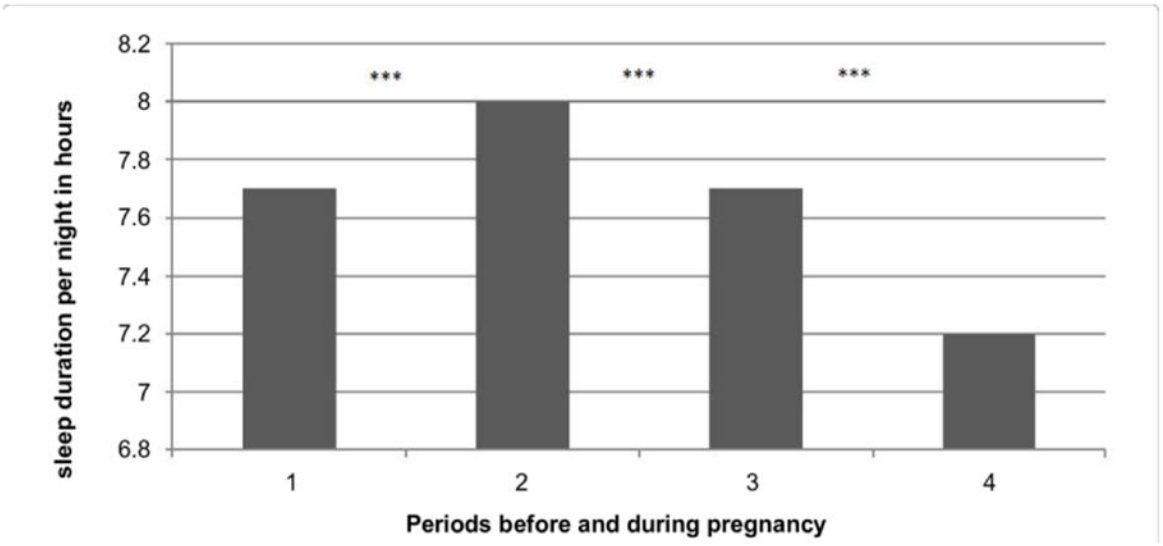

Figure 2.

Evolution of women's sleep duration per night before and during pregnancy. 1: Before pregnancy, 2: First trimester of pregnancy, 3: Second trimester of pregnancy, 4: Third trimester of pregnancy. *** $P \leq 0.001$. Data from Bat-Pitault et al. Sleep Pattern During Pregnancy and Maternal Depression: Study of Aube Cohort. J Sleep Disord Manag 2015, 1:1

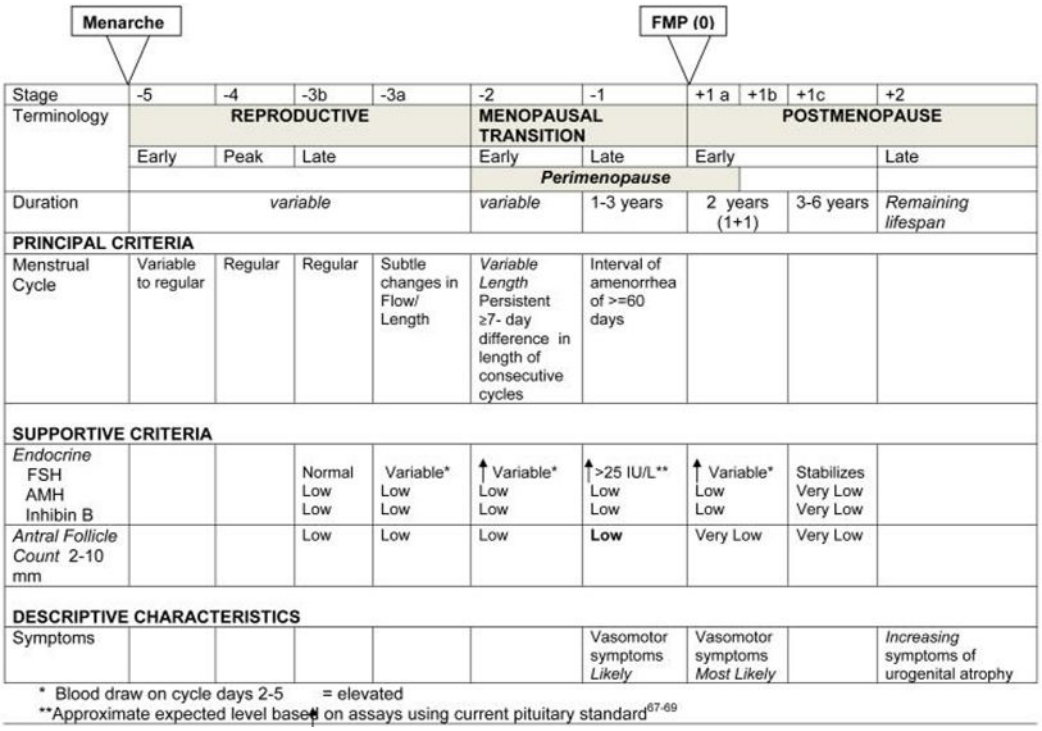

Figure 3.

The STRAW+10 Staging System for Reproductive Aging in Women. From Harlow SD, Gass M, Hall JE, et all. Executive summary of the Stages of Reproductive Aging Workshop +10: addressing the unfinished agenda of staging reproductive aging. Climacteric 15(2). 2012 105-14; with permission.

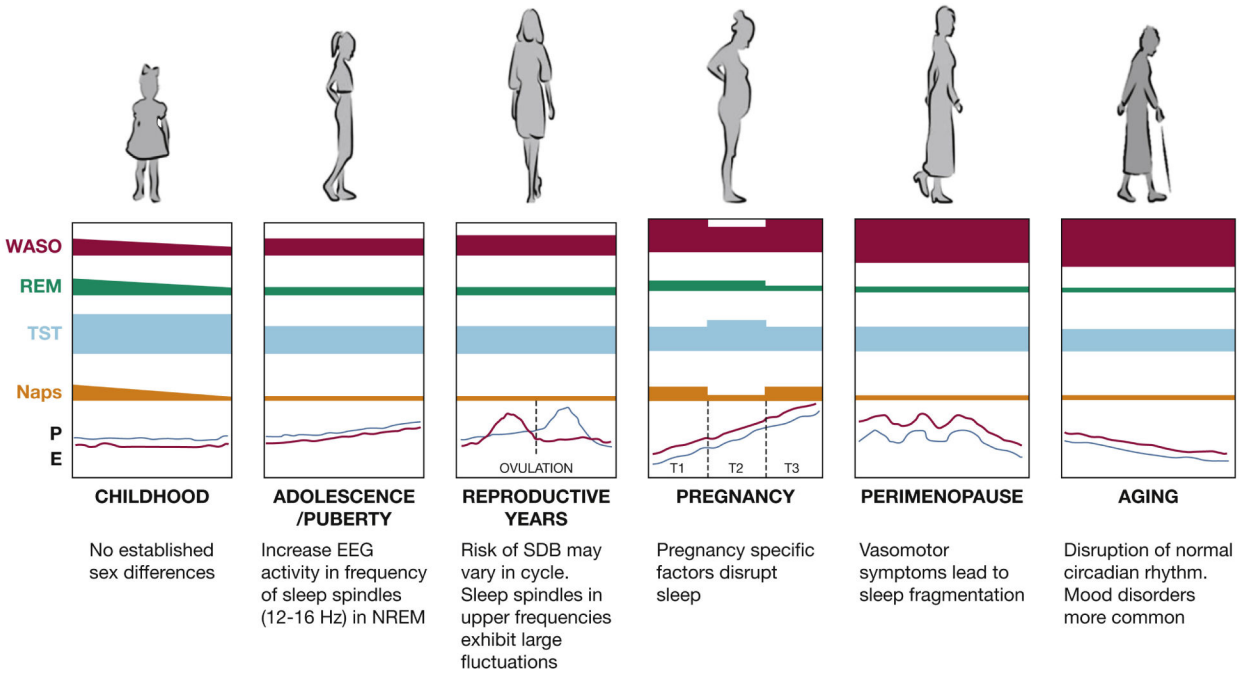

Figure 4.

Sleep in women across the life span. E = estrogen; NREM = non-rapid eye movement; P = progesterone; REM = rapid eye movement; SDB = sleep-disordered breathing; T = trimester; TST = total sleep time; WASO = wake after sleep onset. From Pegno et al. CHEST 2018; 154(1): 196-206; with permission.