Menstrual Cycle Effects on Sleep

Fiona C. Baker, PhD[a,b,*], Kathryn Aldrich Lee, RN, PhD, CBSM[c]

KEYWORDS

• Menstrual cycle • Follicular • Luteal • Estrogen • Premenstrual syndrome • Dysmenorrhea • Polycystic ovary syndrome • Sleep spindles

KEY POINTS

- Self-reported sleep disturbance increases during premenstrual and menstruation phases of the menstrual cycle, particularly in women with premenstrual symptoms or painful menstrual cramps (dysmenorrhea).
- Sleep spindles increase in the luteal phase relative to the follicular phase, possibly due to an effect of progesterone and/or its metabolites.
- Women with polycystic ovary syndrome, particularly if obese, are at risk of sleep disordered breathing, partly due to hyperandrogenism that characterizes this syndrome.
- Poorer sleep quality is apparent in the premenstrual phase in women with severe premenstrual syndrome, yet polysomnographic measures show more traitlike sleep alterations that may be related to altered melatonin rhythms. Light therapy shows efficacy in improving mood symptoms.
- Sleep and reproductive function have a bidirectional relationship such that disrupted sleep is associated with altered menstrual cycles, which could impact reproductive function.

INTRODUCTION

From menarche, or first menstrual period, to menopause that signals the end of reproduction, women experience monthly variations in hormones that regulate reproduction. These hormones have widespread effects outside their direct reproductive functions, including influences on regulating mood, body temperature, respiration, autonomic nervous system, and sleep. This review highlights the effects of the menstrual cycle on sleep, considering both physiologic changes in homeostatic and circadian sleep regulation as well as perceived changes in sleep quality. The authors discuss sleep disturbances in the context of young women and menstrual-associated disorders, including polycystic ovary syndrome, dysmenorrhea, and premenstrual dysphoric disorder. They also consider reverse relationships: how sleep and circadian disturbances impact women's reproductive physiology.

DEFINITIONS AND MENSTRUAL CYCLE PHYSIOLOGY

Most women have menstrual cycle lengths between 21 and 30 days, with menses lasting less than 7 days.[1] The menstrual cycle is divided into a preovulatory follicular phase and postovulatory luteal phase, with the onset of menstrual flow marking the beginning of a new cycle (day 1) (Fig. 1).

During the follicular phase, follicle-stimulating hormone and luteinizing hormone (LH) are released

Disclosure statement: F.C. Baker has received funding unrelated to this work from Ebb Therapeutics Inc, Fitbit Inc, and International Flavors & Fragrances Inc. K.A. Lee has nothing to disclose.

[a] Human Sleep Research Program, SRI International, 333 Ravenswood Avenue, Menlo Park, CA 94025, USA; [b] Brain Function Research Group, School of Physiology, University of the Witwatersrand, 7 York Road, Parktown, Johannesburg 2193, South Africa; [c] Department of Family Health Care Nursing, UCSF School of Nursing, University of California, San Francisco, Box 0606, San Francisco, CA 94143, USA
* Corresponding author. SRI International, 333 Ravenswood Avenue, Menlo Park, CA 94025.
E-mail address: Fiona.baker@sri.com

Sleep Med Clin 13 (2018) 283–294
https://doi.org/10.1016/j.jsmc.2018.04.002

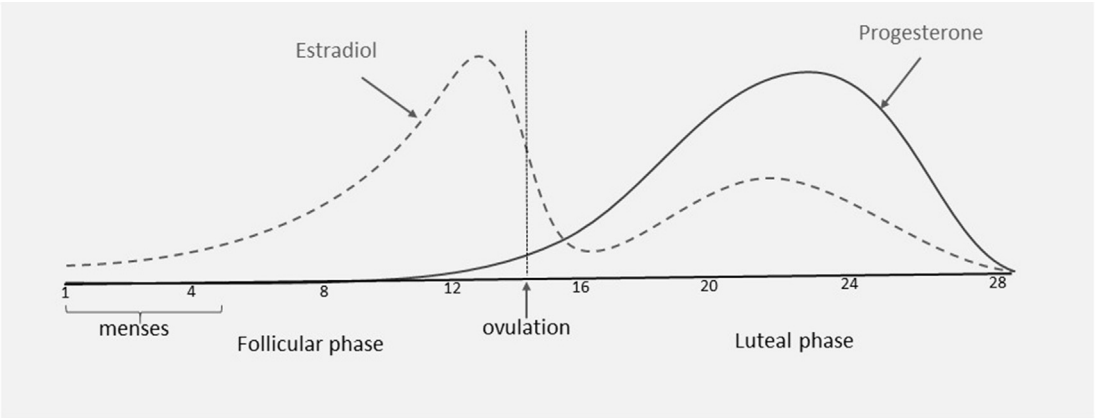

Fig. 1. Changes in estradiol and progesterone across a typical 28-day ovulatory menstrual cycle, where day 1 represents the first day of bleeding.

from the anterior pituitary and act on the ovaries to initiate development of several primary follicles, which produce estrogens, principally estradiol. At the end of the follicular phase, estrogen levels increase, triggering a peak in LH. Ovulation occurs 12 to 16 hours later, around day 14. Following ovulation, the corpus luteum develops, producing progesterone and estrogen, which peak 5 to 7 days after ovulation before declining (in the absence of implantation), resulting in endometrial breakdown and menstruation.

Estrogen and progesterone receptors are widely distributed throughout the central nervous system (CNS), including the basal forebrain, hypothalamus, dorsal raphe nucleus, and locus coeruleus.[2,3] These areas are also involved in sleep regulation, and fluctuations in ovarian steroids across the menstrual cycle can modulate sleep. Indeed, work in rodents shows that sleep patterns fluctuate in concert with natural fluctuations of ovarian steroids; ovariectomy eliminates these fluctuations in sleep, with effects depending on the time of day.[4,5] Although ovarian steroids' mechanisms of action on sleep regulation are not completely clear, both sleep- and wake-promoting areas of the CNS are sensitive to the effects of estrogen. Ovarian steroids could also influence circadian rhythms, including sleep-wake activity, through direct or indirect effects on the master pacemaker: the suprachiasmatic nucleus. The mechanistic framework is, therefore, in place for menstrual cycle–related changes in reproductive hormones to influence sleep and circadian rhythms.

SLEEP AND CIRCADIAN RHYTHMS ACROSS THE MENSTRUAL CYCLE

Self-Reported Sleep Quality

Collectively, studies show that sleep disturbances are more commonly reported by women around the time of menstruation, encompassing the last few premenstrual days (late luteal phase) and the first few days of menstrual bleeding (early follicular phase).[6–9] However, not all studies find a menstrual cycle effect on sleep quality[10] or find only small effects,[11] possibly reflecting between-individual variability in the relationship between sleep and menstrual cycle phase. Van Reen and Kiesner[12] identified 3 patterns: some women show no relationship, others show a midcycle increase in difficulty sleeping, and others show a premenstrual increase in difficulty sleeping. The extent that ovarian hormones directly contribute to perceived sleep disturbance, versus other factors that vary with the menstrual cycle, remains unclear. Changes in progesterone and estrogen, rather than absolute levels, in the late-luteal phase may be a critical factor for sleep quality. Further, symptoms that vary across the menstrual cycle in some women, such as anxiety, depression, headaches, cramps, and breast tenderness, are also associated with difficulty sleeping.[12] Menstrual cycle characteristics are also relevant: women with irregular cycles report more sleep difficulties than women with regular cycles, even when controlling for age, body mass index (BMI), dysmenorrhea, and premenstrual complaints.[13]

Objectively Measured Sleep Quality

Sleep across the menstrual cycle has been studied objectively with actigraphy and polysomnography (PSG). Actigraphy can be easily used to track changes in daily sleep-wake activity in many participants; however, few studies have investigated menstrual cycle–related patterns in sleep. In a actigraphy study of 163 late-reproductive-aged women, there was a significant decline in sleep efficiency (SE) and total sleep time (TST) in the premenstrual week relative to the prior week, with