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Ana K. Rosen Vollmar , Shruthi Mahalingaiah , Anne Marie Jukic *

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The Menstrual Cycle as a Vital Sign: A Comprehensive Review

Running title: Menstrual Cycle as a Vital Sign

Ana K. Rosen Vollmar [1], Shruthi Mahalingaiah [2,3] and Anne Marie Jukic [1,*]

[1] National Institute of Environmental Health Sciences, Epidemiology Branch, PO BOX 12233, Durham, NC, 27709, USA

[2] Department of Environmental Health, Harvard T.H. Chan School of Public Health, Boston, MA, 02115, USA

[3] Department of Obstetrics and Gynecology, Massachusetts General Hospital; Boston, MA, 02114, USA

* Correspondence: jukica@niehs.nih.gov; (919) 724-7766

Abstract: Some medical professional organizations have advocated for including the menstrual cycle as a vital sign in adolescence, but not in adulthood. However, documenting menstrual cycle patterns is not routine clinical or research practice. Vital signs are used to predict health outcomes, indicate needed treatment, and monitor a clinical course. They can help identify pathologies, affirm wellness, and are responsive to exposures. Here we review the scientific evidence showing how the menstrual cycle meets these criteria and should therefore be treated as a vital sign. Using key words and controlled vocabulary terms, we carried out multiple literature searches, prioritizing the inclusion of systematic reviews, meta-analyses, and clinical practice guidelines. This review describes how the menstrual cycle is a health indicator, can cyclically impact health conditions, and its associations with long-term post-menopausal health outcomes. We review exposures influencing the menstrual cycle, evidence underlying its use to optimize wellness, and available tools for documenting cycles. Supplementary materials include patient handouts on menstrual cycle tracking, and an index of related clinical practice guidelines and reviews by subject. The menstrual cycle is a vital sign from menarche through menopause, an underutilized but powerful tool for understanding gynecological and general health.

Keywords: menstrual cycle; menstruation; vital signs; menstrual cycle tracking; menstrual health

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Introduction

In 2006, the American College of Obstetricians and Gynecologists (ACOG) and American Academy of Pediatrics (AAP) advocated using the menstrual cycle as a vital sign for girls and adolescents, allowing early identification of health conditions with abnormal menstrual patterns and early interventions to improve adult health outcomes (1, 2). ACOG reaffirmed its opinion in 2015 and 2021. Since these committee opinions were published, smartphone cycle tracking applications proliferated (3); menstrual equity laws were passed to address period poverty and improve menstrual product accessibility, affordability, and safety (4); and thousands of individuals reported COVID-19 mRNA vaccines seemed to impact their cycles, spurring research and highlighting the fact that cycle information is rarely collected in vaccine trials (5). Menstrual health is of critical public health importance, directly impacting the health and wellbeing of people who menstruate, and requiring the education and involvement of those who do not experience the menstrual cycle (6, 7). The Global Menstrual Collective defines menstrual health as "a state of physical, mental, and social well-being and not merely the absence of disease or infirmity, in relation to the menstrual cycle" (7). Treating the menstrual cycle as a vital sign has the potential to increase access to accurate information

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across the lifespan and improve timely diagnosis and treatment of menstrual health-related conditions (7).Yet, documenting the menstrual cycle as a vital sign is still not routine clinical practice.

In this review, we assess the evidence for treating the menstrual cycle as a vital sign from menarche to menopause. We describe how the menstrual cycle is a health indicator, associated with long-term health outcomes, and used to optimize wellness. We review exposures that can influence the menstrual cycle, and health conditions that can vary with it. We also summarize available tools for documenting cycles. While ACOG and AAP advocated using the menstrual cycle as a vital sign for children and adolescents, based on the evidence we argue it should be considered a vital sign through menopause. In this review, we use the inclusive terms "menstruator" (8) and "people with a menstrual cycle".

Methods

For each of the review's core terms and main subsections, we developed a list of concept terms and used key word and controlled vocabulary searches in the PubMed database to search for current systematic reviews, meta-analyses, or clinical practice guidelines published since 2020 covering the topic. If such literature was unavailable, we searched for original research published since 2020 and earlier reviews from 2010-2020. Concept terms, MeSH terms, and search strategies for each subsection are included in Supplementary Materials. Articles were screened using title and abstract, and were also identified through bibliographic review. During full text review, we also screened for study type, prioritizing the inclusion of high-quality systematic reviews, meta-analyses, clinical practice guidelines, and sentinel research studies. Practice guidelines and reviews with a clinical practice emphasis included in this review are also listed by subject in Supplementary Table S1 for further clinical reference.

Vital Signs

Vital signs are patient features used to predict health outcomes, indicate need for treatment, and monitor a clinical course (9-11). They help identify pathologies, affirm wellness, and are responsive to exposures. Vital signs are dynamic. The classic vital signs – pulse, temperature, respiratory rate, and blood pressure – change over seconds to minutes. The menstrual cycle has a longer timeframe of days to months, but is also dynamic. Although information from a single point in time can be useful, trends over time are key to interpreting vital signs (9, 10). The same is true of the menstrual cycle: although information from a single cycle can be useful, it cannot capture variability or patterns over time (12). Just as the classic vital signs regularly are altered with, for example, antihypertensives and exercise, the menstrual cycle is also routinely altered with medications and hormones.

The Menstrual cycle

The menstrual cycle is a series of interdependent cyclic physiologic events. In a typical cycle, the hypothalamus releases pulses of gonadotropin-releasing hormone (GnRH), leading to the release of follicle stimulating hormone (FSH) and luteinizing hormone (LH) from the pituitary gland (13). During the follicular phase, FSH stimulates the growth of ovarian follicles. As the follicles develop, they secrete increasing levels of estradiol which stimulates endometrial proliferation (14). At the same time, rising estradiol leads to a mid-cycle LH surge, which triggers ovulation. The luteal phase begins as the ruptured follicle becomes the corpus luteum which secretes multiple hormones, especially progesterone which stimulates decidualization of the endometrium. With corpus luteum involution, progesterone declines triggering menstruation and the start of a new menstrual cycle (13-15).

Commonly tracked external indicators reflecting the internal hormonal changes of the menstrual cycle include vaginal bleeding, basal body temperature (BBT), cervical fluid or mucus, and urinary levels of LH, and estradiol, progesterone, and their metabolites (14). BBT is measured upon waking at approximately the same time each day (16). It is approximately 0.5 °F (0.3 °C) lower in the follicular than the luteal phase (14, 15). After ovulation, increasing progesterone raises BBT until 1-2 days before menses, when BBT falls. Daily BBT tracking can be used to confirm ovulation retrospectively.

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Changes to cervical fluid across the menstrual cycle are easily observed at the vulva and cervix (17). In ovulatory cycles, cervical fluid changes in sensation (from dry, to moist, to wet, to slippery), color (from white/yellow to clear), and consistency (from tacky, to creamy, to stretchy) (18, 19). It is produced most abundantly in the days just before ovulation, and the last day of clear, stretchy (at least 1 inch), and slippery cervical fluid occurs within about 24 hours of ovulation in 75% of menstrual cycles (18, 20). As estrogen levels fall after ovulation and progesterone rises, cervical fluid disappears and menstruators experience dry days for the rest of the luteal phase (15, 20). See Supplementary Materials for educational handouts on tracking the menstrual cycle.

Non-Reproductive Physiologic Changes across the Menstrual Cycle

The menstrual cycle impacts an array of non-reproductive physiologic processes in the body (Table 1). The classic vital signs – temperature, heart rate, respiratory rate, blood pressure – all measurably increase in the luteal phase before declining with the onset of menstruation (21-26). The implications of these changes for other physiologic functions are not well known, but at minimum are connected to cyclic changes in thermoregulation, fluid regulation, and metabolism.

Table 1. Non-reproductive physiologic changes across the menstrual cycle.

Physiologic parameter or process	**Menstrual cycle phase**			
	Menses	**Follicular phase**	**Luteal phase**	**References**
Vital signs				
Temperature	↓		↑ 0.5-0.8 °C	(23, 25)
Heart rate	↓		↑ 3 bpm/3-5%	(21, 25, 26)
Heart rate variability		↑ variability	↓ variability	(26)
Respiratory rate	↓		↑ 0.8 breaths/minute	(26)
Blood pressure	↓		↑ 3mmHg	(22, 24)
Thermoregulation				
Sweating			↑ 0.5 °C response threshold compared to follicular phase	(22, 23)
Skin vasodilation			↑ 0.5 °C response threshold compared to follicular phase	(22, 23, 27)
Shivering			↑ 0.5 °C response threshold compared to follicular phase	(22, 23, 27)
Fluid regulation				
Thirst threshold		↓ threshold, ↑↑ thirst stimulation	threshold, ↓ thirst stimulation	(28, 29)
Arginine vasopressin		↑ production, ↓ threshold for release	↓ release	(28, 29)
Aldosterone		↓ production	↑ production	(28, 29)
Interstitial fluid			↑ compared to follicular phase	(28, 29)
Plasma volume		↑ with preovulation peak	↓ up to 8%	(28, 29)
Plasma osmolality		↓	↑	(28, 29)
Metabolism				
Basal metabolic rate			↑ 5-9% compared to follicular phase	(21)
Energy intake		↓, with nadir at ovulation	↑	(30)

Glycogen storage			↑ compared to follicular phase	(30)
Fat metabolism			↑ compared to follicular phase	(30)
Protein metabolism			↑ compared to follicular phase	(30)
Sleep				
REM episodes			↓ compared to follicular phase	(35)
Sleep spindles			↑ compared to follicular phase	(35)
Circadian rhythms				
Temperature			↓ amplitude of change compared to follicular phase	(34, 37)
Cortisol			↓ amplitude of change compared to follicular phase	(34)
Thyroid stimulating hormone			↓ amplitude of change compared to follicular phase	(34)
Immune system				
C-reactive protein	↑ compared to follicular and luteal phases			(31)
Regulatory T-cells		↑ number	↓ number	(32)
Hemostatic factors				
von Willebrand's factor	↓ compared to follicular or luteal phase			(38)
Platelets	↓ compared to follicular or luteal phase			(38)
Microbiome				
Vaginal microbiome	↑ species diversity		↓ species diversity with *Lactobacillus* spp. dominance	(39)

Thermoregulation keeps body temperature stable across varying environments and activities. Increased luteal phase BBT increases the temperature thresholds triggering skin vasodilation, sweating, and shivering (22, 23, 27). Because large volumes of blood are moved to and from skin circulation as part of the body's responses to heat and cold, blood pressure regulation is intertwined with thermoregulation. Cyclic blood pressure changes are thought to be linked to levels of estradiol – a vasodilator – and the sympathetic nervous system, which is more active in the luteal phase as evidenced by decreased heart rate variability (22, 24, 26).

Estrogen and progesterone also influence fluid. Estrogen decreases the threshold for arginine vasopressin (AVP) release; when AVP levels are higher, more water is resorbed by the kidneys rather than excreted in urine, resulting in lower plasma osmolality without water retention (28, 29). Progesterone is thought to increase aldosterone concentration, which promotes sodium reabsorption and water retention (28, 29). The implications of elevated luteal phase estrogen and progesterone for fluid dynamics is not completely understood, but in the luteal phase, plasma volume has been observed to decline up to 8%, and plasma osmolality and interstitial fluid are elevated (28, 29). Energy intake and the basal metabolic rate also increase in the luteal phase, accompanied by changes to carbohydrate, fat, and protein metabolism (21, 30).

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Interactions between the immune system and the menstrual cycle are not yet fully understood. Although research on immune cells fluctuations across the cycle is scant, regulatory T cells appear to be lower in the luteal phase, and C-reactive protein (CRP), an indicator of general inflammation, is elevated during menses (31, 32). This aligns with observations that some autoimmune disorders have cyclic flare-ups, typically worsening premenstrually and during menses (32). Additionally, immune responses occurring with some vaccines, like the COVID-19 mRNA vaccines, are hypothesized to impact the HPO axis, causing temporary changes to cycle length (33).

Circadian rhythms, hemostatic factors, and the vaginal microbiome also vary across the menstrual cycle. The amplitude of several circadian rhythms, including body temperature and cortisol levels, decreases during the luteal phase (34, 35). Circadian rhythms interact with the menstrual cycle in complex ways, including via the suprachiasmatic nucleus, the circadian pacemaker, which contains estrogen and progesterone receptors and interacts with GnRH across the menstrual cycle (36, 37). The complex neuroendocrine interplay between the menstrual cycle and circadian rhythms has primarily been studied in rodents and is not fully understood in humans. Although most hemostatic factors do not appear to fluctuate cyclically, evidence does support changes to von Willebrand factor and platelets, which are lowest during menses and the early follicular phase (38). Composition of the vaginal microbiome strongly varies across the menstrual cycle, with more species diversity during menses. As the cycle progresses, microbial composition stabilizes, with *Lactobacillus* spp. dominance in the luteal phase (39).

Our understanding of these cyclic changes is limited as menstruators are underrepresented in physiologic research and menstrual cycle data is infrequently documented. Despite this, cyclic fluctuations of diverse physiologic parameters and processes have been observed, underscoring the importance and value of collecting menstrual cycle data and accounting for cycle phase in research.

The Menstrual Cycle as Health Indicator

The menstrual cycle responds to diverse health conditions (Table 2). Observed over time, it can serve as an indicator for endocrine diseases, bleeding disorders, structural anomalies of the reproductive tract, neoplasms, infections, and infertility (40, 41). While providing detailed clinical practice guidelines on using menstrual cycle characteristics to diagnose health conditions is beyond the scope of this review, practice guidelines and reviews with a clinical practice emphasis related to the menstrual cycle and cited in this review are listed by topic in Table S1 for ease of further reference.

Table 2. Health conditions and the menstrual cycle.

Health condition	Associated changes to menstrual cycle	References
	Endocrine disorders	
Polycystic ovarian syndrome (PCOS)	Irregular, infrequent bleeding; long cycles; variable volume and duration of bleeding; amenorrhea	(42, 45*, 46*)
Hypothalamic amenorrhea	Amenorrhea	(43*)
Primary or premature ovarian insufficiency	Infrequent bleeding; amenorrhea	(48, 49*)
Ovulatory dysfunction	Irregular bleeding; amenorrhea	(12*, 50*)
Diabetes (types 1 and 2)	Long cycles; infrequent bleeding; variability in menstrual cycle length; prolonged and heavy bleeding; amenorrhea; later menarche and earlier menopause (type 1 diabetes)	(42, 44*)
Hypothyroidism	Irregular and infrequent bleeding; heavy or prolonged bleeding; amenorrhea	(42, 47)
Hyperthyroidism	Infrequent or frequent bleeding; low volume of bleeding; amenorrhea	(42, 47)
	Bleeding disorders	

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von Willebrand's disease	Heavy or prolonged bleeding	(56*, 57*)
Platelet dysfunction	Heavy or prolonged bleeding	(56*, 57*)
Structural anomalies and pathologies		
Congenital structural anomalies	Amenorrhea, increasing dysmenorrhea after menarche, acyclic or cyclic pelvic/abdominal pain	(62*, 63, 64*)
Fibroids (uterine leiomyomas)	Heavy or prolonged bleeding	(40*)
Adenomyosis	Heavy or prolonged bleeding	(40*)
Endometrial polyps	Intermenstrual bleeding	(40*)
Cervical polyps	Intermenstrual bleeding	(40*)
Endometriosis	Heavy or prolonged menstrual bleeding	(40*)
Cancers of the reproductive tract	Heavy or prolonged menstrual bleeding, Intermenstrual bleeding, dysmenorrhea	(40*)
Cervical dysplasia or cancer	Intermenstrual bleeding	(40*)
Infections		
Vaginitis, cervicitis	Intermenstrual bleeding	(65*)
Sexually transmitted infections (i.e., chlamydia, gonorrhea)	Intermenstrual bleeding	(40*, 41*, 65*)
Physiologic changes across the lifespan		
Menarche and development of ovulatory cycles	Cycle length of 21-45 days, with increasing regularity and fewer anovulatory cycles over time; cycle length of 21-34 days by 3 years after menarche; heavy menstrual bleeding is never normal; menses last 2-7 days	(70)
Pregnancy	Amenorrhea	(69)
Postpartum return of the ovarian cycle	Amenorrhea, anovulatory cycles, short luteal phase	(69)
Lactational amenorrhea	Amenorrhea, anovulation, infrequent bleeding	(69)
Perimenopause/menopausal transition	Regular bleeding with increased frequency, shorter cycle length, anovulatory cycles	(69)

Health condition	Condition changes across the menstrual cycle	References
Neurological conditions		
Migraine	Migraines more common in premenstrual phase, during menses, and around ovulation	(71, 72, 73*)
Seizures	Increased seizures in premenstrual phase, during menses, around ovulation, during luteal phase in anovulatory cycles, and during perimenopause; seizures least likely during luteal phase of ovulatory cycles	(71, 74*, 75*)
Autoimmune conditions		
Systemic lupus erythematosus	Symptoms worse in premenstrual phase	(32)
Multiple sclerosis (MS)	Symptoms worse in luteal and premenstrual phases	(74*)
Rheumatoid arthritis	Symptoms better during luteal phase, worse during menses	(71, 76)
Chronic pain conditions		
Fibromyalgia	Pain and symptoms worse in premenstrual phase and during menses	(76)

Musculoskeletal pain	Pain worse in premenstrual phase and during menses	(76)
Temporomandibular disorder	Pain worse in premenstrual phase, during menses, and occasionally around ovulation	(76)
Mental health disorders		
Psychotic disorders	Symptoms worse in premenstrual phase and during menses	(77)
Depression	Symptoms worse in premenstrual phase and during menses	(77)
Panic disorder	Symptoms worse in premenstrual phase and during menses	(77)
Eating disorders	Symptoms worse in premenstrual phase and during menses	(77)
Borderline personality disorder	Symptoms worse in premenstrual phase and during menses	(77)
Bipolar disorder	Symptoms worse in premenstrual phase, during menses, and occasionally around ovulation	(77)
Other conditions		
Asthma	Symptoms worse in premenstrual phase and during menses, with decreased lung function	(71, 78)
Irritable bowel syndrome	Pain and symptoms worse in premenstrual phase and during menses (diarrhea/loose stool) and post-ovulation (constipation)	(71, 76)

* Reference is a clinical practice guideline or review with clinical practice emphasis. See Supplementary Table S1 for a full reference list of practice guidelines and clinical reviews cited in this paper.

Irregular cycle length, variable volume and duration of bleeding, and amenorrhea indicate disturbances to the endocrine system and the hypothalamic-pituitary-ovarian (HPO) axis (42, 43). Endocrine conditions that can perturb the menstrual cycle include type 1 and 2 diabetes (44), polycystic ovarian syndrome (PCOS) (45, 46), thyroid diseases (47), primary or premature ovarian insufficiency (48, 49), and ovulatory disorders (12, 50). Documenting menstrual cycle patterns can help assess, diagnose, and treat infertility, guiding clinical testing and fertility treatment timing (14).

Approximately 27%-53% of menstruators experience heavy menstrual bleeding (HMB) (51, 52), or bleeding that affects quality of life (53). HMB can cause iron deficiency, anemia, fatigue, and hemodynamic instability (54, 55). It is often the sentinel symptom of a bleeding disorder (56, 57): studies found 29%-47% of menstruators with HMB have a bleeding disorder, most commonly von Willebrand's disease or platelet dysfunction (58, 59). While rare, menstruators with bleeding disorders can experience hemorrhage during ovulation (60). A systematic review of hemostatic factors across the menstrual cycle found evidence for cyclic variation of platelets and von Willebrand factor, with lowest levels during menstruation and the early follicular phase (38). Anovulatory cycles from ovulation disorders such as PCOS also increase the risk of HMB, as prolonged estrogen exposure causes increased endometrial build-up and uncontrolled bleeding (61).

The menstrual cycle can indicate congenital structural/obstructive anomalies of the reproductive tract, with symptoms including amenorrhea, increasing dysmenorrhea after menarche, and pelvic or abdominal pain (cyclic and non-cyclic) from menstrual blood retention (62-64). Because structural differences are rarely externally visible, these symptoms during puberty often provide the first clue of an underlying condition (62). Other structural abnormalities causing HMB, dysmenorrhea, and intermenstrual bleeding are polyps, adenomyosis, fibroids, and neoplasms of the reproductive tract ranging from cervical dysplasia to uterine cancers (40).

Abnormal uterine bleeding like spotting and intermenstrual bleeding can signal sexually transmitted infections (40, 41). Chlamydia and gonorrhea, often asymptomatic, commonly cause

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cervicitis (65). Left untreated, they can develop into pelvic inflammatory disease (66, 67), increasing the risk of infertility, ectopic pregnancy, and chronic pelvic pain (65, 68).

Shifts in menstrual cycle patterns can also signal physiologic changes such as pregnancy, the postpartum return of the ovarian cycle, lactational amenorrhea, perimenopause, and menopause (69, 70). When people are familiar with their menstrual cycle patterns, these changes can be detected earlier and better understood.

Menstrual Cycle Impacts on Health Conditions

Hormonal fluctuations across the menstrual cycle can cause cyclic changes in neurological, chronic pain, mental health, gastrointestinal, and other conditions (Table 1) (71). Migraine headaches and seizures are more common perimenstrually and around ovulation. Estrogen withdrawal is thought to contribute to migraines, as estrogen receptors are found throughout the brain, including along pain-processing and migraine pathways (72, 73). Estrogen-progesterone ratios may impact menstrual-related epilepsy, increasing perimenstrual seizures: estrogen is a proconvulsant while progesterone has an anticonvulsant effect (74, 75).

Several autoimmune diseases exhibit cyclic symptom fluctuations. Systemic lupus erythematosus may have premenstrual flare-ups (32). Multiple sclerosis symptoms also worsen premenstrually, with an increased lesion size observed in the luteal phase. These changes are hypothesized to be linked to increased luteal phase BBT, as temperature elevations can exacerbate neurological symptoms in demyelinating conditions (74). In contrast, rheumatoid arthritis symptoms typically improve during the luteal phase when estrogen and progesterone are high, with increased pain and stiffness during menses and the early follicular phase (71, 76). Chronic pain associated with fibromyalgia musculoskeletal conditions, and temporomandibular disorder also can worsen perimenstrually when estrogen, involved along pain pathways, is low (76).

Some mental health disorders can be exacerbated by the menstrual cycle. Symptoms of depression and eating, panic, borderline personality, bipolar, and psychotic disorders all may worsen during the perimenstrual phase, possibly due to some individuals' increased sensitivity to hormone fluctuations (77). Asthma worsens perimenstrually, possibly related to declining progesterone, although the etiology remains largely unknown (71, 78). In irritable bowel syndrome, progesterone relaxes sphincters and delays gastric emptying, with constipation after ovulation when progesterone is high, and perimenstrual loose stool when levels fall (71).

Menstrual Cycle Characteristics and Long-Term Health

Menstrual cycle characteristics – especially long and irregular cycles – are associated with long-term health outcomes, including cancer, diabetes, cardiovascular disease (CVD), fracture, and premature mortality (Table 3).

Table 3. Long-term health outcomes associated with menstrual cycle characteristics.

Health outcome	Participants, n	Menstrual cycle characteristic	Age at menstrual cycle assessment	Comparison group	Age at outcome assessment	Health outcome risk estimate (95% CI)	References
			Cancer – cycle regularity				
a) Any cancer b) Obesity-related cancer[a]	78,943	Always irregular or no menses (self-report)	29-46 yr	Very regular cycles (±3 d)	Incident cases over 22 years of follow-up	a) HR=1.11 (1.02, 1.21) b) HR=1.23 (1.09, 1.39)	(79)
Ovarian cancer	15,528	Irregular cycles (self-reported, diagnosed, or cycle length >35 d)	Median 26 yr	Regular cycles	70 yr	HR=2.26 (1.20, 4.26)	(80)

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Obesity-related cancer[a]	78,943	Change from regular (±7 d) to always irregular or no menses (self-report)	18-22 yr (regular), 29-46 yr (irregular)	No change in regular cycles	Incident cases over 22 years of follow-up	HR=1.36 (1.09, 1.69)	(79)
			Cancer – cycle length				
a) Any cancer b) Obesity-related cancer[a]	78,943	Long cycles (≥40 d)	29-46 yr	26-31 d cycles	Incident cases over 22 years of follow-up	a) HR=1.22 (1.09, 1.37) b) HR=1.37 (1.17, 1.59)	(79)
			Diabetes – cycle regularity				
Type 2 diabetes	704,743	Irregular cycles (medical record, variation >20 d over 12 months)	18-40 yr (median 27 yr)	Regular cycles (variation 2-20 d over 12 months), age-matched	Incident cases over 26 yr after enrollment	HR=1.37 (1.29, 1.45)	(81)
Type 2 diabetes	13,714	Often irregular cycles (self-report)	45-50 yr (mean 48 yr)	Regular cycles (self-report, includes never, rarely, or sometimes irregular cycles)	Incident cases over 20 yr follow-up	HR=1.17 (1.00, 1.38)	(84)
Type 2 diabetes	75,546	Always irregular or no menses (self-report)	a) 14-17 yr b) 18-22 yr c) 29-46 yr	Very regular cycles (±4 d)	Incident cases over 24 yr follow-up	a) HR=1.32 (1.22, 1.44) b) HR=1.41 (1.23, 1.62) c) HR=1.66 (1.49, 1.84)	(82)
Type 2 diabetes	75,546	Change from regular (±7 d) to irregular (self-report)	a) 14-17 yr (regular), 29-46 yr (irregular) b) 18-22 yr (regular), 29-46 yr (irregular)	No change in regular cycles	Incident cases over 24 years of follow-up	a) HR=1.28 (1.14, 1.43) b) HR=1.34 (1.13, 1.60)	(82)
a) Prediabetes b) Type 1 diabetes c) Type 2 diabetes	21,213	Irregular cycles (self-reported as unpredictable)	At study enrollment, mean age 34.5 yr	Regular cycles (self-reported as predictable)	Mean age: a) 38.4 yr b) 19.1 yr c) 39.6 yr	a) POR=1.47 (1.28, 1.67) b) POR=1.13 (0.75, 1.66) c) POR=1.46 (1.18, 1.81)	(85)
a) Prediabetes b) Type 1 diabetes c) Type 2 diabetes	37,707	Prolonged time to cycle regularity (>5 yr after menarche)	Within 5 yr of menarche	Cycle regularity within 4 yr of menarche	Mean age: a) 38.4 yr b) 19.1 yr c) 39.6 yr	a) POR=1.20 (1.08, 1.32) b) POR=1.47 (1.13, 1.89) c) POR=1.24 (1.05, 1.33)	(85)
Gestational diabetes	10,906 (14,418 pregnancies)	Always irregular or no menses (self-report)	29-46 yr	Very regular cycles (±4 d)	Incident cases over 16 years of follow-up	RR=1.65 (1.21, 2.25)	(83)

Gestational diabetes	10,906 (14,418 pregnancies)	Change from regular to irregular (self-report)	18-22 yr (regular), 29-46 yr (irregular)	No change in regular cycles	Incident cases over 16 years of follow-up	RR=1.68 (0.93, 3.01)	(83)
			Diabetes – cycle length				
Type 2 diabetes	704,743	Short (<24 d) or long (>38 d) cycles (medical record)	18-40 yr (median 27 yr)	24-38 d cycle, age-matched	Incident cases over 26 yr after enrollment	HR=1.74 (1.52, 1.98)	(81)
Type 2 Diabetes	75,546	Long cycles (≥40 d)	a) 18-22 yr b) 29-46 yr	26-31 d cycles	Incident cases over 24 yr follow-up	a) HR=1.37 (1.19, 1.57) b) HR=1.50 (1.36, 1.65)	(82)
Type 2 Diabetes	75,546	Change in cycle length from <32 d to ≥32 d	18-22 yr (<32 d), 29-46 yr (≥32 d)	<32 d maintained	Incident cases over 24 yr follow-up	HR=1.62 (1.39, 1.88)	(82)
Gestational diabetes	10,906 (14,418 pregnancies)	Long cycles (≥32 d)	29-46 yr	26-31 d cycles	Incident cases over 16 years of follow-up	RR=1.42 (1.15, 1.75)	(83)
Gestational diabetes	10,906 (14,418 pregnancies)	Change in cycle length from <32 d to ≥32 d	18-22 yr (<32 d), 29-46 yr (≥32 d)	<32 d maintained	Incident cases over 24 yr follow-up	RR=1.98 (1.24, 2.92)	(83)
			Cardiovascular disease – cycle regularity				
CVD[b]	80,630	Always irregular or no menses (self-report)	a) 14-17 yr b) 18-22 yr c) 29-46 yr	Very regular cycles (±4 d)	Incident cases over 24 years of follow-up	a) HR=1.15 (0.99, 1.34) b) HR=1.36 (1.06, 1.75) c) HR=1.40 (1.14, 1.71)	(87)
CVD[c]	704,743	Irregular cycles (medical record, variation >20 d over 12 months)	18-40 yr (median 27 yr)	Regular cycles (variation 2-20 d over 12 months), age-matched	Incident cases over 26 yr after enrollment	a) HR=1.08 (1.00, 1.19)	(81)
CVD[d]	58,056	Irregular cycles (self-report, ≤21 d or ≥35 d)	40-69 yr (median 46 yr)	Regular cycles (22-34 d)	Incident cases over 10-14 yr follow-up	HR=1.19 (1.07, 1.31)	(86)
CVD[e]	13,714	Often irregular cycles (self-report)	45-50 yr (mean 48 yr)	Regular cycles (self-report, includes never, rarely, or sometimes irregular cycles)	Incident cases over 20 yr follow-up	HR=1.20 (1.01, 1.43)	(84)
CVD[b]	80,630	Change from regular (±7 d) to irregular (self-report)	14-17 yr (regular), 29-46 yr (irregular)	No change in regular cycles	Incident cases over 24 years of follow-up	HR=1.43 (1.11, 1.63)	(87)

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a) Hypertension b) Arrhythmia c) Transient ischemic attack d) Heart attack	21,213	Irregular cycles (self-reported as unpredictable)	At study enrollment, mean age 34.5 yr	Regular cycles (self-reported as predictable)	Mean age: a) 37.1 yr b) 32.3 yr c) 39.5 yr d) 43.5 yr	a) POR=1.25 (1.12, 1.35) b) POR=1.28 (1.08, 1.51) c) POR=1.63 (1.12, 2.32) d) POR=1.68 (0.97, 2.79)	(85)
a) Hypertension b) Arrhythmia c) Transient ischemic attack d) Stroke e) Congestive heart failure	37,707	Prolonged time to cycle regularity (>5 yr after menarche)	Within 5 yr of menarche	Cycle regularity within 4 yr of menarche	Mean age: a) 37.1 yr b) 32.3 yr c) 39.5 yr d) 40.5 yr e) 39.0	a) POR=1.08 (1.00, 1.17) b) POR=1.25 (1.11, 1.40) c) POR=1.37 (1.05, 1.76) d) POR=1.49 (1.11, 1.98) e) POR=1.40 (1.00, 1.92)	(85)
			Cardiovascular disease – cycle length				
CVD[b]	80,630	Long cycles (≥40 d)	a) 18-22 yr b) 29-46 yr	26-31 d cycles	Incident cases over 24 years of follow-up	a) HR=1.44 (1.13, 1.84) b) HR=1.30 (1.09, 1.57)	(87)
CVD[c]	704,743	Short (<24 d) or long (>38 d) cycles (medical record)	18-40 yr (median 27 yr)	24-38 d cycles, age-matched	Incident cases over 26 yr after enrollment	a) HR=1.24 (1.02, 1.52)	(81)
CVD[d]	58,056	a) Short cycles, ≤21 d b) Long cycles, ≥35 d (self-report)	40-69 yr (median 46 yr)	28-34 d cycles	Incident cases over 10-14 yr follow-up	a) HR=1.29 (1.11, 1.50) b) HR=1.11 (0.98, 1.56)	(86)
			Fracture				
Hip fracture	33,434	a) Always irregular cycles (>±5 d, self-report) b) Variable length of menses (not usually same number of d, self-report) c) Always irregular cycles and variable bleeding duration	Postmenopausal report of lifetime menstrual cycle history (study enrollment at 55-69 yr)	a) Never irregular cycles b) Length of menses not variable c) Regular cycles and regular bleeding duration	Self-reported cases over 11 years	a) RR=1.36 (1.03, 1.78) b) RR=1.40 (1.10, 1.78) c) RR=1.82 (1.55, 2.15)	(92)
Wrist fracture	832	a) Late menarche (14-18 yr) b) Long cycle length (>30.5 d) c) Long bleeding duration (>6 d)	28-32 yr	a) Menarche at 12-13 yr b) Cycle length 26.6-30.5 d	Fracture history questionnaire at mean age 73 yr	a) OR=3.29 (1.73, 6.23) b) OR=2.23 (1.02, 4.89) c) OR=1.66 (0.89, 3.13)	(93)

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				c) Bleeding duration 4.7-6 d			
			Premature mortality				
Premature mortality (<70 yr)	79,505	Always irregular or no menses (self-report)	a) 14-17 yr b) 18-22 yr c) 29-46 yr	Very regular cycles (±4 d)	Deaths over 24 yr follow-up	a) HR=1.18 (1.02, 1.37) b) HR=1.37 (1.09, 1.73) c) HR=1.39 (1.14, 1.70)	(96)
Premature mortality (<70 yr)	79,505	Long cycles (≥40 d)	a) 18-22 yr b) 29-46 yr	26-31 d cycles	Deaths over 24 yr follow-up	a) HR=1.34 (1.06, 1.69) b) HR=1.40 (1.17, 1.68)	(96)

Notes: CI, confidence interval; CVD, cardiovascular disease; d, days; HR, hazard ratio; OR, odds ratio; POR, prevalence odds ratio; RR, relative risk; yr, years. a. Obesity-related cancers include colorectal, gallbladder, kidney, multiple myeloma, thyroid, pancreatic, esophageal, gastric, liver, endometrial, ovarian and postmenopausal breast cancer. b. Cardiovascular disease included fatal and nonfatal coronary heart disease, myocardial infarction, coronary revascularization, and stroke. c. Cardiovascular disease included ischemic heart disease, heart failure, and cerebrovascular disease (stroke or transient ischemic attack). d. Cardiovascular disease included coronary heart disease, myocardial infarction, heart failure, atrial fibrillation, and stroke. e. Cardiovascular disease included myocardial infarction and angina.

Prolonged estrogen and decreased progesterone exposure, as may occur with long, irregular cycles and amenorrhea, might increase the risk of cancer (79). Two prospective cohort studies (n=94,471) found that compared to participants with regular cycles, those with irregular cycles had 11% (95% CI: 2%, 21%) increased risk of any cancer, 23% (95% CI: 9%, 39%) increased risk of obesity-related cancer (79), and were more than twice as likely to develop ovarian cancer starting at age 70 (HR=2.26; 95% CI: 1.20, 4.26) (80). Menstruators with long cycles also had a 22% (95% CI: 9%, 27%) increased risk of any cancer compared to those with 26- to 31-day cycles (79).

Five cohort studies (n=842,616) examined associations between menstrual cycle characteristics and diabetes (81-84). In irregular and long cycles, FSH and LH stimulate ovarian androgen production, which increases insulin resistance and may lead to diabetes (82). Compared to participants with regular cycles, those with irregular cycles had 17%-66% increased risk of developing type 2 diabetes (81, 82, 84, 85), and were 1.5 times more likely to develop gestational diabetes (83). Menstruators whose cycles took more than 5 years to reach regularity after menarche had a 47% (95% CI: 13%, 89%) increased risk of type 1 diabetes and a 24% (95% CI: 5%, 33%) risk of type 2 diabetes compared to those whose cycles were regular within 4 years of menarche (85). Long cycles were associated with 37%-50% increased risk of type 2 diabetes (82), and 42% (95% CI: 15%, 75%) increased risk of gestational diabetes (83).

Studies within the same cohorts (n=894,850) examined associations between the menstrual cycle and CVD (81, 84-87), as cycle dysfunction can impact glucose homeostasis leading to hyperinsulinemia and elevated testosterone levels, CVD risk factors (81). Additionally, because estrogen reduces vascular inflammation, cycles with lower estrogen levels could contribute to atherosclerotic CVD (81). Compared to regular cycles, irregular cycles were associated with 8%-40% increased risk of CVD (81, 84, 86, 87), and cycle length extremes (long or short cycles) were associated with 11-44% increased risk of CVD (81, 86, 87). While conditions like PCOS could help explain associations between menstrual cycle characteristics and CVD (88), one study including information about PCOS diagnosis found that irregular cycles were associated with CVD and diabetes even among participants without PCOS (85).

Many of the same neuro-endocrine pathways regulating ovarian function also impact bone remodeling and homeostasis (89). Estrogen inhibits bone resorption, reducing bone remodeling, while progesterone stimulates bone formation (89, 90). In estrogen-deficient states – such as functional hypothalamic amenorrhea with low estrogen – bone resorption outpaces bone production,

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accelerating bone loss (89, 90). Because 90% of bone mass is achieved by age 18, amenorrhea and low estrogen during adolescence can irreversibly impair bone density, increasing risks of osteoporosis and fracture (90, 91). Irregular cycles, long cycles, variable bleeding duration, and age at menarche are all associated with increased risk of postmenopausal fracture (92, 93). Reviews on lactational amenorrhea indicate that bone mineral density declines during lactation to provide calcium for the breastfeeding infant but recovers after breastfeeding is finished (94, 95), and breastfeeding duration is not associated with increased postmenopausal fracture risk (94).

Only one study (n=79,505) has examined cycle characteristics and premature mortality (<70 years) (96). Irregular and long cycles were associated with 18%-40% increased risk of death depending on the age when the cycle characteristic was observed, with higher risk for older menstruators.

Collectively, evidence indicates cycle characteristics are associated with long-term health outcomes, with the potential to inform preventive screening and behavior modifications to address long-term health risks. Notably, cycle phenotype transitions from regular to irregular or normal to longer cycles from young- to mid-adulthood were associated with increased risks of cancer, CVD, diabetes, and gestational diabetes (79, 82, 83, 87), underscoring the importance of tracking cycle characteristics over time.

Optimizing Wellness with the Menstrual Cycle

Numerous self-help books and popular press articles frame menstruation as natural, manageable, and potentially empowering: by understanding and aligning their menstrual cycles with their lifestyle, diet, and exercise, menstruators can improve their physical and emotional wellbeing (97). In this section, we review evidence for using the menstrual cycle to optimize reproductive health, exercise, and nutrition.

The primary reasons menstruators report cycle tracking include optimizing reproductive health through conceiving or avoiding pregnancy, improving body literacy, and informing conversations with healthcare providers (98). Menstrual cycle tracking application (app) use increases conception rates for pregnancy planners, particularly when combined with additional fertility indicators like BBT or cervical fluid (99, 100). Cycle tracking is also used for contraception. Only the Natural Cycles app is FDA-approved as a contraceptive device and currently available, with a 13-cycle typical use pregnancy probability of 7.2% (95% CI: 6.4%, 8.1%) (101).

Hormonal fluctuations across the menstrual cycle influence metabolism, thirst, fluid regulation, and thermoregulation, offering a plausible physiologic basis for efforts to optimize nutrition and exercise across the cycle (Table 1). Evidence suggests daily energy intake is lowest during the late follicular phase and ovulation and increases during the luteal phase (30, 102). Estrogen may promote muscle strength by increasing glycogen uptake and has antioxidant properties that could protect against exercise-induced muscle damage and inflammation (103), potentially improving follicular phase resistance training efficacy (104).

However, data are lacking to support cycle phase-specific nutritional and exercise interventions at the population level (102, 105). A meta-analysis of 78 studies found exercise performance might be slightly reduced during menses compared to other menstrual cycle phases ($ES_{0.5} = -0.06$; 95% CrI: -0.16, 0.04) (103). Hypotheses that high pre-ovulatory estrogen concentrations could contribute to ligament laxity and increased mid-cycle injuries are not supported by high quality research (106). Reviews on athlete nutrition concluded that simply having adequate energy intake was crucial, as inadequate intake can cause functional hypothalamic amenorrhea (105, 107).

While generalized recommendations related to menstrual cycle phase, physical exercise, and nutrition are not currently supported by scientific literature, surveys of athletes found that nearly 1/3 reported their menstrual cycle impacted training and performance (108). Accordingly, individuals can track their cycles along with training, recovery, and other symptoms to determine personal patterns, needs, and strategies (107). The lack of data supporting cycle-related nutrition and exercise interventions reflects an underrepresentation of menstruators and a lack of menstrual cycle data

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collection in nutrition and exercise studies, leading to gaps in basic knowledge about the whole-body impact of menstrual cycles (30, 103, 107).

Exposures Influence the Menstrual Cycle

The menstrual cycle responds to diverse environmental exposures, lifestyle factors, and intrinsic characteristics (Table 4) – including age, air pollution, and night-shift work – that interact with neuro-endocrine pathways.

Table 4. External exposures and associated changes to the menstrual cycle.

Exposure	Associated changes to menstrual cycle	References
Intrinsic characteristics		
Age	↓ cycle length at age 30-40, ↑ cycle length and ↑ cycle variability at perimenopause, ↓ peak cervical fluid at age ≥35	(20, 109, 110)
Body mass index (BMI)	↑ cycle length with high BMI, ↑ cycle length variability with low BMI	(109, 111)
Environmental exposures		
Per- and polyfluoroalkyl substances (PFAS)	↑ cycle length, ↑ cycle irregularity	(114)
Bisphenol A (BPA)	↓ luteal phase length	(115, 116)
Butyl paraben	↓ luteal phase length	(109, 115, 116)
Select phthalates	↓ luteal phase length	(115)
Polybrominated diphenyl ethers (PBDEs)	↓ luteal phase length	(109)
Pesticides (pyrethroids, organochlorines, organophosphates)	↑ cycle length, ↑ cycle irregularity	(109)
Cadmium	↓ cycle length	(109)
Selenium	↓ cycle length	(109)
Copper	↑ cycle length	(109)
Mercury	↑ cycle irregularity	(117)
Lead	↑ cycle irregularity	(117)
Air pollution	↑ cycle irregularity, ↑ follicular phase length, ↓ luteal phase length	(109, 116)
Lifestyle factors		
Low vitamin D	↑ cycle length, ↑ cycle irregularity	(118-120)
Nightshift work	↑ cycle disruption (cycle length shorter or longer than usual)	(121)
Low physical activity	↑ cycle irregularity	(122)
High alcohol consumption	↑ cycle irregularity, ↓ cycle length, ↑ menstrual bleeding	(122, 123)
Smoking	↓ cycle length, ↑ menstrual bleeding	(109, 122, 123)
Caffeine	↓ cycle length, ↑ menstrual bleeding	(122)
COVID-19 pandemic exposures		
COVID-19 vaccination	↑ cycle length (1-2 days), ↑ long cycles (>38d), rapid return to pre-vaccination cycle length	(33, 124)
COVID-19 infection	↓ menstrual bleeding, ↑ cycle length	(125, 126)
Lockdown conditions	↑ cycle disruption (cycle length shorter or longer than usual)	(127)

General pandemic conditions	↑ cycle variability, ↑ menstrual bleeding, ↑ dysmenorrhea	(126)

The menstrual cycle varies with intrinsic characteristics, notably age and body mass index (BMI). Cycle length decreases during a menstruator's 30s and early 40s and increases and becomes more variable with perimenopause (109, 110). Menstruators ≥35 years old also have fewer days of peak quality cervical fluid (20). Higher BMI (30-50 kg/m^2) is associated with longer cycles, especially BMI >50 kg/m^2, and lower BMI (<18.5 kg/m^2) with increased cycle length variability (109, 111).

Endocrine-disrupting chemicals (EDCs) interfere with endocrine system function via multiple pathways. Common exposure sources include personal care products, food, water, dust, industrial chemicals, and pesticides (112, 113). Recent reviews found per- and polyfluoroalkyl substances (PFAS) were associated with longer, more irregular cycles (114), while bisphenol A (BPA), butyl paraben, select phthalates, and flame retardant polybrominated diphenyl ethers (PBDEs) were associated with a shorter luteal phase (109, 115, 116). Metals also can have endocrine-disrupting effects: cadmium and selenium are associated with decreased cycle length, copper with increased cycle length, and mercury and lead with irregular cycles (109, 117). Air pollution has been observed to increase irregular cycles and follicular phase length and decrease luteal phase length (109, 116).

Lifestyle factors also influence menstrual cycles. Low vitamin D has been associated with prolonged and irregular menstrual cycles, even in those with no history of PCOS (118-120). Vitamin D is obtained from supplements or synthesized in the skin with sunlight exposure. A meta-analysis of 8 studies (n=28,479) found night-shift work disrupted circadian rhythms, increasing the odds of cycle disruption (OR 1.15; 95% CI 1.01, 1.31) (121). Sedentary behavior and high alcohol consumption were associated with increased cycle irregularity (122), and smoking, caffeine, and high alcohol intake with shorter cycles and HMB (109, 122, 123).

Recently, studies have examined menstrual cycle responses to COVID-19-related exposures. A meta-analysis of 4 studies (n=25,054) compared cycle characteristics before and after COVID-19 vaccination; vaccinated menstruators were more likely to report temporary cycle changes (OR=1.91, 95% CI 1.76, 2.07) (124). A large cohort study (n=9,652, 128,094 cycles) found vaccination was associated with a 1-2 day increase in cycle length and an increased odds of a long cycle (>38 days), especially with the Johnson & Johnson vaccine; cycles quickly returned to pre-vaccination lengths (33). Two systematic reviews found COVID-19 infection was associated with longer cycles and a possible decrease in menstrual bleeding, but the reviewed studies were small and lacked pre-infection data for comparison (125, 126). Pandemic conditions also were associated with cycle changes: a meta-analysis of 7 studies (n=21,729) found that compared to non-lockdown times, lockdowns were associated with an increased odds of changes in menstrual cycle length (OR=9.14; 95% CI 3.16, 26.5) (127). Another review of 17 studies found that during the pandemic, menstruators reported increased menstrual irregularities, cycle variability, heavier bleeding, and dysmenorrhea, with participants reporting higher levels of anxiety, stress, and depression more likely to experience cycle changes (126).

Documenting the Menstrual Cycle as a Vital Sign

Clinicians and researchers should ask patients about their menstrual cycle at least once to identify unusual cycles or acute issues. Ideally, information should be documented over multiple cycles. While data from a single cycle can be used to address an acute issue, patterns over time offer additional insights, as with other vital signs. Clinicians and researchers should educate patients in basic menstrual cycle biology and tracking skills so they can track, observe, and identify patterns in their own cycles over time (see Supplementary Materials, educational handouts, menstrual cycle tracking chart). By tracking their cycles, menstruators have a powerful tool to understand and optimize their own health and wellness, and to access timely treatment and preventative care.

Tracking the menstrual cycle is simple and involves noting dates and intensity of vaginal bleeding. This allows determination of cycle length and bleeding duration and intensity. When multiple cycles are documented, cycle regularity and variability can also be observed. Signs such as

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BBT and cervical fluid can allow retrospective identification of ovulation and calculation of follicular and luteal phase lengths. Other symptoms (mood, pain, headaches), activities (sex, travel, exercise), and information (diet, medications) can also be recorded to understand how the menstrual cycle may be impacting health conditions, and how activities might impact menstrual cycle patterns.

The menstrual cycle can be documented on calendars, special charts (see Supplementary Materials, educational handouts, menstrual cycle tracking chart), or using smartphone-based apps. Apps range from simple calendars to proprietary algorithms predicting menses onset, the fertile window, and ovulation. Many apps allow users to document symptoms and activities (128). Users report apps improve self-knowledge, health management, and information-sharing with healthcare providers (98, 129).

Despite tracking app popularity, reviews have found their algorithms for next cycle or fertile window prediction to be inaccurate, particularly for users with irregular cycles, and that 20% of reviewed apps contained incorrect clinical information (3, 130-132). Few available apps incorporate evidence-based fertility awareness methods, even though 33% are marketed for contraception and 15% for conception (132).

Data privacy is a growing concern, as many apps allow third-party access to users' personal information (133), which can be used without consent for advertising, research, and insurance purposes, or shared with employers (134). Health apps' data collection and privacy practices are not regulated unless they are considered medical devices (134). In the wake of the United States Supreme Court's 2022 *Dobbs v. Jackson Women's Health Organization* decision, which eliminated the constitutional right to abortion, some app users were concerned that information from period tracking apps could be used to prosecute illegal abortions, especially self-managed at-home abortions which are clinically indistinguishable from miscarriages. However, based on case reviews and experience, several legal experts suggest that texts, emails, and search/website histories are more likely to be used than apps as digital evidence in abortion prosecutions (135). Apps that store data locally on smartphones are more secure (135).

Development of a standardized menstrual history questionnaire could improve care and facilitate research (136). In primary care settings, menstrual histories should include an assessment of bleeding characteristics, associated symptoms, impacts on quality of life, and a comprehensive medical history (Table 5) (136). Cycle tracking could complement history-taking. In preparation for a routine health visit, patients could track their cycles for 3-6 months, with charts reviewed at the visit. Alternatively, patients could track their cycles after a visit when potential health concerns or goals have been identified and discuss in follow-up care.

Table 5. Key components of a menstrual history in a primary care setting.

Menstrual history components	Additional information
1. Bleeding characteristics	
a) Frequency of menses	Frequent, normal, infrequent, absent
b) Regularity of menstrual cycle (month-to-month)	Regular, irregular
c) Duration of bleeding	Short, normal, prolonged
d) Flow or volume of bleeding	Light, normal, heavy; for volume assessment techniques see (136)
2. Symptoms associated with menstrual cycle and bleeding	Questions to identify the symptoms most concerning to the patient, and determine etiology of bleeding or symptoms
3. How bleeding and symptoms impact quality of life	Whether work or social plans are missed because of bleeding
4. Comprehensive medical history	

Notes: Table adapted from Matteson et al., 2011 (136).

Conclusion

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Documenting the menstrual cycle as well as consideration of symptoms in relation to the menstrual cycle can inform the diagnosis, assessment, and management of health conditions commonly encountered in primary and specialized care settings. However, research gaps and challenges in integrating its documentation into clinical practice remain.

While much evidence supports the menstrual cycle as a vital sign, more research is needed on its associations with long-term outcomes, external exposures, and wellness. Research suggests strong connections between cycle characteristics and long-term health outcomes, but the etiology is not well understood. Future work could explore using cycle characteristics as biomarkers of future risk, guiding preventive care strategies (137). Menstruators already use cycle self-knowledge to improve their health and wellbeing. Research comprehensively characterizing the menstrual cycle's influences on physiologic processes throughout the body (138) and high-quality studies on wellness-oriented interventions are needed.

Although apps abound, tools for cycle tracking are not integrated into clinical practice. A standardized menstrual history tool incorporating cycle tracking capabilities into electronic medical record systems and simple ways for patients to share app data with providers would facilitate menstrual cycle documentation. As a start, providers can share the tracking and educational tool included in the Supplementary Materials with their patients.

Because of its broad scope, this review has limitations. For example, discussing the impact of exposures for which there is in vivo evidence or few studies, but no systematic reviews, is beyond this paper's scope. Additionally, like other vital signs, the menstrual cycle is frequently altered. Discussion of interventions altering or suppressing the menstrual and ovarian cycles such as hormonal contraceptives, gender-affirming hormone treatment, and ovary-sparing hysterectomy is beyond the scope of this review. Given the high importance of such interventions, research focusing on, for example, post-hysterectomy ovarian function (139) and menstrual cycle responses to hormone therapy (140) is warranted.

Treating and documenting the menstrual cycle as a vital sign has the potential to transform research and clinical care, promoting menstrual health equity and, most fundamentally, improving the health and wellbeing of people who menstruate.

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