MENSTRUAL TRACKING APPLICATIONS AND PMDD

by

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Premenstrual Dysphoric Disorder (PMDD) is a psychiatric and gynecological condition marked by affective, cognitive, and physical symptoms that predominantly manifest during the luteal phase, occurring in the week before menstruation and resolving after the onset of menstruation, affecting 1.2-6.4% of individuals who menstruate (Naik et al. 2023). Symptoms of PMDD heavily overlap with those of other psychiatric disorders but the condition is distinguished by the cyclical timing of symptoms occurring in the week before menstruation and resolving after the onset of menstruation**.** The Carolina Premenstrual Assessment Scoring System (C-PASS) is a standardized computer algorithm that uses the basis of the Daily Record of Severity of Problems (DRSP) to help distinguish clinical presentations of PMDD and other menstrual disorders with data being derived from a self-reported record of symptoms over a two-cycle span (Eisenlohr-Moul et al. 2017). During a clinical study, the C-PASS showed that its conclusion agreed with physicians' diagnoses with face-to-face clinical evaluation 94.5% of the time (Epperson and Hantsoo 2017). With over 200 million downloads of menstrual tracking apps, the potential for a diagnostic tool like C-PASS to be incorporated into an app should be considered to facilitate accurate clinical diagnoses of PMDD (Levy & Romo-Avilés, 2019; Naik et al., 2023).

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Part 1: What Is PMDD?

Globally, over 1.8 billion people experience menstruation (*Menstrual Hygiene | UNICEF*, 2019). Menstruation and the menstrual cycle are an integral part of everyday life, from the approximate ages of 15-44, for pre-menopausal women and people who menstruate (*National Health Statistics Reports, Number 146, September 10, 2020*). Within the experience of the menstrual cycle, the widely known phenomenon of Premenstrual Syndrome (PMS) occurs, which 90% of women experience monthly during the onset of menstruation (Cary and Simpson 2023). Symptoms typically involve physiological changes like bloating, cramps, and headaches, as well as mood fluctuations such as anxiety, increased irritability, or depression (Haskett, 1987). The earliest writings in Ancient Egypt that mention "a woman aching…ill from her wandering womb, the circuit of her womb" dates back to 1800 BCE (*Kahun Medical Papyrus*, 2002).

The first mention of symptoms relating to the menstrual cycle in modern medical literature was described as "premenstrual tension," a term coined in a study by Robert Frank in a 1931 study (Frank, 1931). Frank's study only included 15 women and was used to describe any unspecified "tension" throughout a woman's body during menstruation such as the feeling of tightness of muscles or the feeling of unease (Greene and Dalton 1953). Observed throughout their cycle, these women described their symptoms and reported symptom onset and duration; through these methods, Frank concluded that the study participants' symptoms were associated with a hormonal imbalance (Bailey, 2019). With the discovery of female sex hormones in the 1950's, "premenstrual tension" was then renamed "premenstrual syndrome" by Katharina Dalton and Raymond Greene, who argued that there were more symptoms to consider than those that could be defined by tension (Di Giulio and Reissing 2006) (Naik et al., 2023).

As research into the topic continued, studies in the 1940s and 1950s linked 84% of violent crimes committed by women to their menstrual cycle (Greene and Dalton 1953). It was thought that women who were actively menstruating were dangerous, unruly, and not to be trusted. These attitudes are not just the product of patriarchal-driven societal expectations, however. One of the pioneering doctors of women's health and gynecology who promoted these retrograde notions was a female British physician, Katharina Dalton. As mentioned above, her research with Raymond Greene defined PMS and set the precedent for defining and understanding cyclical hormone-related disorders, which eventually led to her being known as a specialist in PMS (Zietal 2017). Her body of work also involved research into PMS, hormone therapy, and post-partum depression. With her notable contributions to women's health and being the first female president of the general practice department of the Royal Society of Medicine, she also focused her studies on the effects of PMS on behavior ("Katharina Dalton" 2024). In her book, *Once a Month: The Original Premenstrual Syndrome Handbook* (1987), Dalton made negative correlations between PMS and bad driving, criminal activity, and (as the following except demonstrates) marital discord:

> If she is a sufferer from spasmodic dysmenorrhea he will be the first to see that she gets food and complete relief of her pains, for pain is something a man can understand. However, sudden mood changes, irrational behavior, and bursting into tears for no apparent reason are bewildering, while sudden aggression and violence are deeply disturbing when, with little warning, and no justification, his darling little love bird suddenly becomes an angry, argumentative, shouting, abusive bitch.

Dalton then goes on to encourage women to

> Wait until you feel well and then tell him how guilty you feel about your periodic loss of control,...about your fears that you might one day harm your baby or attempt an overdose….tell him that you know you're being horrid but that you can't help it (*Once a Month*, 1987).

Dalton would even go on to serve defense testimony in 50 court cases, attributing the crimes of various women charged with assault and arson to the influence of PMS (Zietal 2017). While her work served as the starting point for many facets of research into women's health, her theories have dangerous implications for societal views of women's menstrual cycles. Her pejorative language within her books not only undermines her contributions in the name of feminism but also serves as an excuse to perpetuate harmful beliefs about menstruation into modern society.

The belief that women are less logical, and that menstruation is a force that cannot be controlled, has affected the attitudes of not only society at large, but of the very women who experience PMS symptoms. Women who perceive menstruation as having a negative impact on their lives tend to report more severe symptoms (Marván et al., 2013). When these ideas are reinforced, women may internalize this narrative, creating a self-fulfilling cycle where their beliefs about menstruation are validated by their experiences. The cultural expectation of how women act during menstruation has also been perpetuated by movies and TV sitcoms that often make jokes at the expense of a woman showing negative emotions and reduce her views to something that should be explained by her biology rather than an expression of her true opinions. A study by Tampax in 1981 showed that both men and women thought that women were not capable of functioning correctly or thinking rationally during menstruation (Haskett, 1987). The Ambivalent Sexism Inventory (ASI) was created in 1996 by Glick and Fiske, researchers who aimed to qualify the sexist attitudes women have about their own beliefs about menstruation. This tool was used in a study in which groups of Mexican and American undergraduates paired different groups of adjectives with women described in different stages of reproductive life. Words that were used to describe menstruating women included "brave, bitter, tense, and angry" (Marván, Vázquez-Toboada, and Chrisler 2013).

These cultural attitudes towards menstruation are what have made disorders of the menstrual cycle more difficult to identify and treat. When Robert Frank started to pioneer medical interest in premenstrual tension in 1931, he identified PMS as a dysfunction of women, while the same year, the feminist psychoanalyst Karen Horney described PMS as fantasies of pregnancy and response to restrictions of female sexuality (Liguori, Saraiello, and Calella 2023). Despite the cultural and outdated implications these researchers made in their studies, research of women's health persisted with the Society for Women's Health Research being founded in 1990 ("1977-1989 Timeline, *Society for Women's Health Research*" 2024). Horney and Frank's independent but concurrent ideas inspired focus on women who experienced a significant amount of disturbance in their menstrual cycles, not just the generalized monthly onset of common symptoms most women experience. As more research into women's health has been done over the last few decades, there has been increased curiosity into the clinical significance of this disturbance, leading to the modern research into Premenstrual Dysphoric Disorder.

Premenstrual Dysphoric Disorder (PMDD) is a psychiatric and gynecological condition marked by affective, cognitive, and physical symptoms that predominantly manifest during the luteal phase, occurring in the week before menstruation and resolving after the onset of menstruation. The condition affects approximately 1.2-6.4% of individuals who menstruate, emphasizing its distinctive prevalence (Naik et al. 2023). PMDD is distinctly different from Premenstrual Syndrome (PMS) because it aims to explain the broader range of symptoms that have the characteristics of timing in relation to the menstrual cycle and their cyclical nature in addition to the combination of psychological and physical symptoms (Hasrett 1987). Throughout the 1970s and 1980s, PMDD was described as "severe menstrual syndrome" and continued to be an elusive entity in the medical literature. In Roger Haskett's article describing this phenomenon

in 1987, he notes that there is a distinct difference in women who have unexplained prominent disturbances in their premenstrual symptoms, and many articles around the same time started describing this condition as PMDD.

In 1994, the 4th edition of the Diagnostic and Statistical Manual of Mental Disorder (DSM-4) introduced a diagnostic table for PMDD in Appendix B, *Criteria Sets and Axes Provided for Further Study* (American Psychiatric Association, 2013). This presented yet another contentious variable—is PMDD a psychiatric or physiological disorder? In a study from the UK's National Female Hormone Clinic, of the 146 women who were referred for menstrual-related disorders, a psychiatric diagnosis was made in 130 of those cases (Reilly et al., 2013.). Furthermore, 94 of these women met the criteria for PMDD, while 67 were thought to have exacerbation of an underlying psychiatric disorder (Reilly et al., 2013). The first systematic review of suicidal experiences in women who have PMDD found that "Suicidal thoughts, ideation, plans and attempts were strongly associated with experiences of PMDD. However, no significant differences were identified between PMDD and non-PMDD cases regarding suicide attempt risk profiles in terms of frequency, impulsivity or lethality or menstrual cycle phase" (Osborn et al. 2021). Women who have severe PMDD are also more likely to develop eating disorders, anxiety disorder, bipolar disorder, and substance abuse problems (Tiranini and Nappi 2022). In the early days of PMDD research, many of the clinical symptoms that were seen in patients with PMDD were also seen in patients with Major Depressive Disorder (MDD). While the most defining quality of PMDD is the coinciding of symptoms in the week leading up to menstruation, this differential diagnosis of MDD was investigated: "Experience shows that if patients with both MDD and PMDD are treated with tricyclic antidepressants, the major depression will respond but not the PMDD. When the same patients receive SSRIs for their

depression, however, most lose the premenstrual exacerbation of their symptoms… although it must be remembered that around 40% of PMDD patients do not respond to SSRIs" (Endicott, 1999). For clinicians, understanding the patient as a whole and considering factors such as adverse life events, personality, and family history can direct the course of treatment. Like any mental health condition, PMDD must be skillfully handled as a multi-faceted condition that questions the thought of reciprocal causation. This complexity contributes to the ongoing debate regarding the clinical significance of women who exhibit symptoms of PMDD but do not meet the criteria now outlined in the body of the DSM-5. This debate has led to the classification of other menstrual-related mood disorders (MRMD's), but this adds to the confusion of defining PMDD as a separate entity (Epperson and Hantsoo 2017).

There is no doubt that symptoms of PMDD overlap heavily with many psychiatric disorders; however, what distinguishes PMDD from any other psychiatric disorder is the cyclicity in which symptoms are experienced—specifically, the onset of symptoms during the luteal phase of the menstrual cycle and the disappearance of symptoms at the time of menstruation (Epperson and Hantsoo 2017). In the early days of PMDD research, studies were not standardized, but over the last 40 years, researchers have developed a methodology to diagnose PMDD: "If one looks in detail at the individual research articles reviewed, it is clear that at each step in the analysis of the data (including the initial choice of self-report instruments), investigators made choices about how to score, combine, and compare data from individual women" (Severino 1993). Current diagnostic tools for PMDD as outlined in the DSM-5 primarily involve prospective and retrospective symptom analysis. Clinicians stipulate that, for a PMDD diagnosis, there must be a presence of at least 5 symptoms occurring within the week leading up to menstruation, with the symptoms subsiding at the onset of menstruation, with this

pattern persisting for 2 or more consecutive menstrual cycles (Nevatte et al. 2013). Organizations like the International Association for Premenstrual Disorders (IAPMD) offer various self-assessments and resources, but the definitive diagnosis hinges on the cyclicity of symptoms and their impact on daily functioning (Cary and Simpson 2023). Clinicians also utilize screening tools such as the Premenstrual Symptoms Screening Tool (PSST), Premenstrual Symptoms Questionnaire (PSQ), and the Daily Record of Severity of Problems (DRSP) (Yoshimi et al. 2023). It's crucial for clinicians to employ a differential diagnosis approach, systematically considering and eliminating various potential causes for a patient's symptoms. The table below is used for determining functional impairment and shows the connection of the DSM-5 to the DRSP. Because research focused heavily on the use of questionnaire tools and the categorization of interference with quality of life, PMDD was moved from the Appendix to the body of the DSM-5 in 2013 due of the increasing body of support for PMDD causing “clinically significant distress” (Moran, 2012).

TABLE 1. Mapping the Items of the DRSP Onto DSM-5 Diagnostic Content for PMDD[a]

DRSP Item	DSM-5 PMDD Content
Core symptoms: criterion B	
5. Had mood swings (e.g., suddenly felt sad or tearful) 6. Was more sensitive to rejection or my feelings were easily hurt	1. Marked affective lability (e.g., mood swings, feeling suddenly sad or tearful, or increased sensitivity to rejection)
7. Felt angry, irritable 8. Had conflicts or problems with people	2. Marked irritability or anger or increased interpersonal conflicts
1. Felt depressed, sad, "down," or blue 2. Felt hopeless 3. Felt worthless or guilty	3. Marked depressed mood, feelings of hopelessness, or self-deprecating thoughts
4. Felt anxious, "keyed up," or "on edge"	4. Marked anxiety, tension, and/or feelings of being keyed up or on edge
Additional symptoms: criterion C	
9. Had less interest in usual activities (e.g., work, school, friends, hobbies)	1. Decreased interest in usual activities (e.g., work, school, friends, hobbies)
10. Had difficulty concentrating	2. Subjective difficulty in concentration
11. Felt lethargic, tired, fatigued, or had a lack of energy	3. Lethargy, easy fatigability, or marked lack of energy
12. Had increased appetite or overate 13. Had specific food cravings	4. Marked change in appetite; overeating; or specific food cravings
14. Slept more, took naps, found it hard to get up 15. Had trouble getting to sleep, staying asleep	5. Hypersomnia or insomnia
16. Felt overwhelmed, that I couldn't cope 17. Felt out of control	6. A sense of being overwhelmed or out of control
18. Had breast tenderness 19. Had breast swelling, felt bloated, or had weight gain 21. Had joint or muscle pain	7. Physical symptoms such as breast tenderness or swelling, joint or muscle pain, sensation of "bloating," or weight gain
20. Had headache	Not included in DSM-5 PMDD

[a] DRSP=Daily Record of Severity of Problems; PMDD=premenstrual dysphoric disorder.

Figure 1: A comparison of the DRSP with the DSM-5 criteria for the diagnosis of PMDD (Eisenlohr-Moul et al. 2017).

A significant obstacle to reliable and valid diagnoses of PMDD lies in the absence of sufficiently sensitive biological markers that can offer definitive diagnoses. Without standardized biological markers, women could receive a multitude of diagnoses and treatments. Although PMDD is essentially a disorder that is determined through self-reporting of symptoms, there has been developing research that can suggest the presence of biological differences in those that suffer from PMDD, which means there can be more empirical determinations of the disorder. In 2022, Lara Tiranini and Rossella Nappi outlined the most recent advances and biological

research into PMDD and discussed the many insights into hormonal and neurotransmitter-related factors that have been studied in the last two decades. Their study delves into research in the hormonal cascades of progesterone receptors, the GABAergic system that regulates stress and anxiety within the central nervous system, and the line between immune-inflammatory responses in those with PMDD (Tiranini and Nappi 2022).

With the popularity of neuroimaging in psychology research, it was thought that studies involving PMDD would benefit from this technology and maybe also provide biological validators of this condition (Naik et al. 2023). Many of the studies in this review, however, lack reliability. There are few conclusions to be made due to many of these studies not being replicable and thus unable to produce data such as an average age of onset of PMDD or how it can affect those of perimenopausal age (Naik et al. 2023). Using many different diagnostic techniques reduces the chance of there being another study that would be able to reproduce another's conclusions (Dubol et al. 2020). There's not enough evidence now to suggest anything concrete in the difference in the brain anatomy or any other physical factors to predict and prove the presence of PMDD (Dubol et al., 2020). Like any psychiatric or psychosomatic illness, we must develop understanding toward what we cannot quantitatively prove. This is not to say that PMDD is not real—its diagnosis just happens to currently fall beyond the realm of empirical science.

Regarding the specificity of a PMDD diagnosis, its distinctive cyclicity is pathognomonic and has led to one of the most sensitive diagnostic tools, the Carolina Premenstrual Assessment Scoring System. The Carolina Premenstrual Assessment Scoring System (C-PASS), developed by Eisenlohr-Moul and colleagues in 2017, is a standardized computer algorithm that uses the basis of the Daily Record of Severity of Problems (DRSP) to help distinguish clinical

presentations of PMDD and other menstrual disorders (Eisenlohr-Moul et al. 2017). The computer program takes the self-reported record of symptoms over a two-cycle span and has parameters for the severity of daily symptoms that can be considered for a PMDD diagnosis. In one study during its development, the C-PASS showed that its conclusion agreed with physicians' diagnoses with face-to-face clinical evaluation 94.5% of the time (Epperson and Hantsoo 2017). In a review of diagnostic validity, the C-PASS was found to have 98% accuracy when diagnosing PMDD (Naik et al., 2023). The DRSP, which is what C-PASS is derived from, has an 83.4% negative predictive value, which is also useful for ruling out PMDD (Biggs and Demuth 2011). The C-PASS is the most accurate diagnostic tool to date and continues to provide clinicians with a reliable tool for PMDD diagnosis and management.

Even with the amazing accuracy of the C-PASS, only 12% of women's health physicians report using tools like the DRSP or other diagnostic surveys for the diagnosis of PMDD in routine visits (Hantsoo et al. 2022). The providers that are being asked about a PMDD diagnosis by their patients are general practitioners or gynecologists 90% of the time (Hantsoo et al. 2022). This same study concluded that gynecologists were more trusted with their knowledge of PMDD than psychiatrists (Hantsoo et al. 2022). Since PMDD is primarily defined as a psychiatric problem, there is an obvious disparity in the ability for women to get a proper diagnosis from their gynecologists who are not qualified to make an informed diagnosis. When 89% of women referred for menstrual-related problems were also diagnosed with a primary psychiatric disorder, it is not appropriate for gynecologists to make the final diagnosis without additional input from psychiatrists (Reilly et al., 2022). When more physicians of both specialties are well-versed on PMDD symptoms and methods of diagnosing, they are trusted more by their patients, which in turn can benefit many patients seeking care and help direct patients to providers who are

qualified to make an accurate diagnosis. Tools, such as diagnostic surveys, that are publicly available to people who menstruate play a valuable role in this conversation. Given the high reliability of the C-PASS, raising awareness of its benefits is advantageous for both patients and physicians. These tools facilitate discussions about abnormal menstruation, enabling patients to present insights and collaborate with their mental health and gynecological physicians to manage their care more effectively. A place where medical information about menstruation can be distributed to a relevant audience is through menstrual tracking apps, as discussed in the next section.

Part 2: Menstrual Tracking Apps

"The empowerment of women who take the initiative to advocate for themselves is one of the most beneficial aspects of menstrual tracking apps" - (Patel, 2024)

A burgeoning tool in recent times is the growing popularity of mobile health and menstrual tracking applications (apps). Accessible to almost every smartphone user, these apps provide diverse data collection methods. One study found that 60% of US adults are currently tracking their weight, diet, or exercise routine, and 33% are monitoring other factors such as blood sugar, blood pressure, headaches, or sleep patterns (Epstein et al. 2017). Those who use menstrual tracking apps can log symptoms throughout their cycle and engage in mood tracking and journaling. Additionally, many apps assist users in navigating their cycles, predicting symptoms based on past entries, and fostering a more mindful approach to their monthly experiences. These apps can generate visual representations of a user's data, allowing them to relate their own symptoms to a bird's-eye view of their overall baseline. These features are important because the education provided is an essential part of the use of period tracking apps. Most people who use period apps feel more comfortable talking to their healthcare provider because they can understand how to explain their symptoms and show a record of their experiences (Zhaunova et al. 2023).

A cognitive benefit of using tracking apps while having PMDD is creating a more in-depth connection to monthly symptoms for those who use the apps regularly. Participants in studies evaluating menstrual tracking apps have noted that their understanding of their symptoms improved while increasing their medical literacy and ability to lead an active role in their own health care and medical decisions (Patel et al. 2024). One of the most popular period apps on the

market, Flo, saw that their users had an increase in menstrual health literacy and understanding (Cunningham et al., 2024). In the context of PMDD, this is a huge breakthrough in terms of symptom management and diagnostic protocols. In general, smartphone health-tracking apps have shown better outcomes in accessible methods for health promotion (Cunningham et al., 2024). Women are often asked questions about their menstrual cycle when visiting many different healthcare providers, and providing accurate information about their cycle length, regularity, and frequency can be a helpful diagnostic tool. A review of studies have shown that people who use period apps track their menstrual cycles for a variety of reasons, but the most common are: (1) to be aware of how their body is doing, (2) to understand their body's reactions to different phases of their cycle, (3) to be prepared for the onset of menstruation, (4) to become pregnant, and (5) to inform conversations with healthcare providers (Epstein et al. 2017). These different factors that women track show connections to other health factors in their lives. One woman said that she even noticed a correlation between her resting heart rate and her menstrual cycle (Trépanier et al. 2023). Being able to track physical, cognitive, and behavioral symptoms could help differentiate between PMDD and different mental conditions. A common pitfall within this area of research is the misattribution of symptoms to one's menstrual cycle. Since the cycle of menstruation is often a notable event throughout the month, it is not uncommon that psychiatric symptoms can worsen throughout the month (Yoshimi et al. 2024). With consistent and diligent tracking, the data that is being logged could reveal changes and patterns within one's cycle as well as help separate one's emotions throughout their cycle from true psychiatric symptoms. This collection of data is where more app developers can start to program their apps to find trends in their users' data as well.

In 2019, the *New York Times* posted an article describing how period apps Flo and Clue, two of the most popular period tracking apps available (with 30 million and 12 million users, respectively, were starting to use data to predict if women who use them had polycystic ovarian syndrome (PCOS) (Singer 2019). "Flo described its service as a 'digital, pre-diagnostic tool' to help women 'discover if they have PCOS and also bring peace of mind to others who may suspect they have it.' Clue said its "probabilistic statistical model' for the hormonal imbalance offered a 'smart assessment that can be shared with doctors.'" (Singer 2019). The biggest concern that was voiced by Singer's article was the possibility for false diagnoses perpetuated by the app based on the data a user enters. A further screening tool was implemented that only offered the diagnostic tool if users had irregular periods by the app's metrics (cycle length being based on personal choices within the app and the app's own metrics) and had logged a minimum of six menstrual cycles (Singer 2019). A clinical study conducted in 2023 of the Flo Symptom Checker found that it had a rate of 88% agreement among clinicians and the app's prediction (Peven et al. 2023). There is also a strong influence on health care workers who are learning how to use the information provided by patients who use tracking apps as long as the apps are providing science-backed information (Poudyal et al. 2024). Flo went on to further investigate their app and health literacy, showing that women who used their app for 12 weeks and participated in the app's education features showed improvement in other menstrual disorders and PMDD knowledge (Cunningham et al., 2024).

With the studies that have shown that the C-PASS has very high reliability and validity, period apps wishing to be used for diagnostic purposes should be using this diagnostic tool (Eisenlohr-Moul et al. 2017). Given that there is a method of diagnosing PMDD with 98% accuracy, specifically C-PASS, this should be an incentive for menstrual tracking apps and

associated companies to use this method to better help their users understand their own menstrual symptoms (Eisenlohr-Moul et al. 2017). Apps that provide adequate science-backed education that is reviewed by a broad range of clinicians show an increase in health literacy. More education on menstrual symptoms only proves to be more beneficial to their users with improvement in menstrual health awareness as well as the feelings of control and management of users' own cycles (Cunningham et al., 2024). Women seeking advice or medical help with managing abnormal menstrual cycles wouldn't be able to replace their doctors with an app. However, with the limited number of physicians implementing these tools in their practice, apps that regularly promote diagnostic tools that are reliable would help bridge the gap of knowledge between physicians and their patients (Hantsoo et al. 2022). Might data tracked in apps also prompt users to bring questions or concerns about patterns and symptoms to their health care provider that they might not otherwise think to bring up (and thus bringing these items to the health care provider's attention)?

Period tracking apps are not only for pre-diagnosis monitoring. They are also helpful in tracking how treatments and lifestyle changes affect symptoms and quality of life (Cunningham et al., 2024). Whether individuals are undergoing treatment with SSRIs, hormonal birth control, or other medications for PMDD, it's crucial to document symptom presentation before and after treatment initiation. With a record of one's body experiencing monthly symptoms, being able to track these symptoms alongside ongoing treatment is enriching for the patient and helps their clinician understand their response to treatment. This data not only empowers patients to understand their own bodies and responses better but also facilitates more informed discussions with healthcare providers, ultimately leading to more tailored and effective treatment strategies.

It is also important to note that the goal of symptom tracking is not to change one's symptoms or figure out a way to "fix" themselves. Understanding symptom presentation in one's body invites the act of planning, mindfulness, and acceptance in how their body behaves throughout the course of the disorder. Women who use tracking apps report that other health factors in their life improved such as sleep, diet, and other mental health conditions like anxiety and depression (Broad, Biswakarma, and Harper 2022). Some health apps also provide their users with tips and information about their habits and provide suggestions to "optimize" the user's health (Ford, Togni, and Miller 2021). A popular movement in recent years is the idea of "Hormone Hacking" or "Cycle Syncing," which relates to those who change their eating, exercise, or social habits based on where they are at in their menstrual cycle (Saripalli, Psy.D. 2019). These wellness trends feed on the idea that one is naive to the "truth" of their bodies and by using their app or product, they will be able to be in control of their health (Ford, Togni, and Miller 2021). In her article "Hormonal Health: Period Tracking Apps, Wellness, and Self-Management in the Era of Surveillance Capitalism," Andrea Ford discusses the mindset that accompanies the promotion of these health applications:

> The kind of 'self-management project' that emerges from our interviewees' use of period tracking apps not only integrates institutional medical expertise with quotidian embodied experience, but integrates mental and physical health, and "subjective" and "objective" information. It calls into question the boundary between illness and wellness, and although it uses menstruation as its departure point, it far exceeds the typical scope of "reproductive medicine" (Ford, Togni, and Miller 2021).

One of the most common complaints about period apps is the lack of accuracy of the predictions of menstrual changes (Broad, Biswakarma, and Harper 2022). Broad discusses that if predictions were more accurate, "This would not only help women to recognize when they might be entering the peri-menopause, but also in the diagnosis of other reproductive health conditions

that remain a challenge to diagnose, such as poly-cystic ovarian syndrome (PCOS)," and improving the accuracy of clinicians' diagnoses as well (Broad, Biswakarma, and Harper 2022). Inaccurate predictions of menstrual cycle start dates and ovulatory windows can generate anxiety, disappointment, and questioning of their health (Levy & Romo-Avilés, 2019). Negative emotions about their experience to mistrust among app users can lead to less frequent logging, which in turn can affect the app's accuracy and primary purpose—a self-fulfilling cycle of inaccuracy and distrust. Repeatedly missing predictions can harm a user's emotional well-being, reinforcing a sense of uncertainty or loss of control over their body.

Additional downsides of these apps are the lack of standardization and the biases that each app has. There is no regulation for what apps can track regarding health information. It has also been shown that how apps present information, interface, and attitudes towards health or gender affects how users track their data (Levy & Romo-Avilés, 2019). It is also difficult for physicians to recommend mobile applications to their patients due to the lack of standardization (Adnan et al. 2021). Menstrual applications have flooded the app market, making it hard to study any one app thoroughly and against other apps due to this lack of standardization. The main issue with clinicians is that when showing apps to their patients, they can reduce the rate at which patients either add pertinent information or increase the likelihood of miscommunication based on the interface of the app (Adnan et al. 2021).

Within this discussion, there is a suggestion of the addition of tracking systems like those found in period apps to a patient's electronic medical record; however, this is a dangerous road for medical records to be accessed in such a way that allows for inaccuracy and likely arbitrary health data to be used as evidence (Kelly and Habib 2023). After Roe v. Wade was overturned in June of 2022 and abortion was ruled no longer a constitutional right in the United States, there

has been increasing concern about the use of data against users of menstrual tracking apps in states where abortion is illegal (Kelly and Habib 2023). Before this Supreme Court ruling, a survey of women using menstrual tracking apps showed that 83.0% of users had no concerns that the data they entered could be used against them or their personal data would be accessible to unnamed companies (Broad, Biswakarma, and Harper 2022). Another study found that users were less concerned about their data when the benefits of the app outweighed their desire for privacy (Ko et al. 2023). While these connections need to be further investigated, learning how to navigate a surveilled world when not all health care is accessible equally is a scary thought for those without access to abortions. When considering the use of menstrual apps, it is important that consumers scrutinize the security involved in keeping their health data private (Kelly and Habib 2023).

Conclusion

Menstrual apps can be highly useful tools for clinicians when patients use them consistently. These apps serve various purposes, such as predicting menstrual cycles and ovulatory windows, helping users understand their cycles, and providing valuable information to healthcare professionals (Levy & Romo-Avilés, 2019). With over 200 million downloads of menstrual tracking apps, the potential for a diagnostic tool like C-PASS with 98% accuracy to reach this population is immense (Levy & Romo-Avilés, 2019; Naik et al., 2023). Because of this. the C-PASS should be incorporated into menstrual tracking apps who wish to add diagnostic predictions for maximum accuracy. To maximize the diagnostic potential of these apps if they incorporate C-PASS, certain conditions must be met:

1. **Accurate and Transparent Presentation**: The app must clearly communicate its diagnostic potential, particularly in screening for PMDD through data logging. Transparency is key, and users should be encouraged to provide accurate data, understanding that the tool offers a preliminary assessment that can be brought to a physician for formal diagnosis. It is crucial that the app does not minimize the need for professional medical confirmation, and it should openly present its limitations to maintain user trust.
2. **Standardized Screening Tool**: The screening tool in the app should strictly adhere to the C-PASS, which is based on the DSM-5 and boasts high accuracy and a strong negative predictive value. Modifying the questions could introduce biases, potentially reducing the tool's accuracy and affecting user engagement (Levy & Romo-Avilés, 2019). The app should also offer easy access to research on the C-PASS to enhance transparency and

support the tool's credibility. Many users of period apps feel more confident communicating with their healthcare providers when they can document and explain their symptoms (Zhaunova et al., 2023).

3. **Encouraging Accurate Data Collection**: The C-PASS requires data from at least two menstrual cycles (Eisenlohr-Moul et al., 2017). To encourage users to provide consistent, consecutive data, the app could withhold the final predicted diagnosis until this time span has been completed. This approach would also minimize errors and replicate a face-to-face C-PASS administration as closely as possible.

While these apps hold promise, there are limitations. False positives for PMDD predictions could occur, and they cannot replace clinical diagnoses from physicians. More research is needed to explore the implications of reproductive data in light of legal changes such as the overturning of *Roe v. Wade*. Future studies should investigate the clinical efficacy of period app-predicted diagnoses in comparison with traditional clinical evaluations for PMDD.

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