Reimagining the cycle: interaction in self-tracking period apps and menstrual empowerment

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FemTech, technology often in the forms of apps developed to specifically target female health issues, have billions of users globally. Yet, despite the popularity of e.g., period trackers or pregnancy apps, we know little about the potential impact of these technologies, often developed outside controlled and regulated healthcare. How interactive technology is designed, and in our case the cycle represented through the design, has the potential to shape women's understanding of menstruation. In this study we analyse the interaction design of nine of the most downloaded menstruation apps, asking how commercial menstruation apps represent the cycle through their interaction design. While previous research has criticized these types of apps for lacking privacy and for enforcing normative ideals on women, they are often marketed in terms of female empowerment and users do indeed seem to find them very useful for period and fertility tracking. However, the term 'empowerment' is today used broadly and is known for having many potential meanings. Even within the field of Human Computer Interaction (HCI), 'empowerment' is used frequently but rarely explicitly defined. The question then becomes what empowerment could mean for menstruation tracking. In order to begin exploring the way menstruation and the period is represented in current apps and the way that future apps could design for empowerment, we engage in a comparative design investigation using what we call *critical app-walkthrough methodology* where an app's design is explored comprehensibly at one point in time and apps interacted with over a longer time period through researcher use-diaries. Our results center around three ways in which these apps represent the cycle to users through design. We analyse; (1) interface metaphors used to represent the temporality of bleeding, (2) datafication of menstruation through input and output for intimate data tracking, and (3) the ways fertility predictions convey certainty over uncertainty. In a second step, we then explore what empowerment could mean for period trackers and how design could support empowering experiences. Finally, we present four design sensitivities meant to inspire designers to design for other types of period tracking experiences that might better empower bleeders. These are: *support lived temporalities, embrace uncertainty, empower the self,* and *design less*.

KEYWORDS

FemTech, menstruation, reproductive health, self-tracking, period apps, interaction design, empowerment, critical feminism

Introduction

Today, digital period tracking applications claim to offer users reliable menstruation tracking and predictions, a sense of control, and discrete design. These applications are part of a wider trend of technologies aimed specifically toward women and female issues, labeled FemTech–Female Technology. These apps offer an alternative to non-digital menstrual tracking techniques used by women and other bleeders, such as diaries, calendars, hormonal birth control, or mental track-keeping (Epstein et al., 2017). They provide the technology for managing reproductive health digitally and are part of a wider trend of uncentering the male body as the sole subject of medical technology and research (Keyes et al., 2020). At the same time, these commercial apps have been heavily criticized for e.g., lacking privacy (Fox et al., 2019; Mehrnezhad and Almeida, 2021; Paul, 2022) and enforcing normative ideals on bleeders (Lupton, 2015b; Fox and Epstein, 2020).

Menstrual tracking apps today have millions of users across the globe, but, despite their popularity, we know little about the role these apps play in how menstruation is understood in society as well as by individual bleeders. Menstruation and women's reproductive health has been and is–still–a contested field, with past and ongoing struggles for power over women's bodies (e.g., Stanworth, 1987; Franklin, 1997; Lupton, 2013; Wilkinson et al., 2015). In a lifetime, people who menstruate are expected to go through about five hundred menstruation cycles (Karlsson, 2019)– which add up to years of bleeding. Yet, the bleeding female body has been deemed "impure," "unclean", and "out of control," and menstruating women emotionally labile, irrational, and mentally or physically ill (Johnston-Robledo and Chrisler, 2013), views that have been used as arguments for excluding women from parts of society and social life (e.g., Stern and Strand, 2022). Due to this, throughout history, women have had to manage bleeding in secret. While we can assume that menstrual tracking has been part of women's lives in all times, there is little historic documentation on it. Some early examples of menstrual tracking are from nineteenth century diaries where women marked menstruation with different codes and hints (Vermeer, 2022). Still today, research shows that knowledge on bleeding and fertility issues tend to be low (Nilsson et al., 2018; Perez Capotosto, 2021).

Period tracking apps can be seen to offer solutions to some of these historical problems. Marketed as providing empowerment through increased knowledge, control and ownership of their reproductive health (Hendl and Jansky, 2022), the apps can be understood as contributing to societal work on liberating female sexuality and reproduction which has been ongoing since at least the 1960s second wave feminist movement (Hewitt, 2002). The apps have the potential to offer women and other bleeders new and improved ways of managing bleeding, particularly if contrasted with how it has been done historically.

Empowerment, is a contested term and studies in HCI have shown how it is rarely defined, and used in a wide variety of ways (Schneider et al., 2018). Our point of departure is thus to explore how these apps represent and frame menstruation through their design in order to start shedding light on their role for menstrual empowerment in the long and contested history of female reproductive health. We do so from a critical theory

framework (Bardzell et al., 2018) where we ground ourselves in feminist theory on how female coded bodies are controlled and understood as well as in theories of ontological design such as Willis (2006) "The double movement of ontological designing." This means that we design and create the material circumstances in our world and those circumstances, in turn, shape us and our understanding of the world back. For menstruation apps, the way that the apps are designed, and the cycle is represented in the design, potentially shapes users' understanding of the cycle and its effect on their general experience of wellbeing. In a second step, we enter current period tracking design practices in conversation with the historical context, and pay particular attention to questions of how empowerment could be supported in menstrual tracking apps today. We build this discussion on the assumption that period apps can contribute to empowerment, if they strengthen users through knowledge, awareness, control, and agency, in relation to reproductive health.

In the paper, we study nine frequently downloaded commercial menstruation apps in order to explore the interactional space they present users with; both opportunities and limitations. We furthermore explore what an interactional space that supports empowerment could look like. We thus ask:

1. How are commercial reproductive health apps representing the cycle through interaction design?
2. How could menstrual tracking apps be designed to empower users?

We focus on a comparative design investigation through what we call *critical app-walkthrough methodology* where the period tracking app's interaction designs are first explored comprehensively at one point in time and in a second step interacted with over a longer time period through researcher use-diaries. We map out trends and compare how these types of apps define menstruation in their design and what it is possible to do, and not do with these applications; i.e., interactional opportunities. Our method allows us to compare design across the apps, analyse interactional opportunities, and secondly build on these results while discussing what menstrual empowerment could be. The aim is to use the critical feminist analysis of the apps to discuss how period apps can be designed to better empower bleeders. In doing so, we use the terms bleeders and women in a strategic essentialist sense (Keyes et al., 2020), to allow us to discuss the use of menstruation apps in relation to a historical context of women's reproductive health, while acknowledging that not all bleeders are women, and not all women are bleeders.

Our analysis shows three main ways in which current period apps represent the cycle through design; (1) graphical representations of the temporal aspects of the cycle, (2) datafication of menstruation through input and output of various more or less cycle-related data for intimate data tracking, and (3) finally, the ways fertility predictions convey certainty over uncertainty and the implications of this. We then propose four design sensitivities that could be built upon to support empowerment in the domain of period tracking. These are, (1) support lived temporalities, (2) embrace uncertainty (3) empower the self (4) design less.

Menstruation apps and femtech

The concept FemTech was coined by Ida Tin, the founder of the menstrual tracking app Clue (Tin, 2016). It commonly describes technologies, wearables, and software that address female general health, diagnostics, sexual wellness, and reproductive health. FemTech is an industry that is good for billions of dollars, and that continues to grow rapidly (Knickerbocker, 2022). A majority of FemTech solutions directed at reproductive health come in the shape of commercially developed apps which include pregnancy and post-partum apps, fertility trackers both used to facilitate pregnancy and as contraceptive methods, and of interest to the study at hand–menstruation tracking apps.

Providing women with tools for daily management of reproductive health without the need for doctor's prescriptions or medical appointments, the apps have the potential to give women the tools to take charge of their own reproductive health, and indeed the apps are popular among users. The menstrual-tracking app Flo is said to have reached 40 million monthly active users and 200 million downloads in 2021 (Flo's webpage June 2023), and the period-tracking app Clue currently reports 11 million monthly active users spread out over 190 countries (Clue's webpage June 2023) .

The apps are often marketed in terms of empowerment (Hendl and Jansky, 2022). For example, the vision of the period and fertility tracking app Clue is that "*everyone with a cycle is empowered to make informed choices for themselves around menstrual, sexual, and reproductive health and wellbeing*". The menstruation app Flo, argues that, "*when it comes to your health, knowledge is power*", and the app company claims to be on a mission to put the power back in the hands of their users. Ironically enough, Flo was in 2019 revealed in a Wall Street Journal published article, to have shared sensitive data–period data–with Facebook (Schechner and Secada, 2019). This scandal is often mentioned as an example to highlight issues of data security and privacy, for which the apps have been heavily criticized, both in public and scholarly debates (Fox et al., 2019; Mehrnezhad and Almeida, 2021; Paul, 2022).

The apps have also been criticized by scholars for turning users into objects of surveillance, discipline, and commodification (Lupton, 2015b; Roetman, 2020; Healy, 2021) and of perpetuating normative stereotypes of women as reproductive subjects (Lupton, 2015b; Fox and Epstein, 2020). Such critique against reproductive health apps have led scholars to call the discourse of "empowerment," promoted via the marketing and social media of the apps, "contradictory, empirically unsubstantiated and gender oppressive" (Hendl and Jansky, 2022, p. 22).

In light of recent critique, can Fem Tech be empowering, and what indeed do we mean by empowerment? Within HCI, research has shown that the term can mean many things, and is often left undefined (Schneider et al., 2018). In this study we thus explore current and potential future ways in which we can think about empowerment in period tracking apps. Starting from a feminist, sociohistorical and political perspective, we argue that FemTech has potential to contribute to reproductive health in an empowering way for women, in three main ways. First of all, related to the historical women's rights movement and the fight for women's right to their own bodies, sexuality, and reproductive

health. Here FemTeach could help in increasing knowledge and allowing women themselves to take control of their reproductive health. Second of all, related to the fact that women and women's health issues have been under-researched in the history of medicine (e.g., Criado Perez, 2020) where women have been mystified and othered in relation to a male norm (Johannisson, 1994) and even in HCI research women's health is underrepresented (Keyes et al., 2020). FemTech and attention to reproductive health is a welcome approach, as it puts women's health needs in the center of attention. The apps do this both through their purpose of being tools for women to manage their reproductive health, and through the collection of data that the users input in the apps. While there is a risk that this data is sold for profit, there is also a potential that this data can be used to contribute to research and knowledge about women's reproductive health. For example, the app Clue writes that they "sometimes share de-identified data with carefully vetted scientists to improve research on menstrual and reproductive health" (Tin, 2022). Thus, the apps collect data that historically has been overlooked and not collected at all. Third, technology has often been criticized by feminists to be designed by men, for men (Wajcman, 2007) yet FemTech is decidedly designed for, and even sometimes by women, for women, and thus challenges this male-centeredness.

We argue that empowerment ought to be taken seriously by designers of FemTech. To make use of its socio-historical and political potential to contribute to the reproductive health of women, the design of current FemTech needs to be critically examined, for future FemTech to be designed with responsibility, care, and a serious intention to aim for empowering user experiences. Therefore, in this study, we conduct a feminist analysis of nine of the most downloaded menstrual apps and discuss the design in relation to the notion of empowerment, and suggest ways in which period apps can be designed to better contribute to the reproductive health of women.

Theory and earlier work

This study aligns with the critical design tradition in HCI. The main purpose of critical stances is to challenge the status quo and the representation of it as natural or given, to reveal concealed social structures, change perspectives, and imagine alternatives (Bardzell et al., 2018). Critical design can largely be divided into two approaches: one oriented toward challenging majority norms and hegemonies in society through alternative designs, and the other is oriented toward using specific perspectives for analyzing recurring patterns in design. In this study we take the second approach and use feminism as a lens for analyzing the interaction design of menstrual tracking apps and contribute to conversations on potentials and problems of their design in relation to menstrual empowerment. We do so based on the acknowledgment that design contains assumptions about the world and the needs of users, and accordingly contributes to reiterating and reproducing these values (Bardzell et al., 2018), stabilizing them in the technology through taken-for-granted user experiences (Bowker and Star, 2000). Grounded in this assumption, we argue that these kinds of

studies that critically examine the design of everyday technology are essential.

Menstruation and self-tracking in HCI

Recently, the topic of menstruation has gained attention in HCI (e.g., Flemings et al., 2018; McDonald et al., 2018; Bardzell, 2019). Studies on menstruation apps have looked at questions of privacy and data security (Karlsson, 2019; Mehrnezhad and Almeida, 2021; Mehrnezhad et al., 2022), and menstruators' tracking practices and experiences of using menstrual tracking apps, related to design (Epstein et al., 2017; Karlsson, 2019; Fox et al., 2020). Much HCI research on menstrual technologies, however, takes a research-through-design approach and has been directed at prototyping and speculative design. Design studies have explored how interactions with the menstruating body can lead to bodily appreciation and new knowledge (Campo Woytuk et al., 2020), how menstrual trackers can enable period-positive ecologies (Tuli et al., 2022) and how technology can be designed for period positivity (Campo Woytuk et al., 2019). Speculative design studies have raised questions such as privacy (Fox et al., 2019), and menstrual taboo through designs such as the internet-connected menstrual cup *PeriodShare* (Søndergaard and Hansen, 2016). Little attention has however been paid to the ways in which commercial menstrual tracking apps frame menstruation, and, concretely, represent bleeding through their design. Thus, we begin to address this gap.

Tracking the cycle is part of a broader concern in HCI regarding tracking various personal data through apps. The overall term for this research is personal informatics and it refers to the practice of collecting, sharing, storing, and retrieving personal information in order to improve self-knowledge through technology. This information can be in any form; personal diary notes, photos, videos, music, as well as data tracked by a device (steps, pulse, hours of use, etc). For an extensive overview see Epstein et al. (2020). Originally personal informatics was concerned with the practical management of the information (see e.g., Jones and Teevan, 2007; Sellen et al., 2007; Clinch et al., 2014), how to store, sort, organize, and retrieve the information, but more recent research focus on how this information becomes meaningful (see e.g., Rooksby et al., 2014; Elsden et al., 2016; Tholander and Normark, 2020) and under what circumstances this collection of personal data can turn out to be problematic (see e.g., Lupton, 2014; Williams, 2015; D'Ignazio and Klein, 2020). Our research is contributing to the understanding of meaningful personal informatics and the tension between objective and subjective personal data.

Empowerment

The concept of 'empowerment' was developed within civil rights movements in the US during the 1960s and 1970s and has since then been used widely within areas such as marketing (Bachouche and Sabri, 2019), social work and policy making (McLaughlin, 2014), and in health care, representing a shift from a paternalistic to a participatory patient approach (Hage and Lorensen, 2005; Halvorsen et al., 2020), While there is no uniform definition of empowerment, the core idea is described by Julian Rappaport as "a belief in the power of people to be both the masters of their own fate and involved in the life of their several communities" (Rappaport, 1987, p. 142). Rappaport describes empowerment as a process through which people, communities and organizations gain control over issues that are relevant to them, and empowerment thus involves dimensions of personal control and influence over ones own life, as well as dimensions of social influence, political power, and legal rights (Rappaport, 1987). A more individual conceptualization of empowerment, is Marc Zimmerman's notion of psychological empowerment, according to which empowering processes are; "those where people create or are given opportunities to control their own destiny and influence the decisions that affect their lives" (Zimmerman, 1995, p. 583). Feminist notions of empowerment have focused on putting the subject's own experiences and interpretations of power at the center of attention, asking questions such as "what do relationships of power feel like from the inside, where are the possibilities for resistance, and what personal and collective processes will take us there?" (Deveaux, 1994, p. 243–244).

Within HCI, increasing attention has been given to the idea of empowering people through technology. However, while the concept is used frequently in HCI research, it is rarely explicitly defined (Schneider et al., 2018). In a review of 54 HCI papers published at the CHI conference that use the terms *empowerment* and *empower*, Schneider et al. (2018) found that notions of empowerment varied from referring to power in the sense of having power in relation to others, to power to act. Furthermore, they found that 'being' empowered was conceptualized in different ways in HCI research; as implicating feeling, action, or knowledge.

In our analysis of what empowerment could mean in the case of menstrual apps, we combine these conceptualisations, and approach empowerment as a process that can occur both on an individual and on a group level, that technology actively can contribute to. We define empowerment in the case of menstruation apps, as those processes which can be seen to strengthen users through knowledge, awareness, control, and agency, in relation to reproductive health. While we in this paper focus on what menstrual empowerment could be based on an analysis of the design of the apps, the study is part of a broader research project in which we will also interview app-users about their experiences, following the feminist imperative of acknowledging the subject's own experiences and interpretations of empowerment.

Methodological approach

To investigate how common menstrual apps represent menstruation through their interaction design we choose nine apps based on an incognito search in a web browser (search term menstrual tracking, 2022-10-14) in the google android app store to simulate real-world experiences with finding apps (as

TABLE 1 The apps analyzed in the study.

Logo	Name (developer)	Version	Country	Downloads Google play	Stars G.play	Stars app store	Release year
	Clue (Biowink)	72.0	Germany	10 Mn+	4.7	4.6	2014
	Flo (Flo health UK)	9.10	US/UK	50 Mn+	4.7	4.6	2016
	Period tracker period calendar (Simple design)	2.44.1	British Virgin Island	100 Mn+	4.9	4.9	2012
	My calendar - period tracker (Simple innovation)	8.4.3	Canada	10 Mn+	4.9	4.6	2015
	Period tracker diary (Simple innovation)	7.0.2	Canada	1 Mn+	4.9	4.6	2017
	Period tracker (Amila tech)	1.2.32	Cyprus	1 Mn+	4.7	5	2015
	Ovulation and period tracker (Leap fitness)	1.078.GP	Singapore	10 Mn+	4.8	–	2017
	Period tracker (GP International)	11.7.6	Canada	10 Mn+	4.5	4.6	2011
	Clover -safe period tracker (Wachanga)	2.51	Cyprus	1 Mn+	4.3	4.5	2018

in Mehrnezhad and Almeida, 2021). We picked the top nine choices, see Table 1, note that 9 months later the same search yielded the same nine top apps. We used the paid, full, version for all apps. Our methodological approach build on a first-person research approach. First-person methods have seen increasing use in HCI, for example research building on use experiences from the researchers themselves (Lucero et al., 2019; Desjardins et al., 2021). As our goal was to compare and track trends and similarities across a broad range of different apps we opted for a methodological approach where we as researchers used several apps simultaneously.

In order to explore the interactional space created by these apps we focused on a comparative design investigation, rather than how e.g., users experience one app in isolation. We wanted to map out trends and compare how these types of apps define menstruation in their design and what it is possible to do, and not do with these applications; i.e. interactional opportunities. We thus draw partly on the app walkthrough method (Light et al., 2018) in combination with inspiration from critical theory and critical gameplay methods (Grace, 2010; Bardzell et al., 2018). We thus engage in what we here call a *critical app-walkthrough methodology*. In particular, we suggest that attention in design exploration can focus on identifying common patterns that have the potential to shape users actions and thinking (Grace, 2010). So in *critical app-walkthrough* we attempt to expose design patterns, which we do by analyzing the interface design of menstrual apps, to investigate the design from a critical perspective, but also to move forward

and suggest redesigns for identified, problematic patterns to which the studied group of designs subscribe. We combine this with a more longitudinal approach in which we engage in researcher use diaries of all applications. In a first person approach we wrote about our experiences of using the apps, inspired by autoethnographic work where the researcher's personal account becomes valuable in ethnographic reporting (Rapp, 2018). However, as our main goal is comparison across a range of apps, we all imputed the same user data. Our reasoning was two-fold: first, we wanted to study how these apps frame the period to someone who is considered to be a core user or within the norm according to previous research (e.g., Epstein et al., 2017). In other words, the users these apps are made for. As we in different ways do not fulfill these criteria, for example some of us are too old, we opted for using fictive data. Secondly, using the same data allowed us to more readily compare how differently or similar the apps behaved to repeated use.

This methodological approach allowed us to compare design across the apps, analyse interactional opportunities, and do so through a lens of critical feminist theory on how women's reproductive health has been treated throughout history. This, allows us to put current technology in use in the field of women's reproductive health in a larger societal context and be able to explore potential consequences and future directions beyond individual use.

Data gathering

We first explored three apps each, going through the steps of registration and entry, everyday use, and discontinuation of use. Carefully documenting each of the steps, we then analyzed the material looking at the technological mechanisms of the app's interface, embedded cultural references and how it shapes user's experience, and what ideal users and uses that are implied. This also involves looking at how the app makes users' self-expression possible and what interactions and relations with other users that the app promotes. We also included company websites and app-store pages in the analysis in order to analyse the app's context in looking at the vision, operating model, and governance (see Light et al., 2018).

In order to be able to capture use and still be able to compare it across a number of applications autoethnographically we further engaged in researcher use diaries. As Hornecker et al. (2017) argued for a first-person method: "It relies on methodological rigor in how attention is directed to experience and how it is described. Rather than for repeatability and objectivity, it aims for relevance and rich descriptions that other people resonate with." We thus used the apps for two full fictional menstrual cycles, regularly engaging with the apps and writing about our own experiences and reflections about that use. This further allowed us to see how usage changes as users become used to the applications. We interacted with three apps each over the period of two full menstrual cycles, engaging in use and keeping diaries of this use. This more longitudinal perspective allowed us to experience the apps through regular use, the way these apps are intended to be used.

For both the use diaries and walkthrough we created a user profile to tour the platform environment. We put the same data in each app to allow for comparison across apps. We created a user profile based on a persona of a 25-year-old woman, with a weight of 65 kg, and a height of 170 cm, with no illnesses, and no use of hormonal contraceptives. While we here, by design, focus on use from a non-problematic user perspective this study is part of a larger project where all manners of experiences and types of bleeders are considered. In the larger project, we will also further investigate users' experiences.

Analysis

Our data comprise nine in-depth app walkthroughs, roughly 93 pages as well as 10 user diaries over several pages each with detailed experiences and thoughts for 2 months of regular use of the apps. In the research group we all have experiences of bleeding, some with no previous experience of period tracking using apps, and some with many years of experience. This provided a constructive setting for our analysis as we could discuss through and reach a consensus on coding through different lenses.

We coded the apps using a deductive approach through the coding scheme adapted from Light et al. (2018) using twenty categories such as the app's vision, operating model and governance, interfaces and content, everyday use case scenario, and so on. For the full coding sheet see Supplementary material 1.

We then coded both app walkthroughs and diaries together using an inductive approach where we looked for relevant analytical themes in the collected data which concerned the representation of menstruation. The three main inductive themes are temporal interface metaphors, tracking with input and output of intimate data, and the way certainty and uncertainty are leveraged in fertility predictions. These are the main categories in the result section.

Finally, building on our results we explore the role empowerment could play in period tracking apps. Considering the history of oppression of female bodies and health we arrive at a series of design sensitivities which could be incorporated into period tracking apps to further their empowering potential.

Results

The core functionality of these apps is to track past and predict future menstruations. Users input the first date of their menstruation and the length of their cycle and based on that input the apps predict future periods. Users can often choose to receive notifications a couple of days before the upcoming menstruation, and most apps will further remind users to log their periods. The interface design is remarkably similar across all apps (see Figures 1, 2), and as shown in previous research (Epstein et al., 2017), the graphic design is distinctly feminine coded. As described in the background, developers market the apps as something that can help menstruators in their everyday life; to keep track of their cycle, to gain a sense of control, and to make planning easier.
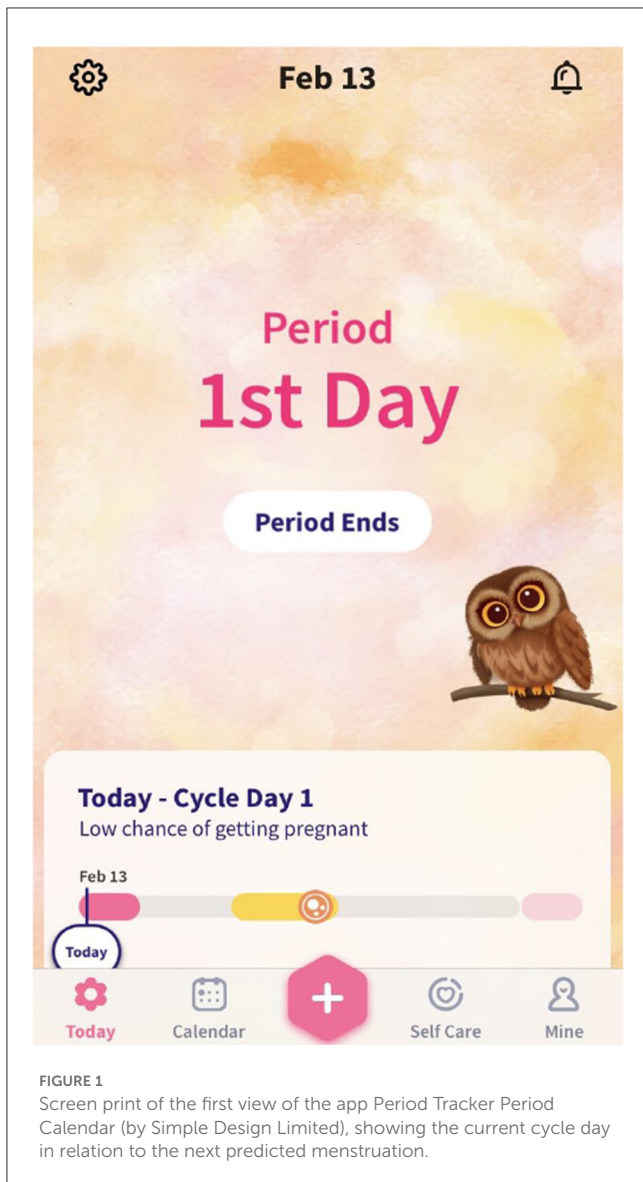
FIGURE 1
Screen print of the first view of the app Period Tracker Period
Calendar (by Simple Design Limited), showing the current cycle day
in relation to the next predicted menstruation.
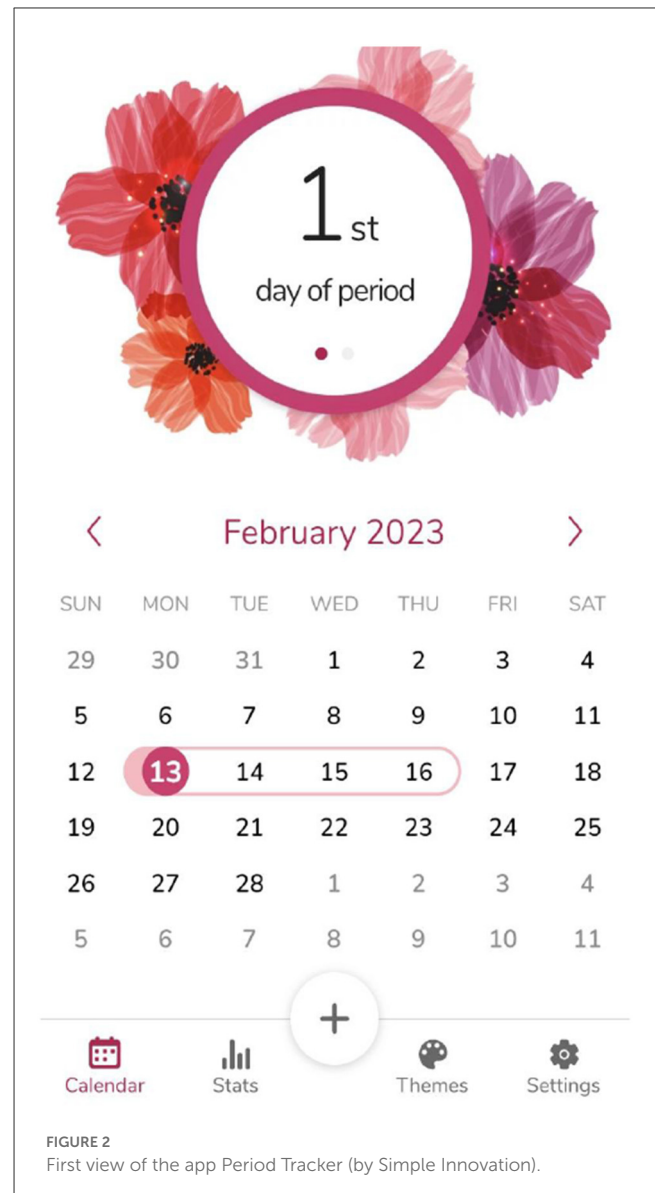
FIGURE 2
First view of the app Period Tracker (by Simple Innovation).

"Want to know your body better? Just track your periods to know fertility window, ovulation and change of pregnancy." -*Amila* website, 2022-10-12

So, the 'why' of use is often framed in the context of offering users control and relief of not having to keep track of menstruation by themselves, and that the technology will do so in a much more accurate, predictable way.
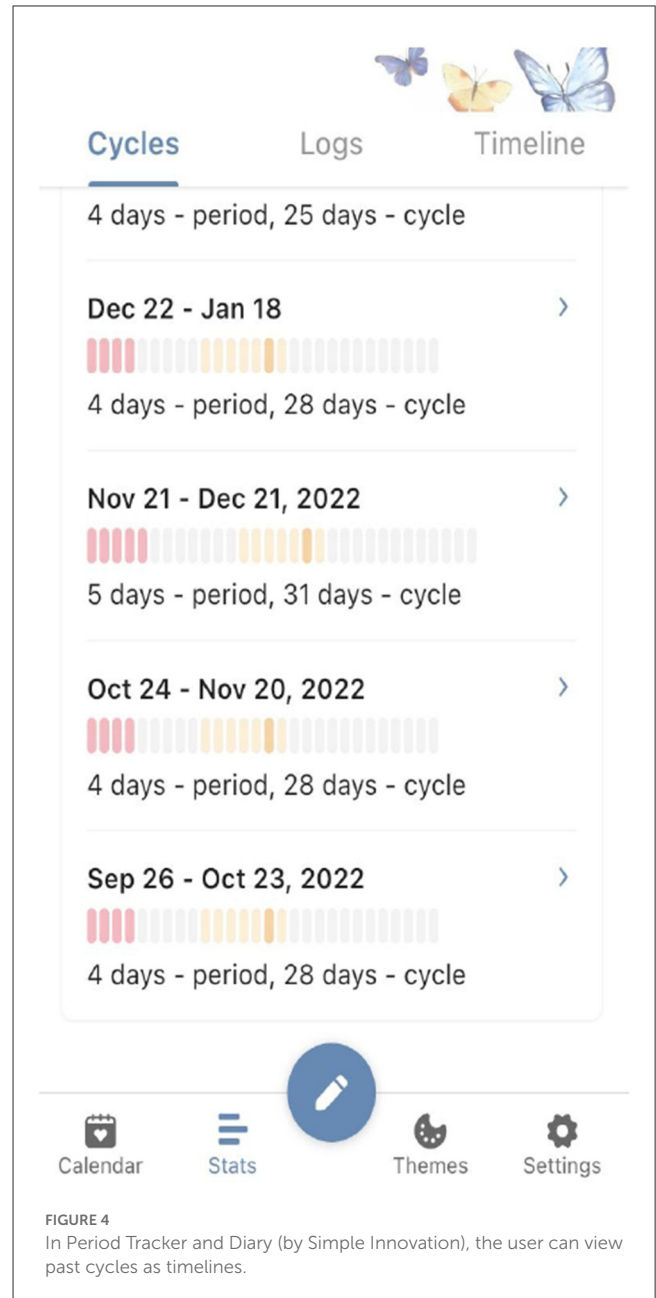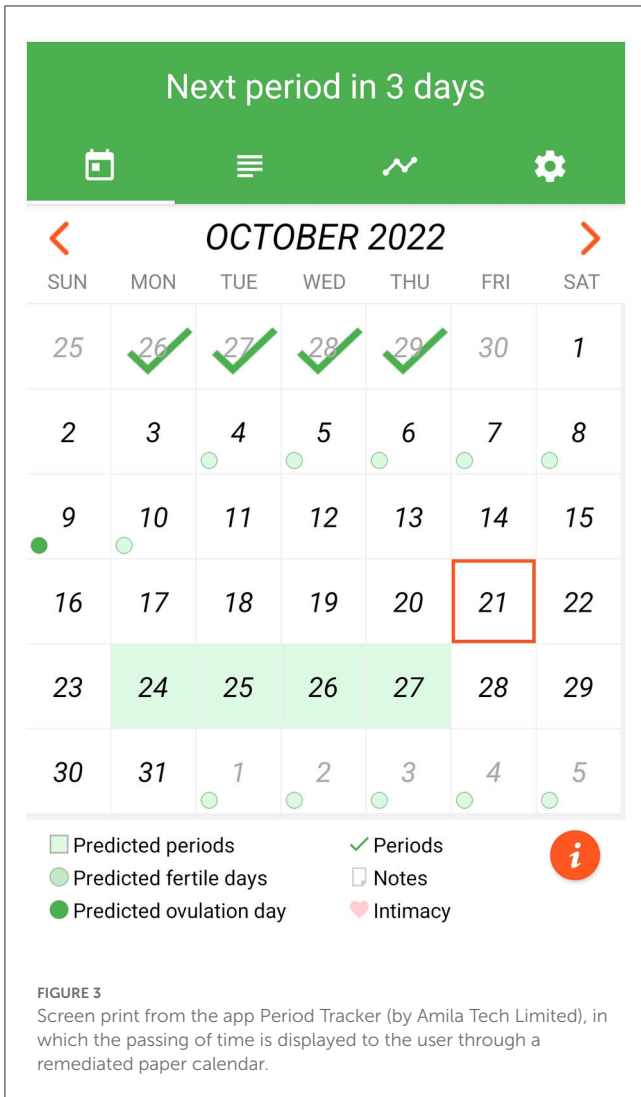
Users start by registering a profile which contains such information as age, weight, height, cycle, period length, and so on. From this base data the apps suggest when the user's next menstrual period will take place and how long it will last, as well as the day of ovulation and fertile days. Some of the apps will adjust these predictions as the user engages with the app and track different categories of data. In addition to the menstrual tracking function, some apps contain articles, videos, and general information about women's reproductive health. This provides users with general, and sometimes tailored knowledge about the female body and menstruation. Content ranges from the anatomy of the female body and menstrual diagnoses, to sex-guides and skin-care advice.

While the apps are similar in their designs, there are some possibilities for users to adjust them to suit their own preferences and intended use by choosing which tracking options are displayed or deciding on what to track, and what not to track. Users can e.g., choose whether fertility is displayed or not, or what push notifications say. Taken together, the apps offer some possibility to appropriate the technology to fit differet users but as we will discuss later, the apps offer few opportunities for users to appropriate the technology in a way that can be said to empower the self.

Bleeding on a timeline

When a user opens an app, the first view is generally a prediction of the next menstruation. In order to signal the

FIGURE 3
Screen print from the app Period Tracker (by Amila Tech Limited), in which the passing of time is displayed to the user through a remediated paper calendar.

FIGURE 4
In Period Tracker and Diary (by Simple Innovation), the user can view past cycles as timelines.

approaching, the arrival of, and passing of bleeding, the apps attempt to convey menstruation and the passing of time through graphical representations. Some do it in the form of remediated paper calendars and timelines, others use the metaphor of the cycle itself (see Figures 3–5).

In those apps that use calendars, time is structured into months, each represented by a new leaf or page to signal the passing of time. Pen-and-paper menstrual tracking using paper calendars is nothing new, and the paper calendar is a readily remediated metaphor that apps can expect users to understand and which fits practices already in use. As such, menstruation is mainly associated with practicalities; the period as something to fit into everyday life. Through the choice of using calendars as the center of attention in the design, menstruation is portrayed as something which can be disciplined and subordinated to life in general, where efficiency and progress become key values (Wajcman, 2007). Indeed, the apps, as expressed by the developers, focus on helping menstruators to control and predict.

"Can't remember the date of your last period? Want to know when your next period is coming? Period Tracker - Ovulation & Pregnancy Calendar is a simple and elegant way to view past and predict future periods, fertile days and ovulation days." *Simple Design Ltm* website, 2022-10-17

The second metaphor used to convey menstruation periods comes from the terminology often used to talk about the time between bleedings as well as the bleedings and that is the circular-shaped cycle.

For example, the cycle in *Clue* begins with bleeding and ends the last day before a new period. A circle does not represent time in the same way as a calendar and is not a remediation of organization in the way that the calendar metaphor is as it is not as easily fitted on
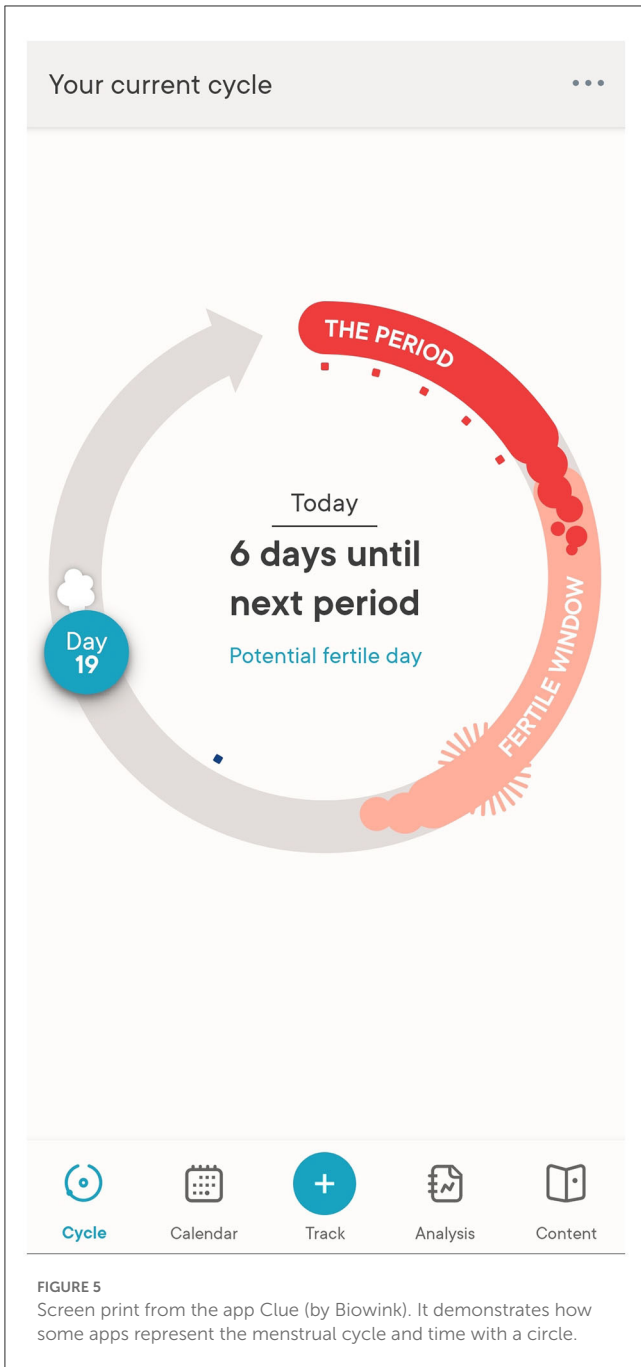
Screen print from the app Clue (by Biowink). It demonstrates how some apps represent the menstrual cycle and time with a circle.

Tracking options for menstrual flow in the app Flo (by Flo Health UK Limited).

top of a user's ordinary calendar. Every user's circle is the same size, despite their periods' having various lengths. In this way, the cycle is whole in itself, not subordinated to another way of representing time that it has to fit and order itself to.

> *Diary 26th of October, researcher 2*
> *Clue has a circle as a metaphor for the period, for me that is somehow a better metaphor for the cycle of life. No beginning or ending. A not so objective western (patriarchal) understanding of time. We don't move forward in an eternal progression, but we stay, circle around, do not move forward but stay.*
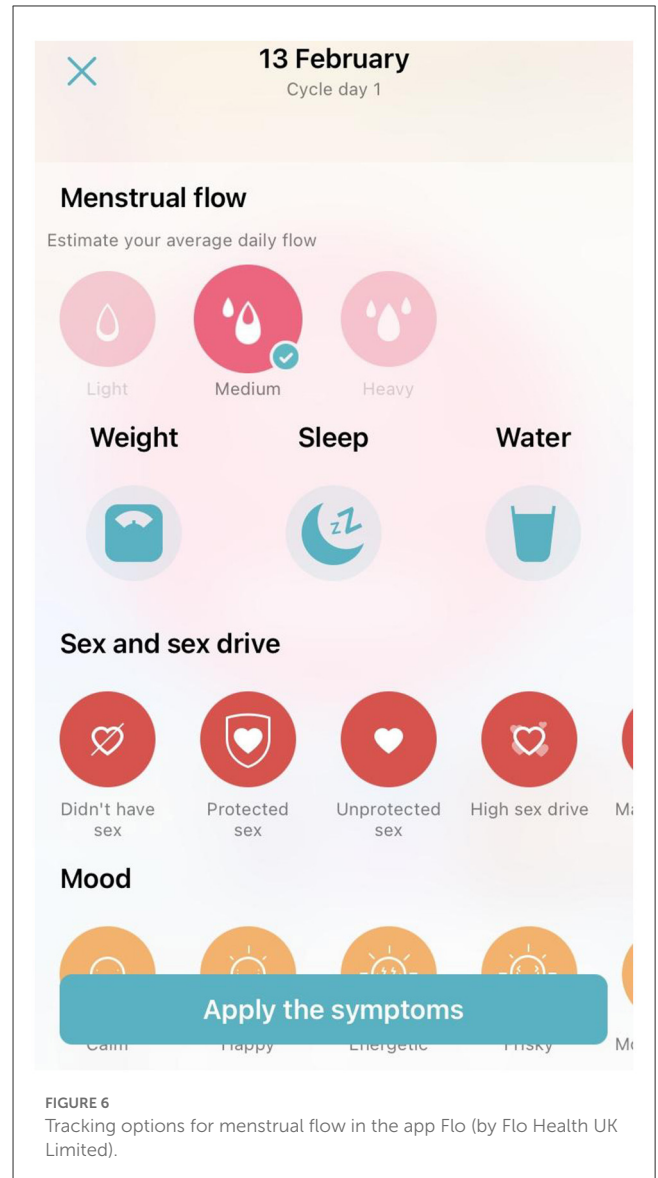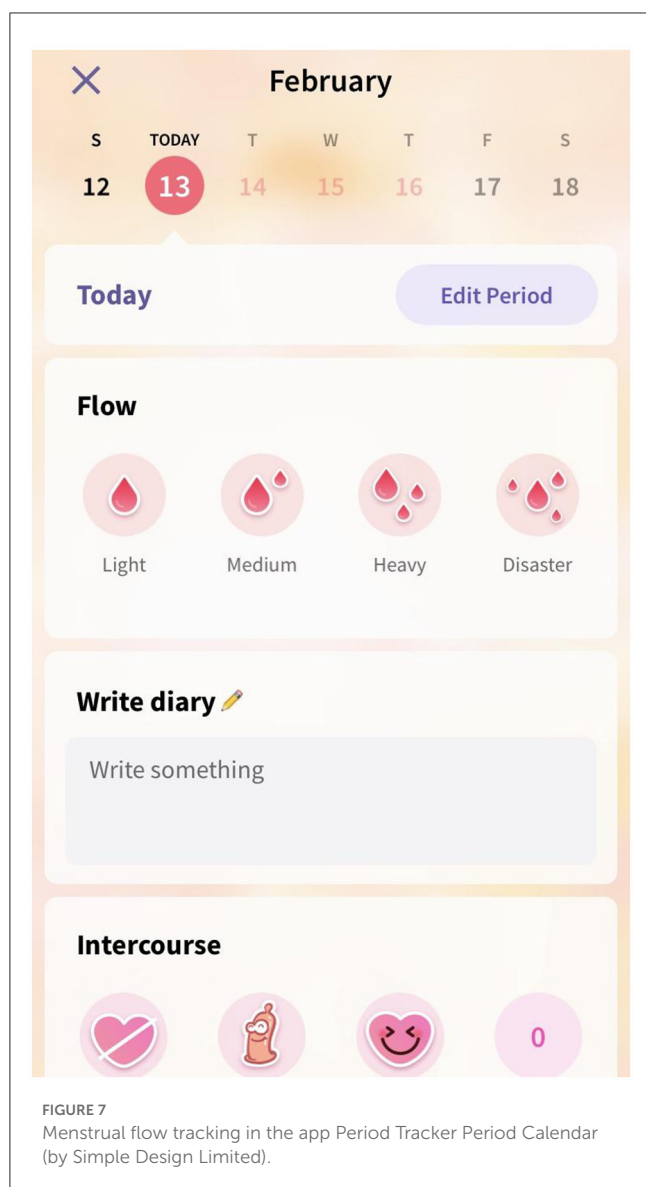
As in the diary quote above, there are various ways of seeing time represented in these apps. Researchers like Leach argue that cyclical and linear time are the two main ways of representing time, either time is seen as repeating, or that all change is irreversible and time passes (1961, p. 125-127). While this reasoning about time came from studying non-Western contexts, the terms are still useful as they describe how time is a social construct with varying meaning. These views on time exist simultaneously, even if the linear view of time as progress tends to dominate in modern rhetoric about which societies are developed and which are not (Schulz, 2012). Of the various representations of time in the menstrual apps, a circle does not convey the forward movement of time in the same way as a calendar or a line. A circle arrives again at the beginning and does not propose a strive or movement forward. The metaphor of a circle can thus be seen as a more accurate representation of the menstrual cycle as continuously recurring and at its own pace, a more embodied view of menstruation and

FIGURE 7
Menstrual flow tracking in the app Period Tracker Period Calendar (by Simple Design Limited).

menstruation as separated from the everyday planning of other parts of life.

A second way that time is represented in the interface design of the apps are through the options for tracking various dimensions of the menstrual cycle experience. Mimicking regular calendars, the apps break down the cycle into daily units where users are suggested to track their cycle related symptoms and activities on a daily basis. This daily instantiation of the menstrual periods takes us into our second topic, that of datafication.

Datafication of menstruation

The apps contain extensive options for entering data about menstruation and related experiences, symptoms, and moods during the menstrual cycle. Often argued to help expand users' understandings of the cycle and body. The different apps, however,

offer vastly disparate categories to track, which in turn suggests that the experience of the menstrual cycle is a question of interpretation in relation to the specific app that a user has. Something which might not be visible to a user who only sees one app at a time. In the next passage we describe how the menstrual body is quantified and interpreted through the input and output of data in the apps.

Input: quantifying the menstruating body

Users log the dates and duration of bleeding, and the intensity of the flow, as the apps often have tracking-options for bleeding that range from light to strong (see Figures 6, 7). Besides tracking the bleeding there are six main categories of data that can be documented daily: symptoms, moods, cycle states, lifestyle, sex and the use of contraception, and, finally, the option to add personal free text notes. Many of the apps contain all or several of these categories which indicate that the menstrual cycle is defined beyond its purely physical or medical aspects through the apps.

Some symptoms to log daily are traditionally related to the cycle, such as cramps, back pain, or acne. But there are also other data options concerning less obviously related symptoms such as shivering (Clover), or salt cravings (Period Tracker). There is also an option of entering what can be defined as cycle states such as vaginal discharge during the cycle. Similarly, the user can record 'moods' from a large set of options. The moods are typically a mixture of emotions (angry or sad) and mental states (tired, sick, or hungry) and can predominantly be characterized as negative, with a few exceptions such as happy or energized. The category of data defined as "lifestyle" is concerned with other somewhat vaguely related health aspects such as nutrition, water intake, and daily steps. Not all of the apps we investigated had this option. Again, what is considered relevant dimensions of these bodily states differs between the apps.

That the symptoms vary suggest that the cycle is not only a medical health condition but an open-ended experience, defined by the user (Lundmark and Normark, 2012). In contrast to the calendar data that can be interpreted as having some practical dimension in users' lives (remembering when the last period was and when the next is to be expected), recording these kinds of data is, however, less motivated in the apps. They contribute to portraying the experience of the cycle, but they are sometimes difficult to make sense of.

For us, engaging with the tracking and use-diaries, affected us, even though the data we tracked was not based on our own menstrual cycles and experiences. As this excerpt shows:

> *Diary 25th of October, researcher 1*
> *It feels like it affects me to track the symptoms in the apps. When I track, I take a moment to tune in on how my body feels, and as I scroll among the different symptoms like 'feeling worried' and having a 'stomach ache', I feel like I actually experience these symptoms, even though I'm not on my period and didn't notice experiencing those symptoms before I saw them in the app. Especially the ones connected to mood risk becoming like a self-fulfilling prophecy for me. I think "well, I am worried today indeed," and when something annoys me I tell myself "I'm*

irritable now because of my period," before I remember that I'm actually not on my period. Very odd. It's like I'm suffering from a phantom-period.

This suggests that drawing attention to certain bodily experiences may enhance those experiences. While this can be useful in some cases (like starting to notice a constant feeling of being tired and being able to do something about it) this may contribute to what is termed 'medicalising' minor issues, accentuating experiences of not being well (Barnack-Tavlaris, 2015).

Output: interpreting the data

By presenting data of all the previous menstruations that a user has registered, the apps allow users to go back in time and identify patterns in their menstruation data. However, while the apps show data on previous cycles, and predictions on forthcoming menstruations, there is no transparency in how the apps process the data and predict menstruation. This lack of transparency was something we reflected upon during our use, as shown in this diary excerpt:

> *Diary 14th of November, researcher 2*
> *Every time I log something the app is thinking and informs me that "Clue is getting smarter and that it has "updated our predictions." Somehow it's like what I do matter, every time I log it leads to something. BUT, then I don't see or know anything. What is actually happening?*

The app encourages the user to track for better predictions, suggesting that it makes the app smarter, but how about the user? As research in general has shown that women's fertility knowledge in many countries is actually very low (e.g., Sweden Nilsson et al., 2018; Perez Capotosto, 2021) this lack of transparency becomes problematic.
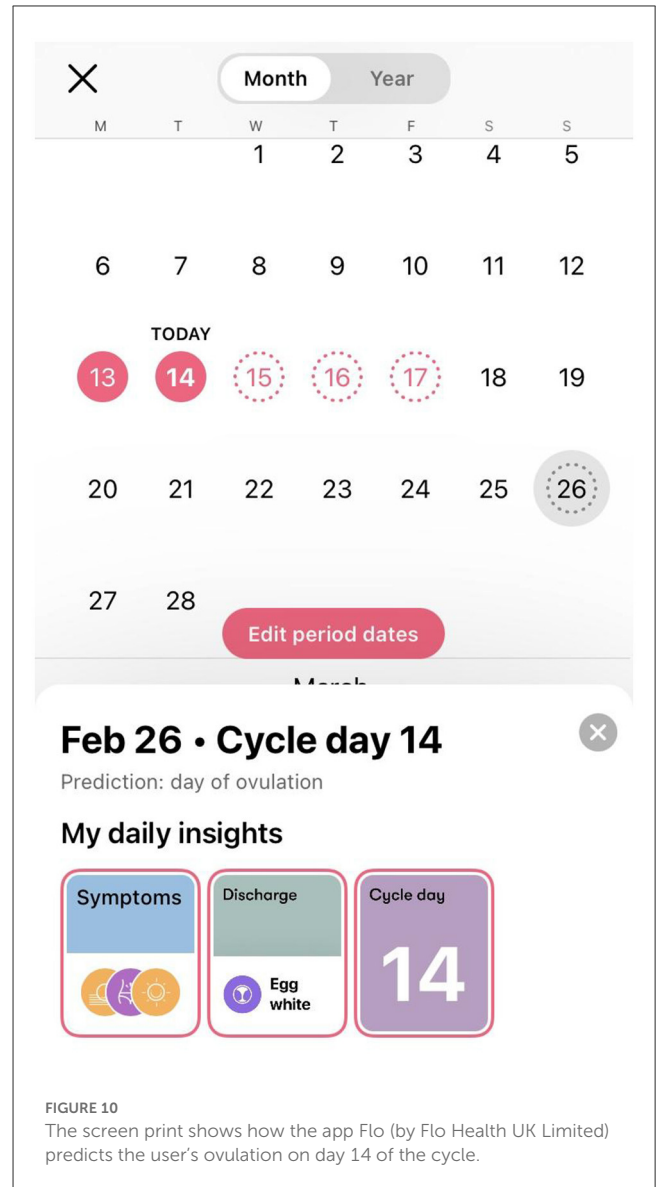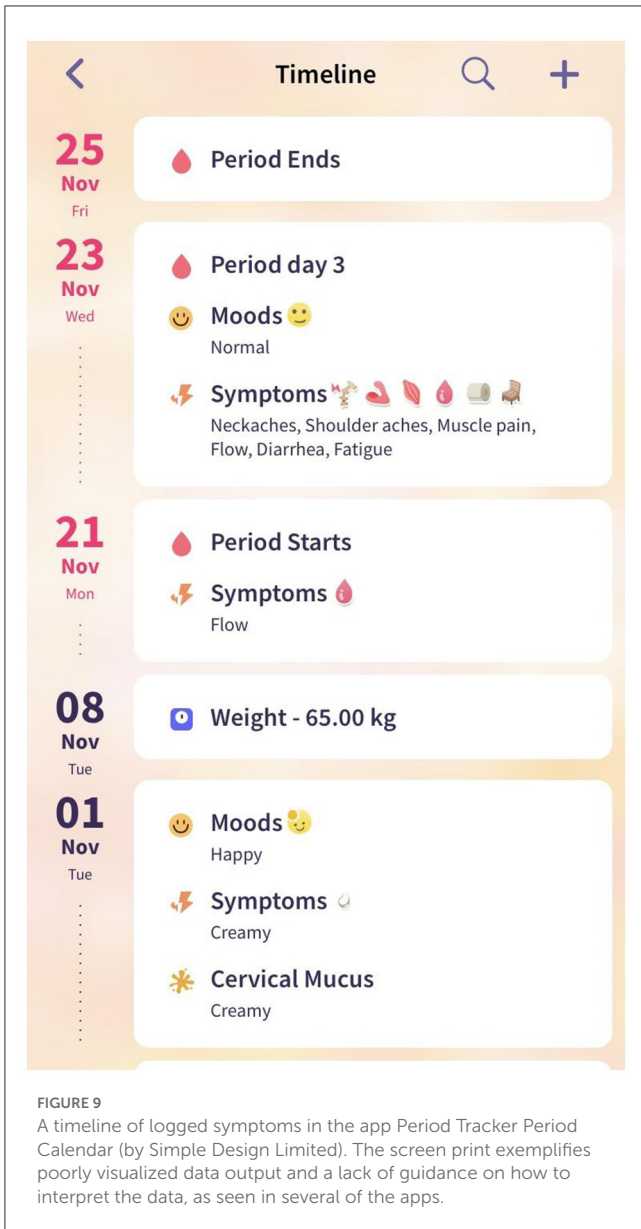
Interaction design concerning entering data into the apps are generally reasonably clear and well-guided. The apps' main task–keeping a record of when the user had their last period and when to expect the next–is well executed and represented. However, interestingly enough, the apps are generally bad at feeding back the complementary data and any conclusions that can be drawn from them to the users. This is particularly so for the less extensive (and less expensive) apps. The data, such as a recorded symptom, is typically represented with a tiny icon or dot in the calendar. There is next to no analysis or advice on how to handle recurring patterns. The user can in some of the apps click on a date to see that day's specific entries. In some cases it is possible to have a graphical overview of the data entered during a specific cycle (see Figures 8, 9). But these representations are not accompanied by instructions on how to interpret the data. What does it mean that the user had headaches three times during the cycle? Should it be compared to other months? This lack of designerly concern and interest in presenting the compiled data is clearly not contributing to users gaining knowledge or insights. Additionally, some research has shown that e.g., fertility tracking can become an emotional burden for users (Costa Figueiredo et al., 2018).

FIGURE 8
Screen print from the app Flo (by Flo Health UK Limited) displaying an example of poorly visualized data output.

Fertility prediction and uncertainty

In the previous sections we have described how menstruation is represented, structured, and datafied in the apps, and in this section, we describe how the apps ascribe menstruation meaning in relation to fertility. While the apps we have looked at are period-tracking apps, many of their functions and content evolve around fertility. By default, every app except for one, informs users of fertile periods and ovulation, and reminds users of the reproductive potential and function of the menstruation cycle. By relating bleeding to reproductive potential, the apps can be seen to frame bleeding in terms of a lost reproductive potential, a "wasted egg" (Healy, 2021), while at the same time acknowledging that not all users track menstruation for reproductive purposes, through allowing users to turn off the ovulation and fertility function. Nevertheless, by default, the apps orient the menstruation cycle in relation to reproductive potential and remind their users of the menstrual cycle's relation to fertility and reproduction–a design

FIGURE 9
A timeline of logged symptoms in the app Period Tracker Period Calendar (by Simple Design Limited). The screen print exemplifies poorly visualized data output and a lack of guidance on how to interpret the data, as seen in several of the apps.

FIGURE 10
The screen print shows how the app Flo (by Flo Health UK Limited) predicts the user's ovulation on day 14 of the cycle.

aspect that has been shown to make groups of users uncomfortable, e.g., those who wish to be pregnant but cannot (Epstein et al., 2017).

Ovulation has commonly been said to occur on day 14 of a menstrual cycle and in the apps 14 or 15 is the day they show ovulation (see Figures 10, 11). However, the actual date of ovulation differs with cycle length (Bull et al., 2019), which varies both from person to person, and from cycle to cycle for the same menstruator, even for menstruators that report having regular periods (Lenton et al., 1984; Creinin et al., 2004; Jones, 2013). Furthermore, when in the cycle the ovulation occurs, and the fertile window, also varies between menstruators and cycles (Wilcox et al., 2000; Bull et al., 2019). In a study that investigated the timing of ovulation in 696 menstrual cycles, it was shown that only 10% of women with 28 days cycles ovulated on day 14, and that the day of ovulation ranged from day 10 to day 22 of the menstrual cycle (Wilcox et al., 2000). The fertile window can thus be highly unpredictable, even

for menstruation cycles that are considered regular (Wilcox et al., 2000).

Considering this variation of the menstrual cycle and ovulation between menstruators and cycles it is remarkable that most apps automatically put an exact ovulation on day 14 or 15. The apps we have looked at use no complementary biodata (such as body temperature) to predict ovulation, but are dependent on the menstrual and symptom data users logs. Given the variation of ovulation, any standardized attempt to predict ovulation based on the menstrual cycle risks being highly inaccurate, and we can therefore assume that there is a risk that the predictions that the apps give on ovulation are actually incorrect. Users will not be able to learn about their cycles, if their cycles are abstracted to a point where the predictions are guesses presented as truths. It is therefore interesting to note that the apps notifies the user about ovulation and fertility with a sense of confidence, precision, and the tone of a medical authority, without informing the user of the margin of error.
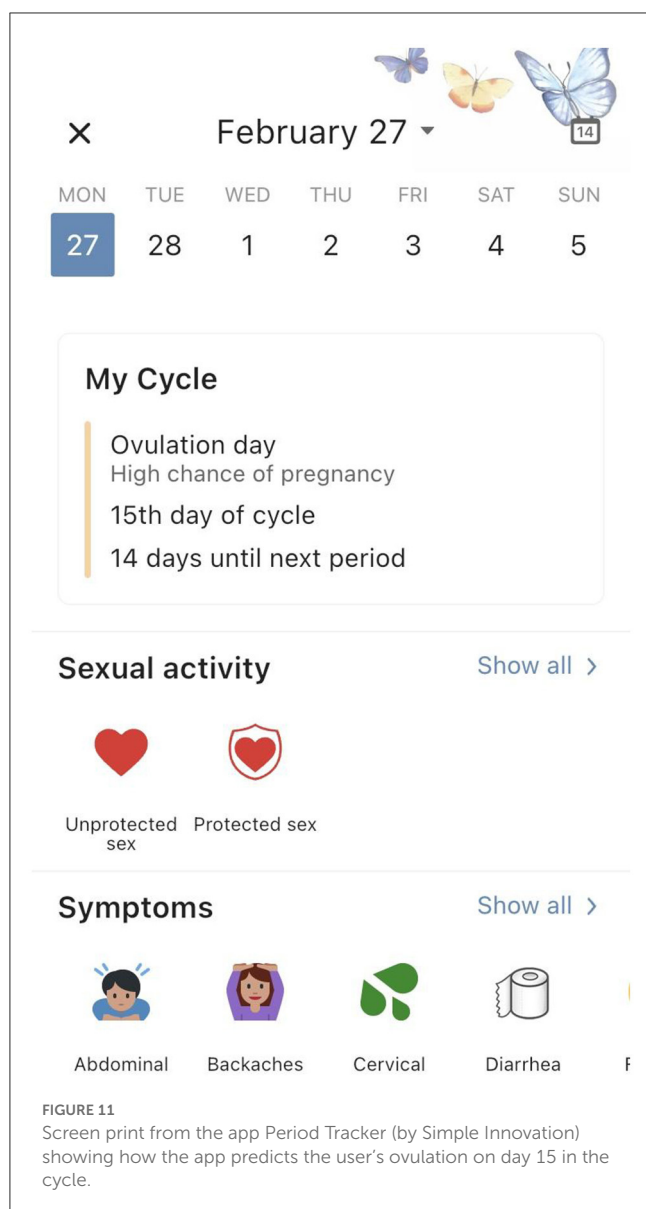
FIGURE 11
Screen print from the app Period Tracker (by Simple Innovation) showing how the app predicts the user's ovulation on day 15 in the cycle.

Discussion

In this study we analyzed how commercial period tracking apps represent menstruation through their interaction designs. Our results highlight how similar the most downloaded apps are. Their interface design, iconography, tracking options, and more to a large extent overlap. There are minor variations between the apps, rather than vastly different user experiences. We know that apps like these reflect cultural values and shape everyday practices (Light et al., 2018). Previous research has shown that some FemTech apps reproduce heterosexual routines and fulfill certain health and fertility ideals, often accompanied by an imperative to procreate (Wilkinson et al., 2015). Analyzing how period tracking apps reproduce particular social norms and values through visual design and app governance is therefore key to understanding these, quite similar, apps. From our results we can see how the apps often frame the period as an event that needs to be managed

and controlled, and fitted into everyday life. In the studied apps, menstruation is datafied and quantified through tracking categories that go beyond menstruation as a physical experience, and the apps frame menstruation in relation to fertility.

We will now turn to imagining the role that empowerment could play in period tracking apps. We defined empowerment in the case of menstruation apps, as those processes which can be seen to strengthen users through knowledge, awareness, control, and agency, in relation to reproductive health, and found that empowerment in the apps primarily configures as giving users a sense of control, reliability, and cycle knowledge. The apps help users keep track of menstruation while using the app and can help users learn about their cycle. Yet, the lack of transparency of the app algorithms means that there is little cycle knowledge for users to bring with them if use is terminated as the menstrual knowledge provided by the apps is dependent on continuous usage. An important question is thus if the apps can be considered to provide users with empowerment in terms of knowledge as users cannot know how the cycle predictions in the apps work.

On a group level, the apps can be seen to strengthen knowledge about reproductive health both through content in the apps, and through ambitions to use aggregated data for research. Of the apps we studied two apps (Clue and Flo) contained content aimed to educate users about reproductive health and we found that some content could work indirectly to normalize menstruation and the female body. An example of such content is an article from the app Flo with the title "7 reasons to love your discharge (because it is magical)," which could potentially contribute to removing the stigma often associated with female bodily fluids. At the same time, the wide range of physical symptoms, mental states, and emotions that the apps include in the representation of the menstrual cycle, could lead to an exaggerated focus on the female body as a source of problems. When the apps are designed to visualize a correlation between the female cycle and a wide variety of emotional and physical shifts, they contribute to establishing a biological explanation for many bodily sensations. This may lead to two problematic things: (1) that bodily symptoms that need medical attention are dismissed as part of the cycle and (2) that challenging life situations that result in bodily and emotional stress needing to be changed are dismissed as part of the cycle. While reproductive health apps and personal informatics have been argued to have a political character (e.g., Fox and Epstein, 2020), we argue that they also could result in depoliticising effects.

Thus, there are certain empowering potentials in the menstruation apps we studied, but we argue that there are ways to improve the design to better empower users. Next, we therefore discuss four design sensitivities meant to reimagine the design of menstruation apps.

Design sensitivities

The following considerations for design come in the form of 'design sensitivities' (Hindmarsh et al., 2005), which rather than providing absolute knowledge are meant to inspire designers. They support the call for attention to female health in HCI which call HCI practitioners to support a plurality of female experiences and

has the potential to empower a historically disempowered group ([Keyes et al., 2020](#)).

Support lived temporalities

Technology is good at representing factual clock/calendar time ([Rapp, 2022](#); [Van Amstel and Gonzatto, 2022](#)). As seen in our examples above, these apps are worse at representing lived time or embodied physical experiences such as menstruation. Self-tracking apps such as these are some of the most frequently downloaded apps to smartphones and tablets and scholars now talk about the quantified self or lifelogging ([Lupton, 2016](#)). Indeed, technology can be seen as a rational force offering people control over their bodies and surroundings by subjecting nature to control. Typically, technological rationales are oriented around efficiency, time management, and solving problems as quickly as possible. Particularly when it concerns the self and the body, this technological narrative needs to be challenged. Temporal aspects of the lived body should not be subordinated to standardized logic. The technological rationale ends up forcing the soft body into a certain shape. The way that the individual experience is represented through structural 'clock time' rather than the personal or existential time frames, we argue, draws attention away from the personal experience; in turn, this means less reflection and less empowerment of the self. The question is whether an app even can be empowering when the self is subordinated to the logic of the technology and the objective standardized data sets.

In opposition to this, in HCI so-called temporal design has been suggested that seeks a: "shift toward a pluralist and politicized perspective on time" ([Bowler et al., 2022](#)). The idea of representing existential time through design has been proposed by [Rapp](#) ([2022](#)) and [Van Amstel and Gonzatto](#) ([2022](#)). Recently, researchers have suggested a focus within HCI on representations of *uncertainty and alternative temporalities* ([Bowler et al., 2022](#)). Bleeding can be a regular, predictable event, but it is also highly varied across bleeders and furthermore variable across a single lifetime ([Wilcox et al., 2000](#)). It shifts across various time horizons such as the year, life as a whole, the time horizon of hormone treatment, a pregnancy, and so on. It is complex and individual and empowering technology could cater to such complexity. Designers need to explore, and empower, other temporalities that are more in tune with lived and bodily experiences.

Embrace uncertainty

Linked to temporal representations of bleeding, the apps further promote a certain technological-rational view on reproductive health, from bleeding to fertility. This in sacrifice of a more embodied experiential perspective. Research has argued that prediction models seldom take physiological variation and uncertainty into account ([Urteaga et al., 2021](#)). Indeed, taking uncertainty into account would mean that users would be shown predictions that might be true, but not easy to act upon, e.g., "your next period will occur within the next 2 weeks" (ibid.). Users of menstrual tracking apps report receiving predictions of bleeding and ovulation as compelling reasons for using the apps, and often rate the apps based on how accurate these predictions are ([Epstein et al., 2017](#)). While the user can evaluate the accuracy

of the estimated period easily, it is however difficult for the user to evaluate the accuracy of fertility predictions, and the tone of accuracy that the apps use, which risks giving users a false sense of reliability.

Previous research on the design of menstrual tracking apps has recommended exploring interfaces that describe the arrival of ovulation and bleeding as probabilities, rather than predictions ([Fox and Epstein, 2020](#)). In other areas, users seem to find this acceptable, for example, weather apps that give the chance of rain as a probability. As we show in the results, the apps present themselves and argue for use through terms such as control, reliability, and security. Period tracking apps become part of a certain model of menstruation, as predictable, exact, trackable through medicalised symptoms, and controllable. An image that does not correspond to the medical interpretation of the variation of the biological cycle of the period ([Wilcox et al., 2000](#)). The apps' techo-medial model which through tracking supports a particular way of seeing menstruation come at the expense of other more embodied ways of experiencing the period. Design then should increasingly turn its attention to representing uncertainty and allow users to explore the predictions for what they are, estimates.

Empower the self

What is the ultimate motive for providing apps for reflection and documentation of the self? [Rapp and Tirassa](#) ([2017](#)) suggest that the promise of these kinds of apps is "*to improve life based on a renewed self-understanding*" (p. 337). We argue that in order to empower users to reflect and learn about their menstruating bodies, there need to be opportunities to reflect on the individual self, not only preset categories and experiences defined by the app. Rapp and Tirassa provide important theoretical groundwork in unpacking what is needed to provide reflections on the self:

> "*It appears to be taken for granted the self that PI tools [self-tracking tools] supposedly help to understand can be reduced to the atomic parameters tracked by these instruments, or defined through a simple reference to the different aims that individuals have to track. However, this theoretical attitude produces a de facto disappearance of the self with the current debate of PI in favor of the individual behaviors that should be its external manifestations.*" (p. 336)

As we have shown in our results above, it is clear that the menstrual apps by and large build on a quantification of the menstrual experience. The data entered in the apps are rarely subjectively defined. In most cases, the only truly subjective option is to add diary notes/free text. We argue that this focus on quantifying the experience does not empower bleeders nor does it contribute enough to the kind of personal knowledge that the apps are promoted for.

With Rapp and Tirassa's theory of self for PI as a point of departure, we find that there are a number of concerns that are potentially helpful for improving the empowerment of the self in menstrual apps. The first concern is to provide better opportunities for *reflection on and interpretation of data*. When does the data become meaningful for the self? Rapp and Tirassa use the term appropriation to describe how users should relate to the data; if

the data is experienced as external metrics rather than (deeply) personal, they won't contribute to any development or insights. The users need more control over the data, both in terms of definitions as well as retrieval of data. The second concern is to improve the *contextualization of data*. The context is necessary for the interpretation of the data. A note of a headache during the cycle does not spur personal reflection if it is not contextualized. What happened on this day? How was the sleep? These interrelated data are necessary to provide any personal insights. The third concern is to provide opportunities to *remember/find certain specific occasions*. To be able to reflect, there is also a need to be able to go back in time and reflect on specific occasions. Being able to tag or mark data that the user considered special or out of the ordinary is therefore necessary. The fourth concern is to provide opportunities for *predictions*. Few of the apps we have investigated provide any predictions besides when the period starts. None of the apps provides the opportunity for users themselves to add future reminders or predictions about their cycle.

Design less

Our last point for future design reflection connects to ideas about where and when we have too much design. Menstruation is a complex phenomenon, being a biological process, a social process, the first and last bleeding also implies identity transformations, it is connected to the reproductive system and thus also contains and can indicate medical conditions, and so on. For bleeders, all or only a few of these aspects come into play. Menstruation apps are used for a wide variety of reasons e.g., to gain knowledge and control and predict bleedings. At the same time, reproductive health technology has a history of being used to control the bodies of women at the same time as there is empowering potential (Stanworth, 1987). Women are mandated and expected to take control and indeed manage fertility and reproduction (Lupton, 2015a). Tracking technologies such as apps further support a trend of biomedicalization—or, the "extension of medical or biological explanations for the way things are" (Neff and Nafus, 2016, p. 14) and studies also suggest that tracking of health data can take a toll on user's emotional lives (Costa Figueiredo et al., 2018). All in all, this should make us vary when designing for sensitive, embodied experiences such as these which are further defined by strong normative expectations.

In the apps studied, an excess of tracking options and features creates an almost endless expectation of what a bleeder should track, and what the apps connect to menstruation. The quantification that tracking offers further fills no function, it takes energy and time from users but gives very little back. It is a greedy, irresponsible design.

We need a discussion and design reflections on when too much design creates a situation where we are worse off than when we started. It is clearly inherent in HCI to solve problems with technology, and a certain amount of 'solutionism' is hard to avoid (Morozov, 2013). However, we urge for more critical reflections on when enough is enough, and a call for more minimalist designs in tune with the embodied experience of bleeding.

Conclusions

Period tracking apps become part of a certain model of menstruation, as predictable, exact, trackable through medicalised symptoms, and controllable through technological means. This model comes at the expense of other ways of seeing and experiencing the period. Feminist theories of the body have long argued for the feminine body as unruly, leaky, and wayward (Kristeva, 1982; Carter, 2010; Butler, 2011). In history, this leaking was used as an argument for keeping female bodies out of certain areas of society, for example the military (Stern and Strand, 2022). Indeed, medical technology for female reproductive health has historically been contentious, often with a negative impact for women and children (Franklin, 1997; Franklin et al., 1997). The way that these apps represent menstruation and offers interactional possibilities to users enforces a certain techno-medical definition of the period at the expense of more embodied, troubled, leaky, and multiple versions and interpretations.

However, as Stanworth (1987) has argued, reproductive health technologies seldom have simple effects but rather often contain both negatives, and potential for empowering women through better health and more control. As we show with these apps, the potential to learn more about both the individual body and the way that the cycle and menstruation are part of everyday life, as well as increasing knowledge on issues such as periods and fertility, holds great potential for something that historically women had to do in secret. Yet, the empowering potential is not utilized enough in current popular designs.

From our results we present four design sensitivities meant to inspire designers to design for other types of period tracking experiences that might better empower bleeders. These are (1) support lived temporalities, (2) embrace uncertainty, (3) empower the self, and (4) design less. Together they support the call for attention to female health in HCI which calls HCI practitioners to support a plurality of female experiences and has the potential to empower a historically disempowered group (Keyes et al., 2020).

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Author contributions

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Supplementary material

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