

ARTICLE

Experiences of users of period tracking apps: which app, frequency of use, data input and output and attitudes



BIOGRAPHY

Uma Patel is a medical student at University College London, UK. She completed her iBSc in Women's Health in 2022. She is also a volunteer for Education for Choice. Through this she has gained a deeper understanding of current reproductive health education and the strengths and weaknesses of Femtech.

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KEY MESSAGE

The infrequency of data input and the wide range of symptoms tracked reflects the differing needs of participants in relation to their period tracking apps. This study highlights the need for increased education and research into understanding the realities of variations in menstrual experiences.

ABSTRACT

Research question: What are the experiences of users of period tracking apps in relation to which apps they use, their frequency of use, the type of data and their attitudes to period tracking apps?

Design: This was an observational mixed-methods study using an online survey designed using Qualtrics XM. The survey included 50 open-ended and multiple choice questions, but only specific questions were analysed in this study. The survey was promoted via social media for 22 days between 30 June and 21 July 2021.

Results: A total of 375 participants responded to the survey, with 326 complete and submitted responses, giving a completion rate of 86.9%. The participants' age range was 14–54 years, with a mean of 26.0 (± 7.81) years. Most participants (62.0%) had been using a period tracking app for 2 years or longer. Of these 85.6% entered more data when on their period, 31% at a frequency of once a day. There were approximately equivalent proportions of participants who felt that entering data into their app was either 'part of their normal routine' (43.3%) or 'not a priority' (38.0%). Thematic analysis of the participants' experiences of using period-tracking apps revealed five main themes: symptom tracking and understanding general health; concerns with period start date predictions; the problems with fertility tracking; concerns about cost; and concerns about data privacy.

Conclusions: The infrequency of data inputting and the wide range of symptoms tracked reflects the differing needs of participants from their period-tracking apps. This highlights the need for increased education and research into understanding the realities of variations in using apps.

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Declaration: J. C. H. is author of Your Fertile Years and founder of Reproductive Health at Work. She runs a podcast called 'Why Didn't Anyone Tell Me This?' One of the employees of Clearblue was involved in the initial discussions of the survey questions but the collaboration was cut short as the collaborator left Clearblue. Clearblue had no further involvement. The other authors report no financial or commercial conflicts of interest.

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KEY WORDS

Apps
Femtech
Menstrual cycle
Menstrual cycle tracker
PMS
Period tracker

INTRODUCTION

Femtech is the use of digital technology for women's health. It is expected to grow at a compound annual growth rate of 16.2% from 2021 to 2027 (*Global Market Insights Inc., 2022*). It is likely this rate has partially been aided by the COVID-19 pandemic, which increased downloads of digital health apps by 25% (ORCHA, 2022). There is an ever-increasing need for technology to support people who menstruate as not only physiology, but also socioeconomic, religious and cultural factors can influence people's experiences of menstruation, meaning that not all menstrual cycles are universally similar (*Pichon et al., 2021*).

Femtech has been largely accepted among women, as they are 75% more likely to use digital health tools than men (*Karim and Talhouk, 2021*). As well as helping with general health, Femtech has the potential to address the desperate need for increased education and awareness surrounding menstruation and female health issues. But it needs to be inclusive, particularly for women from racial minorities and low-income countries, who tend to be underrepresented (*Figueroa et al., 2021*).

Period tracking apps are a subset of the Femtech industry and can provide an easier way of tracking the menstrual cycle than the traditional pen and paper method (*Epstein et al., 2017*). They are the second most popular app among adolescent females, and the fourth most popular app among adults (*Moglia et al., 2016*). In 2021, the period tracking app Flo and the activity tracking app Mi Fit were the most popular health and fitness apps used worldwide, both with 35.8 million downloads (*Statista, 2020*). The popularity and demand for period-tracking apps themselves are expected to grow, highlighted by the estimated 50 million people around the world who already have them downloaded (*Consumer Reports, 2020*).

The main reason for using a period tracker app is for users to track their periods, with the second most common reason being to avoid pregnancy (*Broad et al., 2022; Gonçalves et al., 2021*). However, there is a range of other possible benefits from using the apps, from the empowerment of menstrual health to mental health (*Levy and Romo-Avilés, 2019*).

When users input the date of their period, the apps use a calendar-based algorithm to predict the start date of their next period, usually starting with a 28-day cycle but learning about the user as they put in more period start dates (*Bull et al., 2019; Johnson et al., 2018*). Unfortunately, some apps also tell users their ovulation date, usually 14 days after the period start date, which has been proven to be ineffective, with a 21% maximum probability of it being correct (*Bull et al., 2019; Johnson et al., 2018; Worsfold et al., 2021*).

Few apps use evidence-based methods of period tracking and they do not use peer-reviewed literature or advice from reproductive health experts (*Karasneh et al., 2020; Moglia et al., 2016*). In an attempt to combat this, the UK National Institute for Health Care and Excellence (NICE) released an Evidence Standard framework, with which all health apps (including period-tracking apps) must comply (*NICE, 2021*). Still, a recent study by Wong and colleagues showed that the majority of apps investigated failed to meet the criteria set by the NICE framework (*Wong et al., 2021*).

In 2021, the authors conducted a survey asking women about their real-life experiences of using period tracker apps, with the analysis focusing on their attitudes towards using the apps, ovulation prediction and how the app's accuracy in predicting period start dates affected their feelings and behaviours (*Broad et al., 2022*). The results highlighted the potential usefulness of period-tracking apps in making women feel 'prepared' and 'in control' when expecting their period. Considering that only 6.4% of participants in the study stated that their app always got the start date of their period correct, there is a large margin for period-tracking apps to cause more worry than ease. Participants commonly felt 'anxious' or 'frustrated' when their period was earlier or later than predicted by the app.

This paper reports the analysis of a different set of questions from the survey in order to examine participants' perspectives concerning the different apps they used, whether they had changed the app they used and why. Additionally, it examines the type of data users tended to input, and their attitudes to the information used in the app. The key questions are what apps the participants used, how much data they usually inputted, whether this changed

throughout their cycle, and how they valued or trusted the data that the apps provided them.

MATERIALS AND METHODS

Ethics

The research carried out in this project was approved by the UCL Research Ethics Committee (ID number 9831/004, approval date 30 April 2021), with no anticipated risks for the participants. Before beginning their involvement with this project, the participants were required to provide informed consent, which was built into the survey. All the data collected are presented anonymously in line with the UK Data Protection Act of 1998.

Participants

This study was an observational mixed-methods study, in the form of an online survey. Participants of all ages who had at some point used a period-tracking app were allowed to participate.

Materials

The 50-item survey was created with guidance from Clearblue (<https://uk.clearblue.com/>), initial polls and conversations via social media. Specific questions that were being considered were posted on social media to see what responses were received to help frame the final questions. The survey questions aimed to gather data relating to the demographics of the participants, their menstrual cycle characteristics, period-tracking app usage and feelings towards data in the apps. The apps listed in the survey were chosen by looking for the top downloaded apps in the app store. The survey was laid out to avoid any immaterial questions, and a 'prefer not to say' option was offered for most questions. The survey was written in English and was designed using Qualtrics XM, a mass distribution and data analysis tool. The complete survey can be found in the [Supplementary Material](#).

Before the survey was circulated, validation of the final survey was carried out by Anna Broad through seven cognitive interviewing sessions. In these pilot sessions, she interviewed participants as they completed the survey to affirm the ease of answering and understanding the questions. To confirm the validity of the cognitive interviewing sessions, the survey was initially circulated among a select Facebook group run by the senior author

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(Global Women Connected), before mass online circulation via social media by all the authors, including via Facebook, Twitter, Instagram and LinkedIn. The survey was live on social media for 22 days, from 30 June 2021 to 21 July 2021 and was closed when it was felt that saturation, which was 375 responses, had been reached.

Data analysis

Following on from the analysis of certain questions by Broad and colleagues (Broad et al., 2022), this paper analyses a different set of questions to gain a deeper understanding of the participants’ usage of period tracker apps, including the past and current use of period-tracking apps, as well as reasons for changes in the apps the participants used. This analysis also focuses on the participants’ data input, investigating the frequency and type of data input, attitudes towards data input and value given to the information provided by the apps. Both multiple choice and open-ended questions were selected for analysis. Due to the nature of this observational study, which had no subgroup comparison, no deductive statistical analysis was needed.

Participants could withdraw at any time while completing the survey by closing their browser without submitting their responses. Therefore incomplete responses were not included in the data analysis.

Quantitative data

When analysing the quantitative data in this survey, simple statistical analysis was carried out using SPSS version 28 by calculating the mean, standard deviation and percentage of participants for particular questions, including multiple choice and demographic questions.

Qualitative data

For selected open-ended questions, inductive thematic analysis (Braun and Clarke, 2006) was used to identify and categorize the concepts detailed by the participants with regard to their feelings about the data used and given in the period-tracking apps. When analysing the open-ended questions, two researchers read and re-read the responses so they so they could be organized into codes and then themes.

First, the responses were read to familiarize the authors with the data and to recognize similar words and patterns that were common throughout the responses.

The responses were re-read to highlight repeated patterns to form the initial codes. Next, the responses were re-read so they could be assigned to specific codes. Finally, the responses and codes were re-read to develop themes. The sample size was relatively small, often with only single-sentence comments.

RESULTS

A total of 375 participants started the survey, 45 of whom did not complete the survey or did not press the submit button, giving a completion rate of 88.0%. In addition, four answers were not included in the study, so this study reports on 326 responses.

The figures all show the results as the percentage of participants. For some questions, participants were asked to select all answers that applied or multiple answers that applied; these particular instances are specified in relation to the relevant figure.

Participants’ demographics

The participants’ demographic information, including age, country of residence, sexual orientation, educational level, ethnic background, religious beliefs, relationship status, current field of work and disability status, was collected and has previously been reported (Broad et al., 2022) (TABLE 1). The ages of the participants ranged from 14 to 54 years, with a mean of 26.0 (±7.8) years.

Usage of period-tracking apps

Past usage of period-tracking apps

When the participants were asked about whether they had changed the app they used or had stopped using an app altogether, 39.6% (129/326) said they had. Participants were asked ‘Which apps have you used in the past?’ in relation to the given list of period tracking apps and were asked to select all the options that applied; there was also an option to select ‘Other’ and write a free text answer (FIGURE 1). Similar to the participants’ current period tracking app use, Clue (38.8%, 50/129) and Flo (29.5%, 38/129) were the most popular choices (FIGURE 1). There was a range of ‘Other’ apps listed including FitrWoman, Fermometer and Premom, but no app was prominently mentioned.

Most participants changed or stopped using their app completely due to

inconsistent use (41.1%, 53/129; FIGURE 2). The main theme mentioned in the free text option was that starting hormonal contraception made menstruation cycles regular, therefore rendering period-tracking apps futile.

Current usage of period tracking apps

Participants were asked ‘Which app are you currently using?’ and were provided with a list of period-tracking apps, along with the option to state an ‘Other’ app that was not listed. FIGURE 3 details the participants’ answers. Participants mostly used Clue (31.6%, 103/326) or Flo (24.2%, 79/326). The most common ‘Other’ app used was Garmin Health (21.4%, 6/28).

When participants were asked ‘How long have you used a period tracker app for in total?’, FIGURE 4 shows that most participants had been using a period tracking app for 2–5 years (38.3%, 125/326) or longer (23.6%, 77/326) (FIGURE 4).

Data input into period tracking apps

Frequency of data input

Most participants entered more data when on their period (85.6%, 279/326). When participants were asked ‘Approximately how often do/did you enter data into the app when having your period?’, 31.0% (101/326) of participants said they entered data once a day when on their period, while the next most common frequency was once a month (21.5%, 70/326) (FIGURE 5A). Participants were also asked ‘Approximately how often do/did you enter data into the app at other times of your cycle?’ Most participants (45.4%, 148/326) only entered data when they were on their period, with the next most common answer being once a week (12.0%, 39/326) (FIGURE 5B).

Information provided and input into the apps

Participants were asked ‘What information does/did your app provide you with?’ FIGURE 6 shows the range of information provided by period tracking apps. Participants selected ‘Period start date’ (99.1%, 323/326) and ‘Period end date’ (85.6%, 279/326) as the two most common options, closely followed by ‘Ovulation day’ (84.1%, 274/326).

FIGURE 7 shows the typical amount of data that participants tracked with their apps. The two most common options selected were ‘Bleeding start day’ (86.5%, 282/326) and ‘Bleeding finish day’ (75.5%,

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TABLE 1 PARTICIPANTS' DEMOGRAPHIC INFORMATION

Characteristics	Values
Age (years), mean (SD)	26.0 (7.8)
Country of residence	
UK	290 (89.0)
Other	36 (11.0)
Sexual orientation	
Heterosexual	275 (84.4)
Homosexual	3 (0.9)
Bisexual	29 (8.9)
Pansexual	5 (1.5)
Asexual	2 (0.6)
Prefer not to say	3 (0.9)
Current relationship status	
Single	109 (33.4)
In a relationship but not cohabiting	90 (27.6)
In a relationship and cohabiting	65 (19.9)
Married/civil partnership	50 (15.3)
Prefer not to say	3 (0.9)
Other	9 (2.8)
Ethnic background	
White – English/Welsh/Scottish/ Northern Irish/British	226 (69.3)
White – Irish	8 (2.5)
Any other white background	34 (10.4)
Black/Black British – African	6 (1.8)
Black/Black British – Caribbean	2 (0.6)
Any other Black/African/ Caribbean background	1 (0.3)
Asian/Asian British – Indian	8 (2.5)
Asian/Asian British – Pakistani	1 (0.3)
Any other Asian background	8 (2.5)
Mixed ethnic background	14 (4.3)
Arab	2 (0.6)
Latino	4 (1.2)
Any other ethnic group	0 (0.0)
Prefer not to say	1 (0.3)
Religion/belief	
No religion/belief	192 (58.9)
Christian	99 (30.4)
Hindu	7 (2.1)
Jewish	1 (0.3)
Muslim	9 (2.8)
Sikh	0 (0.0)
Buddhist	0 (0.0)
Other	3 (0.9)
Prefer not to say	6 (1.8)

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TABLE 1 (Continued)

Characteristics	Values
Highest educational qualification	
Secondary school	5 (1.5)
University undergraduate	135 (41.4)
University postgraduate	108 (33.1)
Other	8 (2.5)
Prefer not to say	0 (0.0)
A level/college	61 (18.7)
Field of study/work/trade	
Student/academia	52 (16.0)
Finance and law	34 (10.4)
STEM	144 (44.2)
Other	96 (29.4)
Disability status	
No disability	278 (85.3)
Sensory impaired	4 (1.2)
Physical or mobility impaired	3 (0.9)
Specific learning difficulty or disability (e.g. dyslexia)	16 (4.9)
General learning disability (cognitive)	0 (0.0)
Long-term illness or health condition	18 (5.5)
Autistic spectrum disorder	2 (0.6)
Other, please specify	2 (0.6)
Prefer not to say	3 (0.9)

Data are n (%) unless otherwise indicated; total number of participants, 326.

Cases where participants did not provide an answer: sexual orientation (n = 9); ethnic background (n = 11), religion/belief (n = 9), highest educational qualification (n = 9).

246/326) (FIGURE 7). The majority of participants (67.5%, 220/326) found that their app allowed them to track about the right number of symptoms for their needs.

Attitudes towards data input

Of the participants who felt that entering data into their app was a part of their normal routine, 68.1% had been using a period tracking app for 2 years or more. However, a notable proportion (38.0%, 124/326) often forgot to input their data as it was not a priority for them (FIGURE 8). Some common comments in the 'Other' category were that participants only inputted data when they experienced symptoms or had a notification to prompt them (22.2%, 2/9) or that they only inputted data when they were on their period and wanted to track it (22.2%, 2/9).

Participants were asked which qualities they most valued in their period tracking apps and could select multiple answers (FIGURE 9). The most common answer was 'Ease to use' (85.0%, 277/326), followed by 'Accuracy of cycle prediction' (65.3%, 213/326). A free text 'Other' option was offered, with some participants (30.8%, 4/13) mentioning how tracking their cycle made it easier to plan their normal life, and some (23.1%, 3/13) mentioning how good visuals on the app made it easier to navigate.

Most participants (83.1%, 271/326) believed that their knowledge of their menstrual cycle increased by using a period tracking app. However, when asked about the extent to which they trusted their period tracker, the majority of participants (69.9%, 228/326) only partly trusted the information given to them in their app.

Experiences of using period tracking apps

Participants were asked 'Is there anything else you would like to tell us about your experience of using period tracker apps?' as a free text answer. Thematic analysis revealed five key themes that participants decided to elaborate on: symptom tracking and understanding general health; concerns with period start date predictions; the problems with fertility tracking; concerns about costs; and concerns about data privacy.

Symptom tracking and understanding general health

The majority of women said they were very happy with their app as it helped them understand their menstrual cycle. Some participants also noted how period tracking apps allowed them to improve other aspects of their health, such as polycystic ovarian syndrome (PCOS), heavy bleeding, diet and menopause. The concept of being able to track feelings and emotions through period tracking apps was empowering for participants, with some noting that it helped with their personal relationships or that it allowed them to understand their own body better:

'I've always used it to help me learn about my body and make my own decisions.'

'I think it has really helped me as an endometriosis/pms sufferer ... I know when to take care with my diet and self care ... I know when I am likely to be anxious or taking things personally.'

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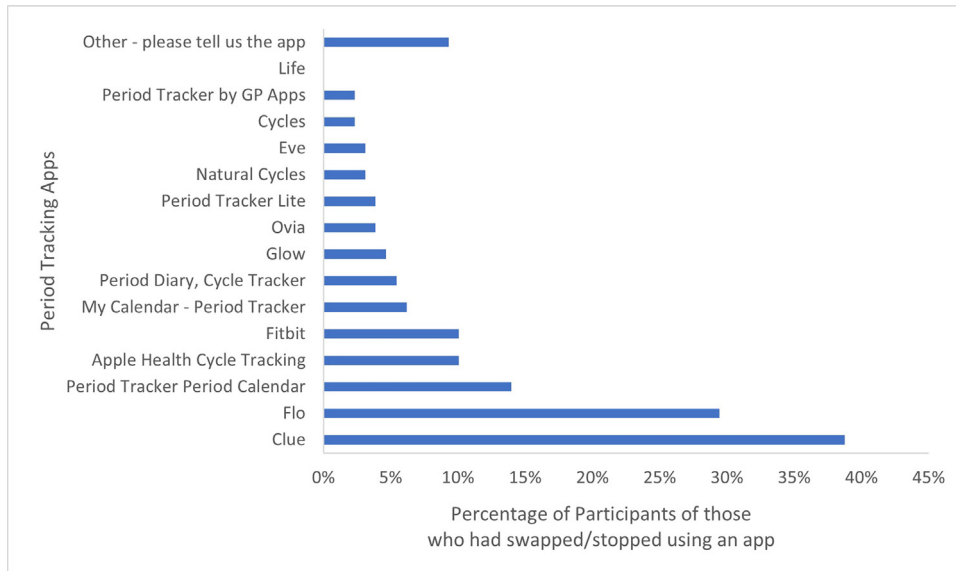


FIGURE 1 Responses to ‘Which apps have you used in the past?’ Participants were asked to select all the options that applied. Only participants who answered ‘yes’ to a question on whether they had stopped/swapped using an app were eligible to answer (n = 129).

‘As I approach menopause, I think it’ll be helpful in tracking my periods which will presumably become less regular.’

Concerns with period start date predictions

Most participants felt happy to be able to track when their period would start. However, an overarching feeling for many participants was frustration, due to inaccuracy in predicting period start dates, especially for participants with irregular cycles. This caused some to entirely reconsider using the apps. Some

participants mentioned how data input could be made more efficient, noting the benefits of automated data entry and a better collection of the wealth of data stored on the apps, to provide more accurate predictions. Other participants stopped using their period tracking app after starting hormonal contraception, such as the pill, as there was little to no need for them to use a period tracking app as their cycle became more regular. Similar findings were also reported in Broad and colleagues’ study (Broad et al., 2022):

‘The app has really made it easier tracking my period as I don’t always have my Calendar with me.’

‘My prediction days have always been correct and accurate, I know this may not be true for other women.’

‘I have a very irregular period so the predictions are constantly wrong.’

‘Automated data entry would be a huge plus! i.e., when I take my temperature in the morning, I do not have to enter it into my phone manually.’

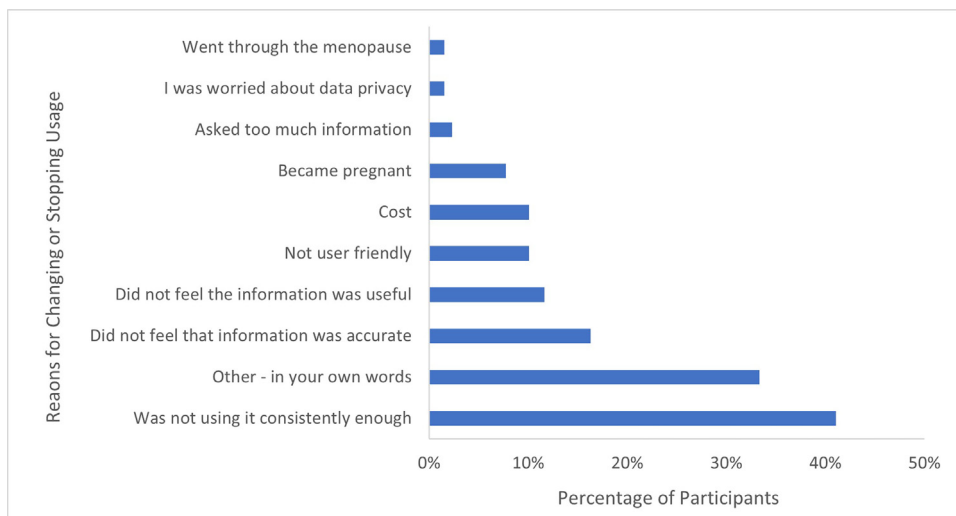


FIGURE 2 Responses to ‘Why did you change, or stop using, the app you used?’ Participants could select multiple answers. Only participants who answered ‘yes’ to a question on whether they had stopped/swapped using an app were eligible to answer (n = 129).

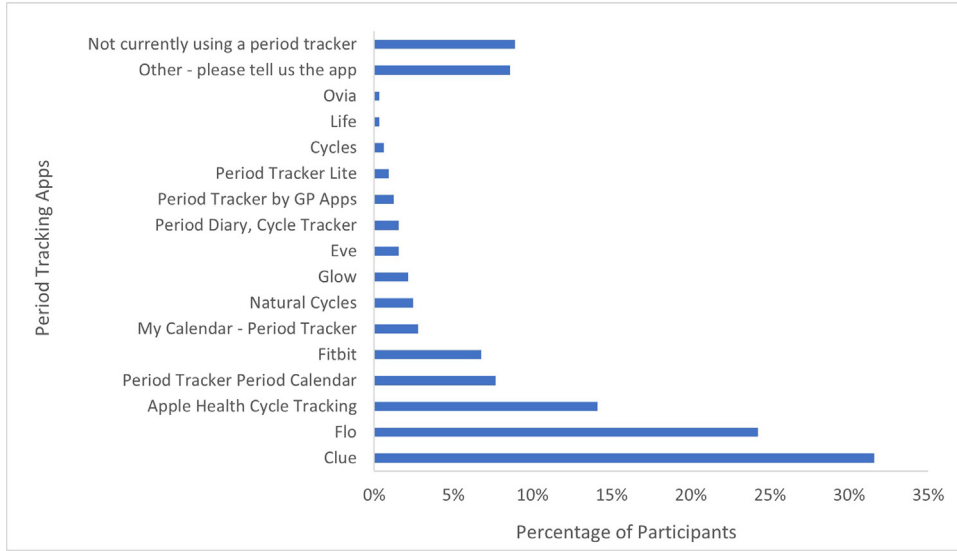


FIGURE 3 Responses to 'Which app are you currently using?' (n = 326).

The problems with fertility tracking

Some participants mentioned the utility of period tracking apps for fertility tracking, with one participant noting they had used their app to both avoid and plan conception. However, more participants noted the unreliability of period tracking apps for fertility tracking, as predictions of the ovulation day and fertile window are often inaccurate:

'I like the idea of it being able to track ovulation, so you know which days you are fertile etc, but I am skeptical as to how accurate they are in regards to this.'

'I am happy to just know approximately when I ovulate.'

Concerns about cost

There were also a few concerns about costs, as in-app purchases were not affordable for some participants, and they said how in-app advertisements diverted their attention from checking their important information:

'The only downside is that it is asking me to pay for more features that I am interested in using (but it's too expensive for me) and a lot of adverts distracting

me from actually checking important data.'

Concerns about data privacy

The final theme from the experiences of using period tracking apps was related to privacy concerns. Participants mentioned unease regarding how their data were used and wanted to have better knowledge of this:

'Privacy statements too long. Not clear what they are doing with all the data they get.'

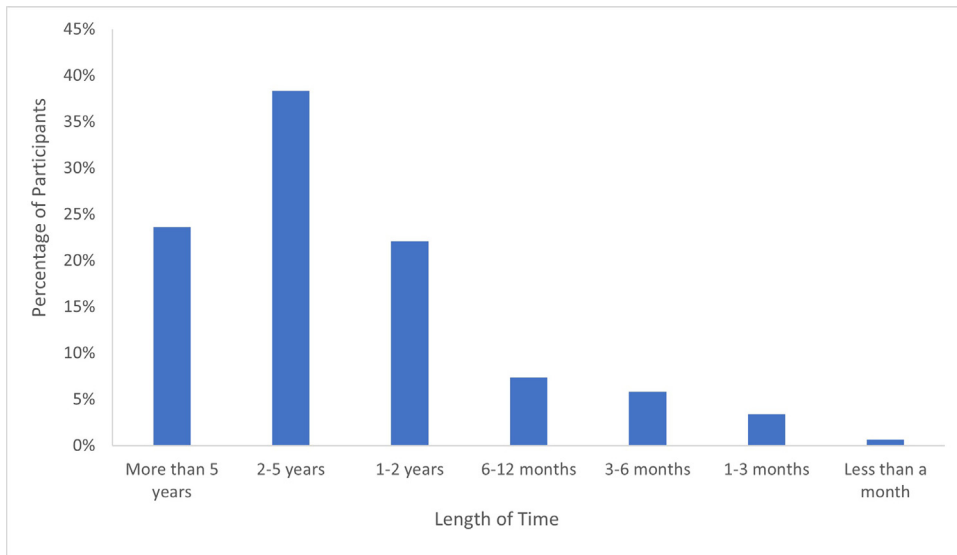
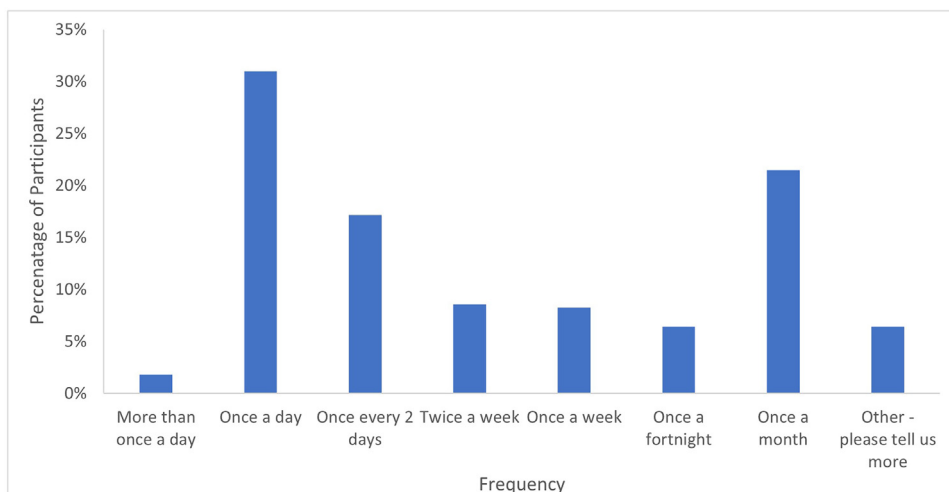
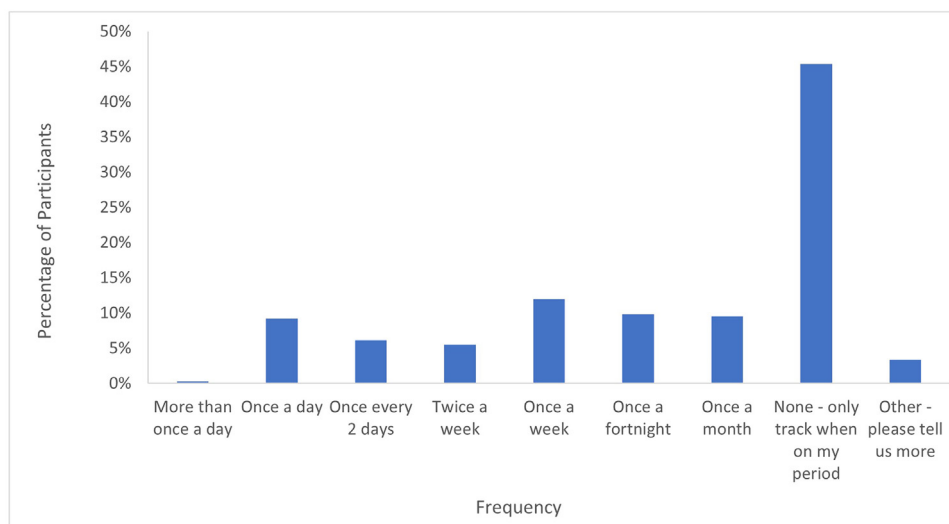


FIGURE 4 Responses to 'How long have you used a period tracker app for in total?' (n = 326).

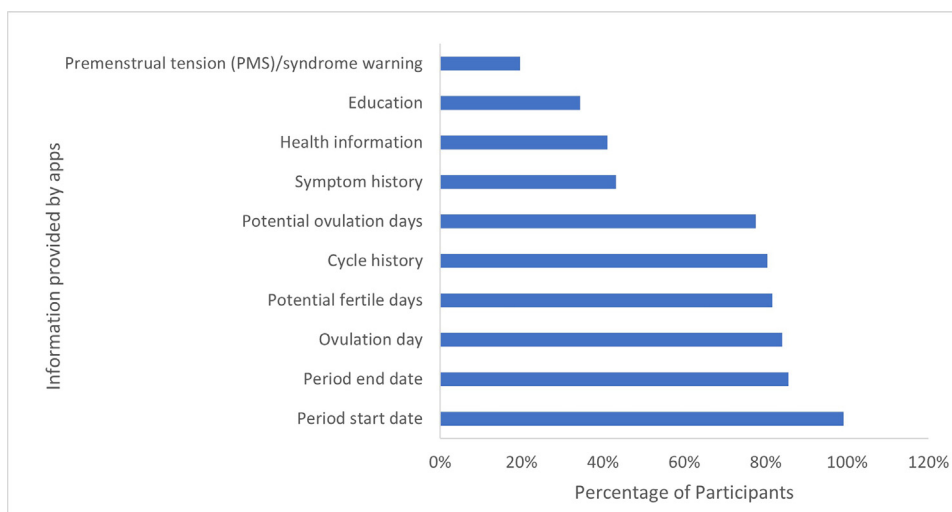


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FIGURE 5 The frequency with which participants entered data into their period tracking apps when (A) they were on their period and (B) at any other point in their cycle (n = 326).



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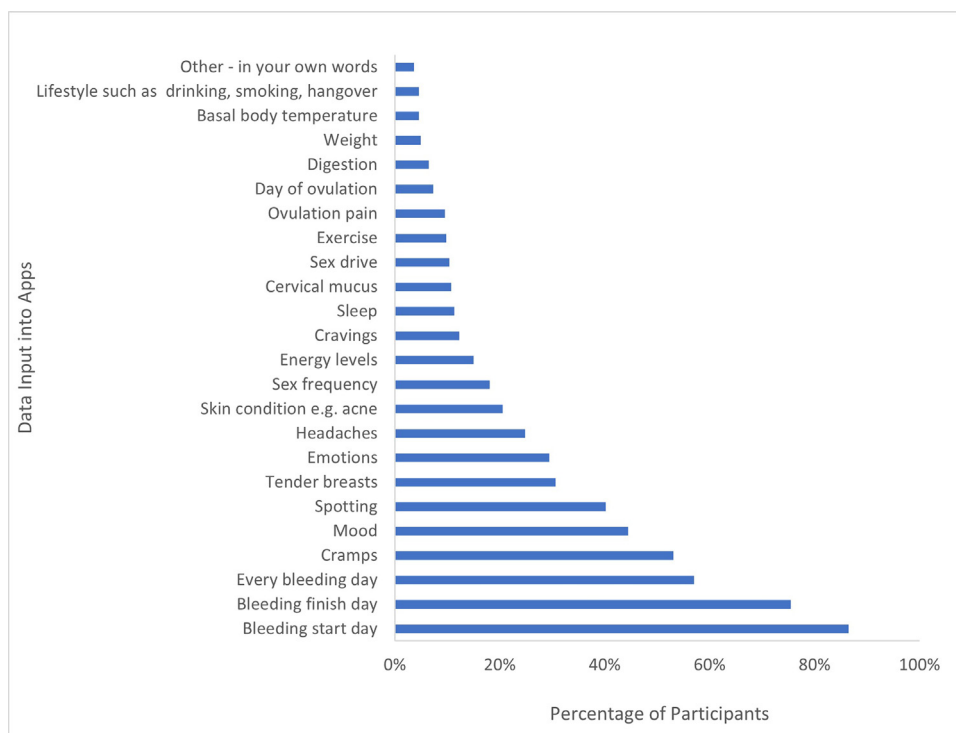


FIGURE 7 The typical data input of participants into their period tracking apps. They could pick multiple answers ($n = 326$).

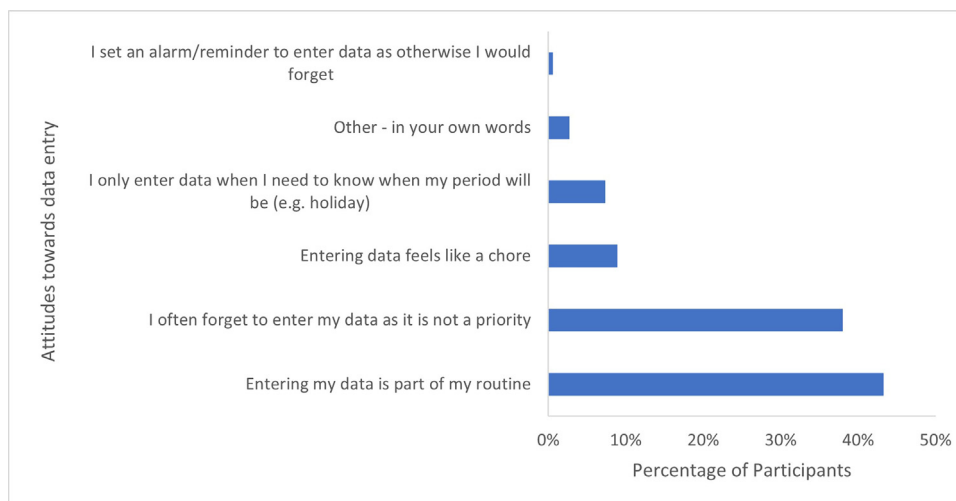


FIGURE 8 Participants' attitudes towards entering data into their period tracking apps ($n = 326$).

DISCUSSION

There have been few large-scale analyses of real-life experiences of using period tracker apps. The survey found that a recurring theme was the irregularity of users' experiences with period tracking apps and their attitudes towards data input. The various experiences provide a key insight into the users' expectations of period tracking apps to provide reliable information on cycle dates, highlighting the need for further clarity on this.

The survey was completed by participants from 14 to 54 years old, providing responses encompassing a wide range of the different stages of reproductive life, from puberty to menopause. This highlights how the apps may be used for a variety of different purposes, depending on the stage of life the user is in.

The most popular period tracking app among the participants was Clue, closely followed by Flo, which is expected given their widespread popularity (*Statista*,

2021b; *Worsfold et al., 2021*). Only a small proportion of participants were no longer using a period tracking app, which signifies the growing satisfaction and popularity of such apps (*Consumer Reports, 2020*; *Moglia et al., 2016*).

Period tracking apps aim to make menstrual tracking easier and more accessible, as 3.8 billion people worldwide use smartphone technology daily (*Statista, 2020*). However, a considerable proportion (39.6%) of users had either

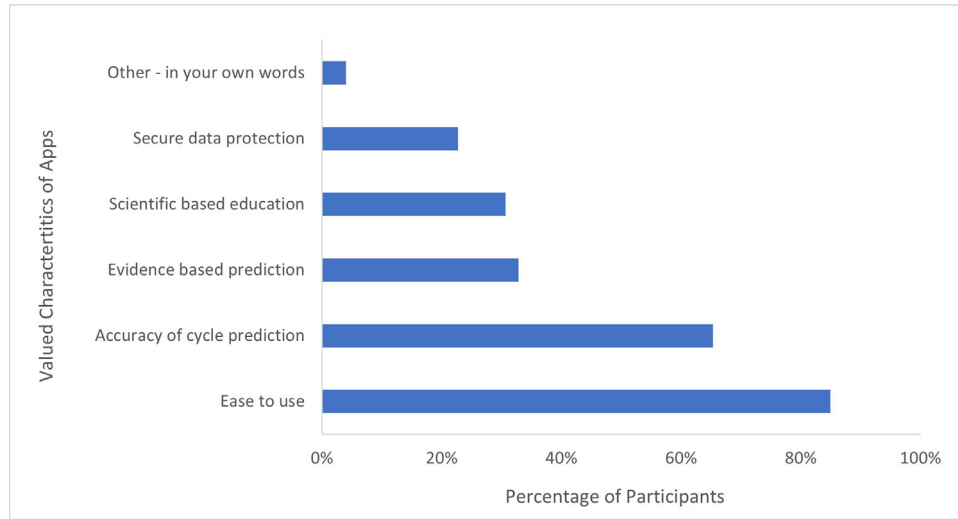


FIGURE 9 Participants’ most valued characteristics of period tracking apps. They could pick multiple answers (n = 326).

changed or stopped using their app, mostly due to inconsistency in use (41.1%) or inaccuracy of information (16.3%). Lack of engagement with the apps can lead to lower data input and therefore less accurate predictions of cycle dates, further frustrating users and causing a change in or cessation of the usage of period tracking apps. A more detailed analysis of the accuracy of the predictions of period tracking apps is detailed in Broad and colleagues’ study (Broad et al., 2022).

Over half of the participants (62.0%) had been using a period tracking app for over 2 years, indicating that despite changing or stopping period tracking apps, participants will still commit to using period tracking apps in the long term. Additionally, 82.2% of participants felt that their period tracking app helped to educate them on their menstrual cycle. This pattern of long-term commitment to period tracking apps to gain more knowledge of the menstrual cycle highlights how users of period tracking apps are looking for private, personal spaces to explore menstrual health issues (Karlsson, 2019).

- Q14** The majority of UK schools teach about puberty and the basics of the menstrual cycle (Maslowski et al., 2022, Maskowski et al., 2023a). However, reproductive health education only became compulsory in schools in the UK from 2019 (Department for Education, 2019). Much of young people’s knowledge on menstruation has come from popular culture (Chrisler, 2013) or the internet (Armour et al. 2021). The 2021 study by Armour and co-workers showed how common self-taught

menstrual health literacy in Australia was, with participants looking to the internet rather than going to medical professionals for information, leaving a wide margin for misinformation.

A recent study on menstrual health education in schools in the UK showed that 37% of participants had had no menstrual education, and that when teaching is provided, it is often focused on the scientific processes behind menstruation, rather than lived experiences (Brown et al., 2022). This reiterates the urgent need for increased education on the experiences and realities of menstruation at a young age, as 1 in 4 young people feel unprepared for menstruation, feeling shocked and embarrassed (Plan International UK, 2018). In research studies on how we can deliver reproductive health education (Biswakarma et al., 2023; Harper and Botero-Meneses, 2022; Maskowski et al., 2023B), the public say that apps are a possible method. More could be done to ensure that period tracker apps give women reliable health education.

Over a third of participants only entered data into their app when they were menstruating (45.4%), and of these participants, nearly half (46.6%) entered data every other day or more frequently when menstruating. This type of data input was the most common with participants aged 18–23 years old, indicating that, despite inconsistencies in data input during other times in their cycle, younger participants have a strong desire to track their period. This further reinforces the

above points regarding an urgent need for more menstrual health education.

Across all participants, there was a contrast in their attitudes towards data input, as approximately equal proportions of participants felt that entering data was either part of their normal routine (43.3%) or that they often forgot to enter data (38.0%). This divide in attitudes to data input may be related to the length of time the individual has been using a period tracking app, as 68.1% of participants who entered data as part of their normal routine had been using a period tracking app for 2 years or more. This could suggest that using period tracking apps for a longer period of time allows users to make data entry a part of their normal daily routine, whereas new users may not be as accustomed to routine data input. Despite period tracking apps encouraging users to log data regularly, there is no clear evidence that greater data input equates to more accurate predictions of cycle dates (Pichon et al., 2021).

When looking at participants’ data input by with respect to the data output they received from their apps, the top two inputs were ‘Bleeding start day’ and ‘Bleeding finish day’, and the top two outputs were ‘Period start date’ and ‘Period end date’. This again highlights that, as expected, most participants input data on menstruation to their period tracking apps.

The third and fourth most common outputs from the participants’ apps were ‘Ovulation day’ and ‘Potential fertile days’,

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respectively. However, only 15.3% of participants entered data on cervical mucous or basal body temperature, which are biological markers of ovulation; this meant that the majority were relying on inaccurate date-only prediction. It is misleading for the majority of period tracking apps that do not measure such biological markers to claim that they provide reliable information on potential fertile days (Ali et al., 2021; Favaro et al., 2021; Stanford et al., 2020; Su et al., 2017). This is a key recurring theme in both this study and that of Broad and colleagues (Broad et al., 2022), as period tracking apps could seriously deceive their users, causing potentially serious implications for users who employ a period tracking app as a form of non-hormonal contraception (Al-Rshoud et al., 2021; Levy and Romo-Avilés, 2019). This is especially worrisome when considering the ambiguity of regulatory and data protection laws around Femtech apps as medical devices (McMillan, 2023).

Period tracking apps that claim to provide accurate predictions of cycle dates using a calendar-based method are lacking transparency on their ability for their users. This could explain the value participants place on the data they receive from their apps, as 71.5% of participants did not trust or only partly trusted the data that were provided to them in their period tracking apps. This suggests that, although participants invest years into using their period tracking app, the extent to which they believe the information being provided to them is still limited. This is supported by the free text answers, which suggest that many participants are at the very least partially aware of the limitations of period tracking apps in providing accurate information, even if they individually have accurate predictions. The most valued characteristic of the participants' period tracking apps was 'Ease to use' (85.0%) as digital methods of period tracking are more convenient than traditional methods (Epstein et al., 2017).

When analysing the participants' comments on their experiences of period tracking apps, one overarching theme was that the apps empower users and allow them to take control of their own health and well-being. However, this largely depended on the participants' cycle, and it is not surprising that those participants with irregular cycles felt discouraged as their predictions were often inaccurate. The authors have previously reported that

cycle prediction is inaccurate for irregular cycles (Worsfold et al., 2021).

The study showed that participants had concerns with period start date predictions, symptom tracking and understanding general health, and fertility tracking. Overall, participants felt that being able to track when to expect their period, or other symptoms during their cycle, such as hunger or mood swings, enabled them to feel in control of their lives and understand their own bodies more. Being able to prepare for menstruation enabled participants to plan their daily lives more efficiently, such as for work commitments, vacations or their personal relationships with their partners. This feeling of empowerment can help combat the stigma of menstruation and provide control for patients over their biology, which can in turn lead to better self-management in clinical interactions (Eschler et al., 2019; Gee et al., 2015).

This was highlighted by some participants, who mentioned how the data collected in their period tracking app helped them manage other health issues, such as PCOS or endometriosis, by tracking their symptoms and being able to plan for flare ups in the future. This illustrates the potential benefits of using period tracking apps in the currently marginalized research into women's and menstrual health, to further our understanding of and diagnostic abilities related to gynaecological conditions (Jain et al., 2021; Li et al., 2020; Symul et al., 2019). However, it must be considered that the self-reported nature of period tracking apps could mean inconsistencies in data input or inaccuracies in reporting symptoms, which may lead to difficulties in separating true pathologies from poor user engagement (Li et al., 2020).

Despite the positive experience that many participants had, there were many areas in which participants felt their period tracking apps were unsuccessful. The main let-down was the inaccuracy of predicting cycle dates, especially for participants with irregular cycles, as these participants would have an increased need to track their period to allow time to prepare and avoid unexpected bleeding. Additionally, some participants commented on forgetfulness leading to missed days and miscalculations of period start dates. As participants' period tracking apps would often miscalculate cycle dates, this explains the disengagement with regular data input,

creating a continuous cycle as the users are not benefiting from the data given.

Automated data collection was mentioned by a few participants as a way to improve their period tracking apps. Although automated data entry is difficult for self-reported data, such as menstruation, many participants noted that notifications from their app remind them to input data. This positive effect of notifications on data input has been corroborated by Epstein and co-workers (Epstein et al., 2017), yet this study also noted that notifications can conflict with many users' desire for privacy regarding their menstrual cycle, and it therefore made recommendations for discreet, subtle notifications as an alternative.

For participants trying to conceive, there were discouraging feelings about the effectiveness of period tracking apps; most participants who mentioned fertility planning stated that they would rather use fertility awareness-based methods, such as cervical mucous consistency, urinary LH concentrations or basal body temperature, as they are more accurate than calendar-based methods (Favaro et al., 2021; Stanford et al., 2020). Some participants felt that using a period tracking app was futile in general, either due to an inaccuracy in predicting cycle dates, or due to menopause or starting new hormonal contraception, which meant they no longer needed to track their period. This presents a new demographic that could potentially benefit from Femtech apps, as the current design of period tracking apps is limited in its support for menopausal women or hormonal contraceptive users (Pichon et al., 2021).

In general, there were not many comments by participants about their data concerns. With regard to data collection, few participants noted that they were unsure how their period tracking app used the data they inputted, with one participant listing data protection as a concern by mentioning they were 'not clear what they are doing with all the data they get'. A willingness of participants to continue to use health apps may be a result of a lack of awareness around data privacy (Atienza et al., 2015), due to cumbersome and difficult to understand privacy policies (Fowler et al., 2020). This has been reported by recent studies on data privacy in Femtech, highlighting the ambiguity in current regulations,

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1251 particularly regarding data sharing and
 1252 classification of the apps as ‘medical
 1253 devices’ (Alfawzan et al., 2021; McMillan,
 1254 **Q22** 2021). With this lack of transparency, it is
 1255 therefore likely that participants feel that
 1256 the benefits of using such apps outweighs
 1257 the risks of data privacy breaches (Joo et
 1258 **Q23** al., 2021). In the wider realm of Femtech,
 1259 more research needs to be conducted on
 1260 data privacy, especially in regard to sharing
 1261 sensitive data to third-party marketing
 1262 companies as well as enabling all users of
 1263 period tracking apps to be aware of how
 1264 their data are being used.

1265 Epstein and colleagues (Epstein et al., 2017)
 1266 showed that menstrual apps often assume
 1267 that their users’ sexual relationships are
 1268 heterosexual, which is a problem, as period
 1269 tracking apps would notify users about
 1270 pregnancy risks without taking the users’
 1271 sexuality into account. Many of the period
 1272 tracking apps available today use feminine-
 1273 orientated marketing and designs, which
 1274 would make them not inclusive of the wide
 1275 range of users, particularly transgender
 1276 and non-binary individuals. Further
 1277 research is needed on heteronormativity in
 1278 period tracking apps, as this is beyond the
 1279 scope of the current study’s results.

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 1281 This study’s limitations, however, need to
 1282 be noted. Although the survey was
 1283 available worldwide, the majority of
 1284 participants were from the UK, were of a
 1285 white ethnic background and had a
 1286 university education, which may have been
 1287 caused by selection bias due to the
 1288 distribution of the survey through the
 1289 researchers’ social media accounts.
 1290 Furthermore, the inherent design of this
 1291 survey through an online format means
 1292 that responses may be less reliable and
 1293 potentially more fraudulent than in-person
 1294 surveys (Lefever et al., 2007). In addition, it
 1295 was felt that the sample size was too small
 1296 to do a subgroup analysis. Lastly, this
 1297 survey relies on self-reported data, which
 1298 must be taken into account when
 1299 considering the accuracy of the answers.

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 1303 **CONCLUSIONS**

1304 Period tracker apps have the ability to allow
 1305 users to take control of their reproductive
 1306 lives and improve their overall physical and
 1307 mental well-being. However, there are
 1308 inherent limitations on accurate
 1309 predictions, such as gynaecological
 1310 pathologies or natural variations in
 1311 menstrual cycles. As well as changes in app
 1312 design, from clarity on the limitations of

the data period trackers provide and use,
 to the apps’ language and formatting, this
 study highlights the need for further
 education and research into
 understanding the realities of the variations
 in menstrual experiences.

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DATA AVAILABILITY

The data that has been used is confidential.

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AUTHOR CONTRIBUTIONS

J. H. conceived the idea. The survey was designed and validated by J. H. and A. B. A. B. and U. P. analysed the data, and R. B. helped with statistics and data analysis. U. P. and J. H. wrote the manuscript and all the authors edited it.

SUPPLEMENTARY MATERIALS

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.rbmo.2023.103599.

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