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## The global pandemic and changes in women's reproductive health: an observational study

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### ABSTRACT

**Objective:** The COVID-19 global pandemic has led to the death of millions around the world and impacted the overall health of many people. In this article we aim to compare reproductive health indicators in the first 6 months of 2020 to the prior year, as well as explore stress and quality of life during this time.

**Methods:** This retrospective observational study examined the menstrual cycles of 1159 women who were using a fertility tracking device to record their menstrual cycle and BBT data. We utilised a supplemental mobile application to administer a supplemental survey to collect data on stress and quality of life. Descriptive analyses were conducted with *t*-tests for two-group comparisons.

**Results:** Study participants from 15 countries contributed to a total of 13,194 cycles. 23.1% (268/1159) responded to the survey focussed on assessing psychosocial distress. 44.4% (119/268) of the study participants reported that they had noticed a change in their menstrual cycle, temperature curve, or menstruation in the past 12 months. Cycle analysis found the average cycle length and pre-ovulation phase length was longer in the first 6 months of 2019, while the average days of menstruation was slightly longer in 2020.

**Discussion:** Our findings indicate that menstrual cycle indicators changed only slightly in the first 6 months of 2020 but were still statistically significant. We were also able to understand that these study participants had some level of awareness of changes to their menstrual health.

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### KEYWORDS

Pandemic; COVID-19; reproductive health; menstrual cycle; fertility pandemic; coronavirus menstruation

### Introduction

The global research community accelerated efforts to understand the coronavirus (COVID-19) as it rapidly spread across the globe, creating dire public health demands. However, one of the most important yet understudied public health impacts of this pandemic is reproductive health. From the extensive research that has been conducted, external stimuli highly impacts the reproductive health system. Research has shown that stress, diet, exercise, age, and other inputs affect ovulation and the menstrual cycle [1–4]. Current research is minimal on the impacts of an upper respiratory infection like COVID-19 on a woman's menstrual health. Most studies looking at the impact of COVID-19 on women's bodies are cross-sectional or limited in only understanding the perceived consequences of the pandemic [5,6]. One recent study found that women recorded more anovulatory cycles and abnormal cycle lengths during the COVID-19 pandemic. Although this study did not report population level changes to ovulation and menstruation, changes in menstrual cycle health biomarkers were observed [7].

Besides the imminent threat of the virus on people's health, women were also impacted by several factors during the pandemic such as increased risk of gender-based violence [8], financial insecurity [9], stress, and a multitude of other stressors. There have been several studies that examined women's reaction to stress, change in schedules, and mental health during the pandemic and the stages of lockdown [6,10]. These studies found that a multitude of factors such as anxiety and lack of sleep all had an impact on menstrual cycle health and symptoms [11].

In a small sample study of women ( $n = 59$ ) aged 20–54, 100% of study participants reported experiencing changes in their menstrual cycle, with 25 participants experiencing a delay in menstruation between 2 and 5 or more days [10]. A slightly larger study of 263 women compared cycle changes of women before and after COVID-19, and found that women experienced more menstrual cycle symptoms during the pandemic, although the length of their menstruation and use of sanitary pads had decreased [12]. Menstrual changes were also observed in another study of over 700 women who were physically active and reported that 35.6% of study participants experienced a change in

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bleeding patterns [7]. This study also found that one of the main contributing factors to changes in the menstrual cycle was stress and managing family life. Interestingly, this study did not find that financial insecurity and job insecurity impacted menstrual symptoms for more than 50 participants [6].

Although these studies provide insight into perceived changes of the menstrual cycle, they lack real time data to support the reported changes. In this study, we aim to analyse the menstrual cycles of women that were using a fertility tracking device during the COVID-19 pandemic and the same period of the preceding year to better understand how the pandemic impacted various reproductive health indicators like cycle length and variability, and basal body temperature (BBT) as well as reported quality of life.

The study aimed to answer the following questions:

- Is there a difference in the measurable markers of menstruation (menstrual cycle length variables, etc.) between the period before and during the pandemic (primary outcome – data of total sample based on fertility tracker data)?
- Is there a difference in the subjectively experienced psychosocial distress between the period before and during the pandemic (secondary outcome: Data from subgroup answering questionnaire in addition to fertility tracker menstruation related data)?
- Is there an association between the subjectively experienced distress and menstrual cycle changes (secondary outcome: Data from subgroup answering questionnaire in addition to fertility tracker menstruation related data)?

## Materials and methods

### Materials

The study was conducted in accordance with the declaration of Helsinki and approved by the institutional ethics committee at FAU Erlangen (21-402-ANF).

Menstrual cycle and BBT data were collected through a fertility tracker (Daisy), a medical device based on fertility awareness. The device records women's BBT and uses a modified calculothermal method to analyse and provide a fertility output to users on a daily basis. To receive this information, women must record their daily BBT measurements every morning immediately after waking up and also confirm menstruation/bleeding. The device displays the user's estimated fertility status through LED lights, in which green

indicates 'infertile', red indicates 'possibly fertile' and yellow indicates 'unknown' (Figure 1). The colours are indicative of a woman's fertility determined by the amount of data provided by the users. Consistently measuring BBT lowers the amount of 'red' or 'possibly fertile' days as the device caters to the user's individual menstrual cycle. The device is also accompanied by an optional free mobile application (app) called DaysyDay. The app allows users to visualise their data in real time. Daysy fertility device users provide their consent to use their unidentifiable data strictly for research purposes in the terms and conditions upon using the device. We utilised a supplemental mobile application associated with the Daysy fertility device to administer this survey. Women received this survey directly on their Daysy application. They provided consent directly on their mobile device.

Sociodemographic data as well as other measures were collected between June and August 2021. The survey questions were either multiple choice or based on a likert scale of 1–10, with 1 being the lowest and the 10 being the highest. This questionnaire with an additional consent process was developed and uploaded to a survey software (TypeForm) and a link to the survey was generated. This link was embedded into a pop-up message in the DaysyDay mobile application and sent exclusively to the study sample. Upon receiving the pop-up notification, study participants were asked if they would be interested in participating (anonymously) in this study and then further asked for their consent. Once consented, women were asked to complete the survey, although none of the questions were required in order to submit the survey. In addition to analysing BBT data collected through the fertility device, we also collected data on stress factors such as change in perceived stress level, relationship, and job security to understand the impact the COVID-19 pandemic had on women's bodies. In the appendix, you will find the list of questions sent to study participants.

### Methods

This was an observational study of women who were using the Daisy fertility device from 1 January to 30 June 2020 and also reported data during the same period in 2019 (see Figure 1). Study participants ( $n = 1159$ ) were randomly selected from a pool of Daisy users who met the study inclusion criteria. To be included in the study sample, users must have used the device for at least 90 days prior to 1 January 2019 and recorded data for at least 80% of their cycle. Each data set contained six cycles from these women in 2019 and six cycles in the same time period for 2020. Study participants were from 15 different countries (Andorra, Australia, Canada, Colombia, Estonia, Germany, Israel, Latvia, Netherlands, Romania, Spain, Sweden, Switzerland, United Kingdom, and the United States). Each study participant was identified with a specific study number.

Data were analysed in August 2021 using GraphPad Prism (v. 9.2.0) and Microsoft Excel. One sample  $t$ -tests were used for two-group comparisons. Data are represented as mean  $\pm$  standard deviation (SD), frequencies, and percentages. Statistical significance was set at  $p \leq 0.05$ .

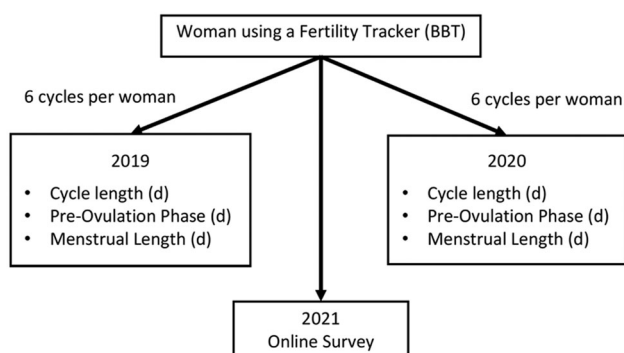


Figure 1. Study design.

**Table 1.** Socio demographic characteristics.

Characteristic	Categories	% (n = 268)
Age (years)	18–24	10.4% (28)
	25–29	36.9% (99)
	30–34	31.7% (85)
	35–39	13.1% (35)
	40–45	5.6% (15)
	Older than 45	2.2% (6)
Relationship Status	Married	38.1% (102)
	Separated	3.0% (8)
	Single (without a Partner)	8.6% (23)
	Long Term relationship (> 3 Month)	48.1% (129)
	Short Term relationship (< 3 Month)	1.5% (4)
	Dating but not in a relationship	0.7% (2)
Kids	Yes	12.3% (33)
	No	87.7% (235)
Working Status before the Pandemic	Full-Time	64.9 (175)
	Part-Time	16.0 (34)
	Unemployed	2.6 (7)
	Student	12.7 (34)
	No information	3.8 (18)
	Full-Time	64.2 (172)
Working Status during the Pandemic	Part-Time	19.4 (52)
	Unemployed	6.3 (17)
	Student	9.7 (26)
	No information	0.4 (1)

## Results

The analysis contained data from 1159 women who contributed a total of 13,194 cycles. A total of 23.1% (268/1159) of women who were sent the survey responded.

Of the study participants that completed the survey (5th of July 2021), 81.7% (219/268) were between 25 and 39 years old and a majority held a bachelor's degree or postgraduate degree (see Table 1). Only 12.3% (33/268) reported having children.

As indicated in Table 2, in 2019 the average duration was longer for the total length of the cycle and for the pre-ovulation phase. Further, the most noticeable change is in the days of menstruation, in which on average women menstruated slightly more in 2020 than they did in 2019. There was a statistically significant difference in the average menstrual cycle length, pre-ovulation phase length, and menstruation length of these women between 2019 ( $n = 6582$  cycles) and 2020 ( $n = 6607$  cycles).

38.1% (102/268) of all women reported being personally affected or having had family members that were affected by COVID-19. About 69% (186/268) reported their quality of life had changed. Of these 186 study participants, 76 reported that their life had either somewhat improved or improved (reporting 6–10 on a scale of 1–10). However, of the women who were affected or had family that was affected by COVID-19, 46% (47/102) reported that their quality of life worsened in the last 12 months and during (reporting a 0–4 on a scale of 1–10).

As shown in Table 3, there was some difference in the menstrual cycle and menstruation length among women ( $n = 47$ ) between 2019 and 2020. The length of menstruation was slightly higher in 2020 among women who reported that their quality of life had worsened during the pandemic. 44.4% (119/268) of the study participants reported that they had noticed a change in their menstrual cycle, temperature curve, or menstruation in the past 12 months. This finding was only slightly higher in women who reported being affected or had family that was affected by COVID-19, at 53.9% (50/102). After a sample  $t$ -test calculation of over 6000 menstrual cycles of women

**Table 2.** Data set ( $n = 1159$  Woman) 6 cycles each from 2020 vs. 2019.

Average	Mean $\pm$ SD	
	2020 ( $n = 6607$ cycles)	2019 ( $n = 6582$ cycles)
Menstrual Cycle Length (d)	28.7 $\pm$ 4.58	29.8 $\pm$ 6.08 (<0.0001)
Pre-ovulation Phase Length (d)	16.2 $\pm$ 4.39	17.12 $\pm$ 5.96 (<0.0001)
Menstruation Length (d)	3.92 $\pm$ 1.22	3.90 $\pm$ 1.54 (<0.0001)

**Table 3.** Women ( $n = 47$  out of 268) who reported that their quality of life had worsened during the pandemic (>5).

Average	Mean $\pm$ SD	
	2020 ( $n = 522$ cycles)	2019 ( $n = 515$ cycles)
Menstrual Cycle Length (d)	29.2 $\pm$ 4.60	30.0 $\pm$ 5.47 (<0.0001)
Menstruation Length (d)	4.00 $\pm$ 1.11	3.87 $\pm$ 1.15 (<0.0001)

who reported that they had noticed a change in their menstrual cycle, temperature curve, or menstruation in the past 12 months, we found there to be a significant difference across time for cycle length, pre-ovulation phase length, and days of menstrual bleeding. We also found that 58.2% of all women reported that the pandemic had direct consequences for them and their families.

As shown in Table 4, the most reported direct consequences for study participants were limited social contact and no possibility to practice a hobby. There were very few differences regarding perceived changes in the menstrual cycle, temperature curve, or menstruation in the past 12 months among women who received the vaccine and women who did not. Of the 191 who received the vaccine, 85 reported that they noticed a change in their menstrual cycle and/or temperature curve.

We found that 66.4% (178/268) of women reported feeling sometimes to always stressed because of the pandemic. We measured stress through different indicators reported in the Table 5 below and found that the 'health of the family' was the biggest stressor for study participants. We also found a statistical difference ( $p < 0.0001$ ) between menstrual cycle and menstruation length between

**Table 4.** Types of direct consequences for women during the pandemic.

Consequence	% (n = 156)
Reduced work	23.1% (36)
Self-employed existence is at risk	20.2% (18)
Loss of job	11.5% (12)
Moved to home office	27.0% (58)
Children at home	37.2% (28)
Limited social contact	79.5% (124)
No possibility to practice a hobby	46.8% (73)

Participants were able to select more than one answer.

**Table 5.** Psychosocial indicators of study participants (n = 268).

	% (n = 268)
Reported below 5 (Never to Sometimes) on a scale of 1–10	
Felt confident about your ability to handle your personal problems	13.8% (37)
Felt that things were going your way	23.9% (64)
Felt that you were on top of things	23.9% (64)
Reported above 5 (Sometimes to Always) on a scale of 1–10	
Been angered because of things that were outside of your control	55.2% (148)
Felt difficulties were piling up so high that you could not overcome them	23.8% (64)
Found that you could not cope with all the things that you had to do	33.6% (90)

2020 and 2019 for women (n = 95) who reported feeling stressed during the pandemic (0–2 on a scale of 1–5).

## Discussion

The objective of this observational analysis was to explore whether or not women's menstrual cycles changed in the first six cycles of 2020 compared to the same period of the preceding year. We considered menstrual cycle indicators such as menstrual cycle length, pre-ovulation phase length, and menstruation length. Our findings indicate that these indicators changed only slightly in the first 6 months of 2020 but were still statistically significant. The sample demographics largely reflect women who would typically use the *Daisy* device or similar fertility devices, as other studies have had similar demographics [7,13].

The study was able to identify whether perceived changes in the menstrual cycle actually translated to changes in the menstrual cycle. Of the 50.4% of women who reported feeling a difference in their menstrual cycle and/or menstruation, we found that menstruation was longer in the first 6 months of 2020 than it was in 2019. From this we were able to understand that these study participants had some level of awareness of changes to their menstrual health.

Previous studies have shown that various factors like stress, diet, and exercise have an impact on the menstrual cycle [1]. Beyond the fear of contracting the disease, the COVID-19 pandemic brought unprecedented lifestyle changes for women and couples who were impacted by national lockdowns, occupational changes, and children at home. We found that 57.4% of all women in the study reported that the pandemic had direct consequences for them and their families. Women reported the biggest consequences for them during the lockdown were limited social contact and no possibility to practice a hobby. Furthermore, 69% of study participants reported feeling 'sometimes stressed' to 'always stressed' because of the

pandemic. This is similar to a recent study that found 45.4% of study participants reported COVID-19 related stress [7]. Research has shown that significant lifestyle changes and social engagement have an impact on stress and mental health, all of which have major downstream effects on the hypothalamic–pituitary–gonadal axis [14]. Higher stress levels cause an increase in the glucocorticoid stress hormone which targets and lowers gonadotropin releasing hormones [15]. This in turn may impact the timing of ovulation and women's ability to identify when in their cycle they are fertile or infertile. Studies have also found that high stress levels are associated with menstrual cycle irregularities [1–2].

Additionally, our findings show that a majority of study participants reported changes in the quality of life during the pandemic, 65% (84/129), and of the women who were affected or had family that was affected by COVID-19, 27% (15/55) reported that their quality of life worsened in the last 12 months (reporting a 0–4 on a scale of 1–10).

A strength of the study lies in the characteristics of the participants and the way of collecting the data. The data sent by the participants to the tracker in 2019, well before the onset of the pandemic, had the goal of obtaining faithful feedback on their fertility status. The same happened in 2020 before being asked for consent. Consequently, the users were interested in its accuracy. Thus, the results on cycle indicators are highly reliable. Moreover, the participants used to be aware of their menstrual situation and especially sensitive to any change, even subtle, of their cycle characteristics.

Although this study was able to provide us insight into menstrual cycle changes during the pandemic beyond perceived changes, there were several limitations. The first limitation of this study is that the sample reflects the events in a selected group of women of high educational level which limits the results generalisability. Secondly the sample size is not powerful enough to apply these results to the general population of fertility awareness users, thus limiting results to specifically *Daisy* users or similar fertility device users. Thirdly, study participants were from 15 different countries and data has shown that the beginning of the pandemic was different in the first 6 months for many of these countries. Therefore, the first 6 months for a user in Australia may be very different from the first 6 months of a study participant in Spain. Furthermore, the survey data is self-reported and may contain recall bias since the survey was administered to study participants in July 2021.

Future studies should focus on changes in the menstrual cycle in relation to the peaks of the pandemic for study participants based on their location and analyse data based on targeted information. Analysing the degree of change in basal body temperature as well as menstrual cycle indicators for both 2020 and 2021 may provide more insight into how women's menstruations were affected over time and throughout different pandemic peaks.

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