

# The impact of the Coronavirus (COVID-19) on the menstrual cycle and mental health of young Georgian women

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## Abstract

The Coronavirus (COVID19) damages various systems and organs and can directly affect the reproductive system. Coronavirus infection affects not only physical health but also causes a significant threat to mental health.

**Objective of the study was** to investigate the impact of the coronavirus infection and vaccination against coronavirus infection on the menstrual cycle and mental health of young Georgian women and establish the relationship between them.

**Methods:** A cross-sectional study was conducted by administering online questionnaires to young women (18-25 years) in Georgia. Through questionnaires, we determined the characteristics of the menstrual cycle, the psychological state of the participants before being infected with the coronavirus, in the period 3-6 months after the infection and after the vaccination against the coronavirus infection.

**Results:** 48.2 % of participants reported significant changes in their menstrual cycle after the coronavirus infection. Participants' mean menstrual cycle length significantly increased after 3 months of coronavirus infection,  $p < 0.05$ . Participants' mean menstrual cycle length before, and 6 months after the coronavirus infection did not differ significantly. Duration of menstruation before the pandemic was significantly shorter than after 3 and 6 months of infection,  $p < 0.05$ . The prevalence of premenstrual symptoms components and dysmenorrhea was significantly increased after 3 and 6 months of the coronavirus infection,  $p < 0.05$ .

Changes in the menstrual cycle within 3 months after vaccination were found in 58.8% of cases, the severity of which significantly decreased 6 months after vaccination,  $p < 0.001$ . Women noted a significant increase in low mood, poor concentration, anxiety, poor sleep, loneliness after COVID-19 and vaccination,  $p < 0.05$

**Conclusions:** Coronavirus infection causes significant changes of the menstrual cycle and mental health in Georgian young women. The study indicated a link between the COVID-19 pandemic-induced anxiety, stress, depression, and menstrual cycle irregularity.

## **Keywords**

COVID-19, coronavirus infection, menstrual cycle, depression, stress

## **Introduction**

The coronavirus infection (COVID-19), due to its contagiousness and severe complications, has caused great damage to humanity [1,2]. At the beginning of the pandemic, the main focus was on treating organ system disorders that cause death. Later, when the mechanism of action of the coronavirus became clear, studies in other directions became relevant. Coronavirus infection affects not only physical health but also causes a significant threat to mental health [2,3,4,5].

The coronavirus pandemic resulted in stress, anxiety, and depression [2-5]. It is known that long-term stress can affect the hypothalamic-pituitary-ovarian axis, which is responsible for regulating the menstrual cycle. The main consequences of that are disruptions of hormone secretion and the menstrual cycle [4-6].

In addition, COVID-19 can directly affect the reproductive system. The entry of the coronavirus into the target cell occurs through its binding to the angiotensin-converting enzyme (ACE 2), which is not only an enzyme but also a functional receptor on cell surfaces [7,8]. Through ACE 2, SARS-CoV-2 enters host cells and initiates upregulation of ACE2 expression. SARS-CoV-2 induces ACE/ACE2 imbalance and activation of renin-angiotensin-aldosterone system (RAAS), which ultimately contributes to the progression of COVID-19 [7-9]. As it is known, ACE 2 is not only the main component of the regulation of the renin-angiotensin system, but also plays an important role in the female reproductive function. Recent studies have shown that ACE 2 is expressed in the ovaries, uterus, vagina, and placenta. ACE 2 is involved in the regulation of follicle development, ovulation, and regression of the corpus luteum. It also affects the transformation of the endometrium [7-10]. To sum up, coronavirus infection, depending on its pathogenesis, may be the cause of reproductive dysfunction.

Presently, studies on the impact of the coronavirus infection and vaccination against the coronavirus infection on the female reproductive system and the psychological state of patients are of great

interest. The subject of discussion is the relationship between psychological stress and menstrual cycle disorders. Despite the fact that the coronavirus infection is the most studied disease in the last 3 years, its impact on various systems has not yet been fully established. The last period is characterized by a worsening of the epidemiological situation in various regions with an increase in cases of coronavirus infection, and we still cannot announce the end of the epidemic

Taking into consideration the fact that the impact of the coronavirus infection on women's health is different depending on the population, and the results of studies related to coronavirus infection are contraindicated, it should be considered appropriate to continue research in this direction, involving population characteristics.

**Objective of the study was** to investigate the impact of the coronavirus infection and vaccination against coronavirus infection on the menstrual cycle and mental health of young Georgian women and establish the relationship between them.

**Material and methods:** A cross-sectional study was conducted by administering online questionnaires to young women (18-25 years) in Georgia, from 8th to 28th June 2022. The questionnaires were designed by a gynecologist, a psychotherapist and clinical epidemiologist.

Online questionnaires were sent to female students of different Universities in Georgia. The questionnaires were anonymous and their results were used only in a generalized form. The Ethics Committee of the Center for Reproductive Medicine “Universe” agreed to conduct the study [Approval code: 12/22].

Through the questionnaire, we determined the characteristics of the menstrual cycle, the psychological state of the participants before being infected with the coronavirus, in the period 3-6 months after the infection and after the prophylactic vaccination against the coronavirus infection.

The number of questions in the questionnaire was 60. The first part of the free-part questionnaire included demographic characteristics of the participants, the conditions of education and job, physical characteristics, medical and reproductive history. The second part of the questionnaire was related to the history of infections of the coronavirus, diagnostic methods, type and quantity of the vaccine, the peculiarities of the menstrual cycle before and after 3-6 months of the coronavirus infection and vaccination. The third part describes the general condition, activity, emotional state of women before the pandemic and after infection with COVID 19 and also after vaccination.

**Criteria for inclusion in the study:**

- Age 18-25 years
- Having had regular menstrual cycle during 1 year before pandemic
- During the last 6 months women should not have taken a drug containing sex hormones.
- Agreeing to participate in the study

### **Criteria for exclusion from the study:**

Women who were pregnant, postpartum, or breastfeeding, taking hormone medication, with irregular menstrual cycles or with other somatic diseases that could affect their menstrual patterns.

### **Statistical analysis**

Statistical analysis was done using office software MS excel 2021 and Statistical Package for the Social Sciences, version 24.0 (SPSS 24.0, Chicago, IL, USA). A p-value of 0.05 or lower is considered statistically significant. Data were shown as means $\pm$ SD for continuous variables or frequency (N). Categorical variables were expressed as a percentage of the total. Changes before and after COVID-19 were evaluated with a paired sample t-test and chi-square test. A Pearson correlation test was used to show the relationships between variables [11,12].

### **Results**

850 participants completed the questionnaire, and 310 were excluded because they did not match the inclusion criteria for the study.

The analysis of the menstrual cycle and psychological state before and after infection with coronavirus in 420 young women was carried out.

Pre- and post-vaccination changes in menstrual cycle and mental health were assessed in 285 female students vaccinated with  $\geq 2$  doses.

The percentage of smokers was 1.5%. 63.6% (n267) of the participants were single, 28.3% (n119)-married and 1% (n8)-divorced.

The average age of the participants was 22.5 $\pm$ 2.5 years (18–25). The average Body Mass Index (BMI) is 21.5 $\pm$ 5.5.

48.2 % of participants reported significant changes in their menstrual cycle after 3 and 6 months of the coronavirus infection. These included changes in menstrual cycle length (48%), the duration of menses (34%), and changes in premenstrual symptoms (25%). Table 1.

Delay in menstruation after 3 months of coronavirus infection detected in 20.7% and 6 months later – in 20.95%. Shortening of the menstrual period after 3 months of coronavirus infection was detected by 1.7% and after 6 months – by 5.7% Table 1.

Participants' mean menstrual cycle length significantly increased after 3 months of coronavirus infection,  $p < 0.05$ . Participants' mean menstrual cycle length before the pandemic was 28.8 $\pm$ 5.5 days, and after 3 months of coronavirus infection -32 $\pm$ 6.5. Participants' menstrual cycle length before and 6 months of coronavirus infection (28.2 $\pm$ 5.8 days) did not differ significantly. Diagram 1.

Duration of menstruation before the pandemic (5.3 $\pm$ 2.6 days) was significantly lower than after 3 months of infection (6.9 $\pm$ 3.1 days) and - after 6 months (7.3 $\pm$ 2.1),  $p < 0.05$ . The duration of menstruation after 3- and 6- months of coronavirus infection did not differ significantly.

An increase in the duration of menstruation was noted in 7.86% after 3 months transmission of coronavirus infection and in 10.95% after 6 months of coronavirus infection. Decrease duration of the menstruation after 3 months of transmission of coronavirus infection detected in 6.2% of participants and in 6.4% after 6 months Table 1.

The prevalence of premenstrual symptoms (PMS) components and dysmenorrhea was significantly increased after covid infection compared with before,  $p < 0.05$ . Table 1

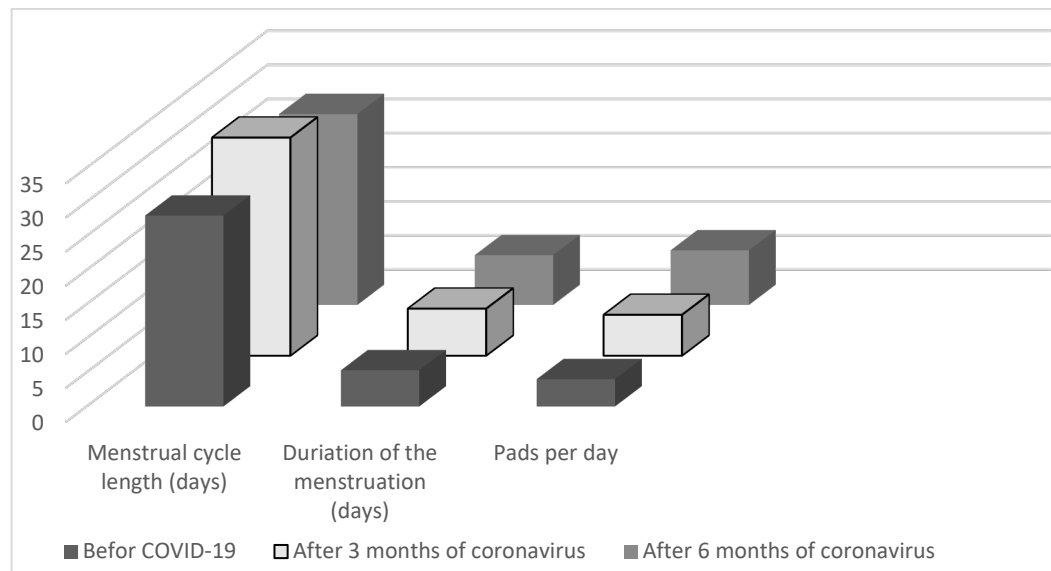
Worsening of premenstrual symptoms after 3 months of the coronavirus infection was noted in 5.24% and after 6 months – in 8.8%. The reduction in premenstrual symptoms after 3 months of coronavirus infection was noted in 0.5% of participants, and in -1.2% after 6 months. Table 1

More painful menstruation after 3 months of coronavirus infection was detected in 8.8% and after 6 months – in 10.5% of participants. Less painful menstruation was noted in 3.6% after 3 months of the coronavirus infection and in 3.3% after 6 months of participants Table 1

**Table 1. Menstrual cycle characteristics after 3 and 6 months of coronavirus infection and vaccination**

The peculiarity of the menstrual cycle	After 3 months of COVID19 (n 420)	After 6 months of COVID19 (n 420)	After 3 months of vaccination (n285)	After 6 months of vaccination (n285)
Changes of menstrual cycle characteristics	48.1% (n202)	58.3% (n245)	58.9 % (n168)	27%(n77)
Delay in menstruation	20.7% (n 87)	20.95% (n 88)	20.3% (n 58)	11.9% (n 34)
Shortening of the menstrual period	1.7% (n7)	5.7% (n24)	4.9% (n14)	1.7% (n5)
Decrease duration of the menstruation	6.2% (n26)	6.4% (n27)	9.8% (n28)	4.9% (n14)
Increase duration of the menstruation	7.86% (n33)	10.95% (n46)	11.2% (n32)	6.5% (n 16)
More painful menstruation	8.8% (n37)	10.5% (n44)	8.8% (n25)	3.1% (n 9)
Less painful menstruation	3.6% (n15)	3.3% (n14)	4.2% (n12)	2.8% (n 8)
Worsening of premenstrual symptoms	5.24% (n22)	8.8% (n37)	7% (n 20)	6% (n17)
The reduction in premenstrual symptoms	0.5% (n2)	1.2% (n5)	3.5% (n10)	1.7% (n5)

**Diagram 1. Menstrual cycle characteristics in study participants before infection and 3 and 6 months of coronavirus infection**



78% of participants report various changes in their psychological state after COVID-19 infection. Women detected a significant increase in low mood, poor concentration, anxiety, poor sleep, loneliness, poor appetite, binge eating after 3 and 6 months of coronavirus infection,  $p < 0.05$ . Table 2.

Positive correlations between COVID-19-associated mental health disorders and changes of the menstrual cycle, dysmenorrhea severity and PMS were observed,  $p < 0.05$ . The multiple linear regression model revealed that dysmenorrhea severity, PMS symptoms, and changes of the menstrual cycle were associated with worsening of depression and aggravation of anxiety.

The majority of participants received Pfizer-BioNTech (43.5%; n124); Sinopharm (25.6%; n73), and AstraZeneca (1%; n3), Moderna (1%). The majority (86.5%) received two doses. 4.2% do not remember exactly the name of the vaccine and 3.9% of participants were vaccinated with one of the listed + booster. 32.14% of study participants were not vaccinated.

Changes associated with the menstrual cycle within 3 months after vaccination were noted in 58.8% of cases, the severity of which significantly decreased after 6 months of after vaccination and occurred in 27% of cases ( $p < 0.001$ ). Table 1.

The characteristics of the change in the menstrual cycle after vaccination in women with and without COVID-19 in anamnesis did not differ significantly. The type of vaccine did not affect significantly on the incidence of symptoms.

73% of participants report various changes in their psychological state after COVID-19 vaccination. Women detected a significant increase in low mood, poor concentration, anxiety, poor sleep, loneliness, poor appetite, binge eating after 3 months of vaccination against coronavirus infection,  $p < 0.05$ . Table 2.

Changes in mental health of participants, which were noted 6 months after the transmission of the coronavirus infection and vaccination, compared to the data after 3 months, are significantly reduced, as well as the frequency of menstrual cycle disorders. Table 2.

**Table 2. Mental health status after 3 and 6 months of coronavirus infection (n 420) and vaccination (n 285)**

The changes of the mental health	After 3 months of COVID19 (n 420)	After 6 months of COVID19 (n 420)	After 3 months of vaccination (n285)	After 6 months of vaccination (n285)
Poor concentration	71.6% (n301)	65.2% (n274)	48.8% (n139)	27% (n77)
Depression	28.8% (n121)	20% (n83)	27.4% (n 78)	20.3% (n58)
Poor sleep	69% (n290)	71.4% (n300)	41% (n117)	33% (n94)
Loneliness	23.6% (n99)	17.9% (n75)	21% (n60)	15.8% (n45)
Low mood	83% (n350)	25.2% (n106)	43.5% (n124)	23.5% (n67)
Anxiety	48% (n202)	25% (n105)	43.5% (n124)	13% (n37)

**Discussion:**

Regular menstrual cycle is an indicator of a woman's health. Menstrual cycle disorders are associated not only with reproductive health problems, but also with other pathologies and a decrease in the quality of life [13,14].

Our study results showed that the coronavirus infection causes significant changes in the menstrual cycle and mental health in young Georgian women. These included changes in menstrual cycle length, the duration of menses, and changes in premenstrual symptoms. Similar findings were confirmed by other studies [5,15,16], but some authors, however, were in contrast with our findings [5,17].

When we compared the average menstrual cycle length in the participants before and after the coronavirus infection, we found that it significantly increased after 3 months infection, but returned to initial levels 6 months after infection. The menstrual cycle length in the participants before the pandemic and after 6 months of the coronavirus was not significantly different. This result suggests that various types of menstrual cycle changes may be transitory, last for a short time and are associated with various factors, such as stress, and do not cause deep disorders. However, it will be interesting to conduct future studies after the end of the pandemic, based on which it will be assessed whether the parameters of the menstrual cycle will return to the pre-pandemic state.

Our study showed that duration of menstruation before the pandemic was significantly lower than 3 and 6 months after coronavirus infection. Some studies found similar outcomes; however, others did not find a significant association between the coronavirus and duration of menstruation [5,18,19].

Dysmenorrhea and PMS are considered not only a medical problem, but also a condition that significantly reduces quality of life. Previous studies have shown that dysmenorrhea in female students is directly correlated with reduced academic performance and socialization [20]. Our study results showed that the prevalence of premenstrual symptoms (PMS) components and dysmenorrhea and severity of this symptom was significantly increased after COVID-19 infection compared with before. This was found to be consistent with information in the literature [2,18]. Some studies did not find the association between dysmenorrhea, PMS and coronavirus [5].

The coronavirus is considered a neuro-infection, it affects certain segments of the central nervous system, which is manifested by loss of smell and taste [21,22]. Some studies considered that it can affect the psychological state, mental and cognitive abilities, memory and sleep. However, in many cases, all this is not irreversible, and in dynamics it is possible to reduce the symptoms [2,5,22]. Other studies did not confirm this association [23]. The result of our study indicated that about 78% of participants report various changes in their psychological state after COVID-19. Participants noted a significant increase in low mood, poor concentration, anxiety, and depression after coronavirus infection.

It is known that just as stress can cause menstrual irregularities, menstrual dysfunction can affect a woman's psychological well-being, causing long-term complications and a reduced quality of life [6,23]. Our study showed a significant positive association between anxiety, stress, depressive symptoms, and menstrual cycle changes in young Georgian women caused by the COVID-19 pandemic. This relationship is also indicated by the fact that, according to our data, 6 months after the transmission of a covid infection, compared with the data after 3 months, both various changes in their psychological state and the frequency of menstrual cycle disorders simultaneously decrease. Literature data on this issue are diverse and heterogeneous [4,24,25].

The study showed a possible link between the COVID-19 vaccine and menstrual abnormalities that have impacted their quality of life. As a result of this study, significant changes associated with the menstrual cycle and mental health were detected within 3 months after vaccination, however, it should be noted that after 6 months, the manifestations of fatigue significantly decreased, which once again indicates the possible influence of mental health (psychological moods) on nature of the menstrual cycle. The type of vaccine did not significantly affect the frequency of symptoms. Literature data on this topic are heterogeneous [24,25,26].



The limitations of our study are that the study is based on a questionnaire and therefore cannot have face-to-face communication with participants, which would lead to a more accurate detection of changes in reproductive and mental health. It would also be interesting to conduct future studies after the end of the pandemic to assess whether menstrual cycle parameters and mental health changes will return to pre-pandemic states.

## Conclusions

Coronavirus infection causes significant changes of the menstrual cycle and mental health in young Georgian women.

The study indicated a link between the COVID-19 pandemic-induced anxiety, stress, depression, and menstrual cycle irregularity among young Georgian woman.

The study showed a link between the COVID-19 vaccine and menstrual abnormalities and changes of the mental health in young Georgian woman.

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