








# COVID-19-associated mental health impact on menstruation physiology: A survey study among medical students in Jordan

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## Abstract

**Background:** The coronavirus disease 2019 pandemic has been an extraordinarily stressful situation in recent years. Stress is a physiological reaction to negative stimuli that is regulated by different neuroendocrine pathways. The female reproductive function is maintained by the menstrual cycle, which is negatively affected by hyperstimulation of stress signals.

**Objectives:** This study evaluates the effect of the coronavirus disease 2019 outbreak on menstrual function and mental health, exploring the relationship between them.

**Design:** The current study uses a cross-sectional, survey-based design.

**Methods:** During this cross-sectional study, an online self-completion questionnaire was conducted among a sample of 385 Jordanian female medical students during the pandemic. The survey compared menstrual characteristics, depression, anxiety, and stress 10 months after the coronavirus disease 2019 pandemic with 10 months prior. Paired *t*-test, McNemar's test, Pearson's correlation, and multiple linear regression model were employed to analyze data using SPSS software.

**Results:** The mean age of female medical student respondents was 19.89 years. Data showed that the menstrual cycle length significantly increased during the coronavirus disease 2019 pandemic compared with 10 months prior (32.23 days versus 30.02 days,  $p=0.019$ ). The average number of heavy bleeding days also increased during the coronavirus disease 2019 pandemic (2.82 days versus 2.42 days,  $p=0.002$ ). The proportion of females with heavy bleeding amount was more than doubled during the pandemic of coronavirus disease 2019 compared with before (27.3% versus 10.4%,  $p=0.000$ ). Unpleasant menstrual signs such as nausea and/or vomiting, breast pain, and urinary urgency were significantly increased during the pandemic ( $p=0.000$ ,  $p=0.008$ , and  $p=0.024$ , respectively). During coronavirus disease 2019, a positive association between total Depression, Anxiety, and Stress Scale-21 Questionnaire score and heavy bleeding was identified ( $p < 0.05$ ). The findings also indicated that mental disorders and the incidence of amenorrhea, nausea and/or vomiting, and urinary urgency were positively correlated during the coronavirus disease 2019 pandemic. The multiple regression analysis revealed associations between several menstrual characteristics such as amenorrhea and severity of bleeding with coronavirus disease 2019-related depression, anxiety, and stress.

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**Conclusion:** This study revealed that the stress related to the pandemic of coronavirus disease 2019 could affect the female menstrual cycle and hence the quality of women's life. Therefore, this study could serve as a baseline for planning and introducing stress mitigation interventions in crisis situations to improve the physiological and mental well-being of females and improve their quality of life.

### Keywords

COVID-19, DASS-21, menstrual function, mental health, stress physiology

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## Introduction

Stress is the body's physiological response to unpleasant triggers. The human body adapts to stress by activation of several complementary pathways, involving the nervous system and hypothalamic-pituitary-adrenal (HPA) axis.<sup>1,2</sup> Different biological components such as neurotransmitters, hormones, and proteins are employed in the process of stress response, to maintain homeostasis. However, overstimulation of stress response mechanisms is associated with inverse physiological and health consequences.<sup>1,2</sup> The recent coronavirus disease 2019 (COVID-19) outbreak, caused by the SARS-CoV-2 virus, constitutes a major traumatic situation in the history of the world. More than 620 million people have been infected with the virus, and more than 6.5 million COVID-19-related deaths were reported.<sup>3</sup> In addition, the pandemic has changed the quality of life and increased the incidence of depression, anxiety, and stress among the world's population.<sup>4,5</sup>

The menstrual cycle is a physiological process that maintains human reproductive function. Normal menstruation is tightly regulated by neuroendocrine mechanisms; mainly by the HPA axis.<sup>6</sup> Both organic and psychological factors, such as stress, can play a direct role in menstrual perturbations related to frequency, regularity, length, and bleeding amount,<sup>6,7</sup> which can affect the quality of women's lives. The highest incidence of menstrual abnormalities is observed among females who are aged 20–24 years.<sup>8</sup> In addition, recent reports showed that university students are vulnerable to elevated levels of stress, anxiety, and depression,<sup>9</sup> and female gender is more susceptible to COVID-19-linked stress.<sup>10,11</sup> Accordingly, the current study aims to explore the effect of COVID-19-related mental health on menstrual characteristics and to evaluate the relationship between menstrual characteristics, and depression, anxiety, and stress during the COVID-19 pandemic among Jordanian female medical students. To the best of our knowledge, no similar studies have been previously conducted in Jordan. This work provides a broad insight into the prevalence of menstrual and mental health disorders and evaluates the association between them during the COVID-19 outbreak. Therefore, the current study could aid university systems to develop educational programs,

and assessment services evaluating physiological and mental status to safeguard the mental and physiological well-being of future female doctors.

## Material and methods

### *Sample, survey design, and data collection*

The sample size for the current study was calculated using Raosoft online sample size calculator.<sup>12</sup> The calculation was based on 50% response distribution, 5% margin of error, and 95% confidence interval. The estimated total number of undergraduate students in Jordanian medical schools is approximately 12,000 males and females. The calculated sample size was 373 students, including both genders, and the present study employed 385 female medical students. An online structured questionnaire was developed to collect the data from all Jordanian medical schools during the early spark of the COVID-19 outbreak pandemic in Jordan (January–February, 2021). The first part of the survey included an overview of the study, its objectives, target population, freedom and confidentiality of participation, and informed consent. The second part of the questionnaire included demographic information, while the third part assessed changes in menstrual features, such as menstrual cycle length, cycle regularity, bleeding days, amount of menstruation, menstruation signs, and treatment options for menstruation signs. The other sections of the survey, which evaluated dysmenorrhea signs, premenstrual syndrome, and reproductive tract health of the participants, were published previously.<sup>13</sup> The questionnaire evaluating menstrual features was initially designed in English. A native Arabic professional translator then translated the English version of the questionnaire to an Arabic version. A pilot test with 40 female medical students was conducted to validate the clarity and reliability of the survey. Further improvements to the survey contents were performed based on the feedback of the pilot survey participants. In addition, the previously validated Depression, Anxiety, And Stress Scale-21 Questionnaire (DASS-21)<sup>14</sup> was employed to explore the impact of the COVID-19 outbreak on female's mental status in the last section of the online questionnaire. The Arabic version of the DASS-21

questionnaire has already been created and validated previously and showed acceptable reliability and good psychometric properties.<sup>15–17</sup> The DASS-21 questionnaire includes 21 questions in three sub-divisions (depression, anxiety, and stress), with 7 questions for each sub-division. The questions are scored on a 4-point Likert-type scale that ranges from 0 (not at all) to 3 (on most occasions). The score level for depression is rated as: 10–13 mild; 14–20 moderate; 21–27 severe; and  $\geq 28$  extremely severe. The score level for anxiety is rated as: 8–9 mild; 10–14 moderate; 15–19 severe; and  $\geq 20$  extremely severe. The score level for stress is rated as: 15–18 mild; 19–25 moderate; 26–33 severe; and  $\geq 34$  extremely severe.<sup>14</sup> Most of the questions in this survey explored participants' responses during two different periods: during the COVID-19 outbreak and 10 months before the viral outbreak, as a control for comparison. The inclusion criteria for the current study were undergraduate medical students, who were assigned female at birth (cisgender women), aged  $\geq 18$  years and single ones. The exclusion criteria were age under 18-year-old and married women. Teaching platforms and social media were used to disseminate the questionnaire and collect the data. The study was approved by the Institutional Review Board of the Hashemite University. An electronic informed consent for participation in the study and publication of data was obtained from all participants involved in the study. Study methods are reported using the Checklist for Reporting Results of Internet E-Surveys (supplementary file).

### Statistical analysis

The data were processed using the SPSS version 25 (IBM Corporation). Data are displayed as mean  $\pm$  standard deviation (SD), frequency (*N*) or percentages (%), as appropriate. McNemar's test was used to evaluate categorical variables before and during the COVID-19 outbreak. The paired student *t*-test was employed to compare continuous variables before and after COVID-19. The bivariate Pearson's correlation test and the multiple linear regression model were employed to verify the correlations. A *p*-value  $< 0.05$  was deemed statistically significant.

### Results

Participant characteristics and demographics are listed in Table 1. The mean age of the females, who participated in this study was 19.89 years, and the average age of menarche was 12.98 years. The proportion of participants, who tested positive for SARS-CoV-2 virus, was 11.9%. According to the DASS-21 scoring scale, for the pre-pandemic era, 32.7% of the participants reported mild to severe depression, 36.1% of the females showed mild to extremely severe anxiety, and 19.5% of the students experienced mild to moderate stress. In contrast, during the COVID-19

**Table 1.** Demographics of study participants.

Demographic variable	Mean $\pm$ SD or <i>N</i> (%)
Age (years)	19.89 $\pm$ 1.56
Height (cm)	161.00 $\pm$ 7.78
Menarche (years)	12.98 $\pm$ 1.286
COVID-19 infection	
Yes	46 (11.9)
No	251 (65.2)
I don't know	88 (22.9)

SD: standard deviation; COVID-19: coronavirus disease 2019.

outbreak, 53.5% of the students reported mild to severe depression, 53.2% of the students suffered from mild to extremely severe anxiety, and 35.8% of the students had mild to moderate stress responses. Percentages of moderate (16.4% versus 27.0%) and severe (2.9% versus 14.8%) depression were significantly increased during the COVID-19 pandemic ( $p=0.000$ ). Similarly, the frequency of moderate (13.5% versus 20.8%) and extremely severe anxiety (1.3% versus 11.2%) was significantly increased during the viral outbreak ( $p=0.000$ ). Finally, the proportion of students with moderate stress was more than doubled during the COVID-19 pandemic ( $p=0.000$ ) (Table 2).

Table 3 shows the changes in menstrual cycle characteristics among the participants before and during the COVID-19 pandemic. The average menstrual cycle length was significantly increased during the pandemic (32.23 versus 30.02 days,  $p=0.019$ ). The females had significantly prolonged heavy bleeding days during the COVID-19 outbreak compared with before (2.82 versus 2.42,  $p=0.002$ ). The proportion of students with heavy bleeding was almost tripled during the COVID-19 pandemic (27.3% versus 10.4%,  $p=0.000$ ). Before the pandemic, 75 females reported irregular cycles. However, during the COVID-19 outbreak, this number was significantly increased to 131 participants ( $p=0.000$ ). The proportion of students who suffered from intermenstrual spotting during COVID-19 was 40.3% compared with 35.3% before ( $p=0.008$ ). More than 90% of the female medical students experienced the following symptoms during menstruation before and during the COVID-19 outbreak: fatigue, mood swings, anger, appetite change, and abdominal flatulence. However, the proportion of females experiencing nausea and/or vomiting, breast pain, and urinary urgency during menstruation was significantly increased during the COVID-19 outbreak ( $p=0.000$ ,  $p=0.008$ , and  $p=0.024$ , respectively). A significant increase in the proportion of students who used "other" treatment options such as traditional medicine, diet, etc. for menstruation signs was observed during the COVID-19 pandemic ( $p=0.000$ ).

Table 4 shows the Pearson's correlation coefficients between mental health status during the COVID-19 outbreak along with participants' menstrual characteristics.

**Table 2.** Depression, Anxiety, and Stress Scale 21 (DASS-21) scores analyses before and after COVID-19 among study participants ( $n=385$ ).

Category	Pre-COVID-19 N (%)	Post-COVID-19 N (%)	<i>p</i> value
Depression severity			
Normal	259 (67.3)	179 (46.5)	0.000***
Mild	52 (13.5)	45 (11.7)	0.483
Moderate	63 (16.4)	104 (27.0)	0.000***
Severe	11 (2.9)	57 (14.8)	0.000***
Extremely severe	0 (0)	0 (0)	NA
Anxiety severity			
Normal	246 (63.9)	180 (46.8)	0.000***
Mild	40 (10.4)	41 (10.6)	1.00
Moderate	52 (13.5)	80 (20.8)	0.008**
Severe	42 (10.9)	41 (10.6)	1.00
Extremely severe	5 (1.3)	43 (11.2)	0.000***
Stress severity			
Normal	310 (80.5)	247 (64.2)	0.000***
Mild	38 (9.9)	49 (12.7)	0.193
Moderate	37 (9.6)	89 (23.1)	0.000***
Severe	0 (0)	0 (0)	NA
Extremely severe	0 (0)	0 (0)	NA

COVID-19: coronavirus disease 2019; NA: not available.

\*\* $p \leq 0.01$ .

\*\*\* $p \leq 0.001$ .

During the COVID-19 pandemic period, a significant positive correlation was detected between total DASS-21, anxiety, and stress scores with heavy menstrual bleeding ( $p < 0.05$ ). Furthermore, a positive association between total DASS-21, depression, anxiety, and stress scores with absent menstruation for 6 months was reported during the pandemic. Total DASS-21, anxiety, and stress scores were also related positively to urgency, nausea and/or vomiting during the COVID-19 outbreak.

Tables 5–7 present the relationship between different menstrual characteristics of medical students during the COVID-19 pandemic and the amount of COVID-19-related depression, anxiety, and stress symptoms, consequently, as determined by multiple linear regression analysis.

The multiple linear regression analysis revealed that 6-month amenorrhea was linked with deteriorating COVID-19-linked depression ( $B=4.614$ , 95% CI=1.297–7.931,  $p=0.007$ ), anxiety ( $B=3.845$ , 95% CI=0.77–6.912,  $p=0.014$ ), and stress ( $B=3.058$ , 95% CI=–0.084–6.201,  $p=0.05$ ). In addition, the amount of menstrual bleeding was associated with aggravated COVID-19-linked stress in terms of mild bleeding ( $B=1.049$ , 95% CI= –0.752–2.850,  $p=0.05$ ) and anxiety with regard to heavy bleeding ( $B=25.613$ , 95% CI=1.132–4.094,  $p=0.001$ ). Nausea as a symptom of menstruation was associated with worsening of COVID-19-associated anxiety ( $B=1.706$ , 95% CI=0.322–3.090,  $p=0.016$ ) and stress ( $B=1.663$ , 95% CI=0.249–3.077,  $p=0.021$ ). There was a positive association between urinary urgency and increased anxiety ( $B=1.837$ , 95% CI=0.424–3.249,  $p=0.011$ ) and stress levels ( $B=1.656$ , 95% CI=0.211–3.101,  $p=0.025$ ).

In contrast, moderate menstrual bleeding during COVID-19 was linked to a reduced risk of depression ( $B=-1.895$ , 95% CI= –3.341–0.448,  $p=0.01$ ) and anxiety ( $B=-2.619$ , 95% CI= –3.940–1.298,  $p < 0.001$ ). Furthermore, unknown treatments and herbal remedies that were used to treat menstruation symptoms during the pandemic were linked to a reduced risk of depression ( $B=-7.853$ , 95% CI=–14.963–0.743,  $p=0.030$ ), ( $B=-2.039$ , 95% CI= –3.675–0.403,  $p=0.015$ ), respectively). On the other hand, “other” treatments that were used to treat menstruation symptoms during the viral outbreak were linked to an increased risk of depression ( $B=2.574$ , 95% CI=0.331–4.817,  $p=0.025$ ). During COVID-19, hormonal treatment was linked to decreased risk of anxiety ( $B= -6.837$ , 95% CI= –13.406–0.268,  $p=0.040$ ); however, elevated risk of anxiety was linked to “other” treatments used for management of menstrual symptoms during COVID-19 ( $B=3.486$ , 95% CI=1.431–5.540,  $p=0.001$ ). While herbal remedies and unknown treatments during COVID-19 were linked to a reduced risk of stress ( $B=-1.734$ , 95% CI=–3.279–0.189,  $p=0.028$ ), and ( $B= -7.393$ , CI= –14.09–0.689,  $p=0.031$ ), respectively), “other” treatments were associated with increased risk of stress ( $B=2.706$ , 95% CI=0.594–4.817,  $p=0.012$ ).

## Discussion

This study explored the influence of the stressful COVID-19 pandemic on menstrual characteristics of Jordanian medical students and their mental status. The study also investigated the association between COVID-19-related

**Table 3.** Menstrual features of the study population before and during COVID-19.

Variable	Pre-COVID-19 (mean $\pm$ SD) or N (%)	Post-COVID-19 (mean $\pm$ SD) or N (%)	p values
Cycle length (days)	30.02 $\pm$ 8.99	32.23 $\pm$ 19.57	0.019*
Bleeding days	5.75 $\pm$ 1.47	5.84 $\pm$ 1.67	0.210
Heavy bleeding days no.	2.42 $\pm$ 1.01	2.82 $\pm$ 2.82	0.002**
Pads per day	4.17 $\pm$ 2.638	4.33 $\pm$ 2.86	0.134
Pads per night	1.67 $\pm$ 0.89	1.71 $\pm$ 0.88	0.239
Bleeding amount			
Mild	28 (7.3)	67 (17.4)	0.000***
Moderate	317 (82.3)	213 (55.3)	0.000***
Heavy	40 (10.4)	105 (27.3)	0.000***
Indicators for heavy menstrual bleeding			
Double protection	142 (36.9)	149 (38.7)	0.167
Night leak	215 (55.8)	224 (58.2)	0.336
Clots	301 (78.2)	304 (79.0)	0.728
Anemia due to heavy bleeding	102 (26.5)	102 (26.5)	1.00
Symptoms of menstruation			
Nausea and/or vomiting	219 (56.9)	246 (63.9)	0.000***
Constipation and/or diarrhea	308 (80.0)	316 (82.1)	0.152
Flatulence	347 (90.1)	355 (92.2)	0.077
Breast pain	278 (72.2)	290 (75.3)	0.008**
Fatigue	373 (96.9)	376 (97.7)	0.375
Appetite change	355 (92.2)	349 (90.6)	0.210
Headache	301 (78.2)	303 (78.7)	0.845
Urgency	244 (63.4)	258 (67.0)	0.024*
Mood swings	361 (93.8)	365 (94.8)	0.219
Anger	357 (92.7)	356 (92.5)	1.00
Acne	348 (90.4)	346 (89.9)	0.791
Irregular cycle	75 (19.5)	131 (34.0)	0.000***
Irregular bleeding between periods	136 (35.3)	155 (40.3)	0.008**
Light or absent period	156 (40.5)	147 (38.2)	0.422
Six-month absence	25 (6.5)	19 (4.5)	0.180
Menstrual disorders treatment			
Herbal	97 (25.2)	101 (26.2)	0.585
Hormonal therapy	7 (1.8)	9 (2.3)	0.727
Contraceptive pills	13 (3.4)	14 (3.6)	1.00
Surgery	1 (0.3)	2 (0.5)	NA
Unknown	5 (1.3)	4 (1.0)	1.00
Others	32 (8.3)	45 (11.7)	0.000***

COVID-19: coronavirus disease 2019; SD: standard deviation; NA: not available.

\* $p \leq 0.05$ .

\*\* $p \leq 0.01$ .

\*\*\* $p \leq 0.001$ .

mental status and menstrual features of the students during the pandemic. This research revealed that the COVID-19 pandemic negatively impacted the menstrual function of medical students, resulting in prolonged heavy menstrual cycles, irregular menstrual cycles, intermenstrual spotting, and increased unpleasant menstrual symptoms during the COVID-19 outbreak in comparison to before. In addition, female medical students showed elevated levels of depression, anxiety, and stress after the appearance of COVID-19 in Jordan in comparison to the pre-pandemic period. Finally, positive correlations between mental health disorders, and

amenorrhea, heavy menses, and uncomfortable menstrual symptoms were identified. Furthermore, the multiple regression analysis revealed that there were associations between several menstrual characteristics such as amenorrhea and severity of bleeding with COVID-19-associated depression, anxiety and stress.

Our data showed that during the COVID-19 pandemic, menstrual cycle length, the number of heavy bleeding days, and the incidence of heavy bleeding were significantly increased. In addition, the prevalence of irregular menstrual cycle, intermenstrual bleeding, and unpleasant

**Table 4.** The relationships of the DASS-21 during COVID-19 with menstrual characteristics during the pandemic using Pearson correlation.

	Depression after COVID-19	Anxiety after COVID-19	Stress after COVID-19	DASS21 After COVID-19
Cycle length (days)	-0.039	-0.016	-0.041	-0.034
Bleeding days	0.034	0.002	0.018	0.019
Heavy bleeding	0.081	0.175**	0.110*	0.128*
Heavy bleeding days number	-0.002	0.035	-0.019	0.004
Pads per day	0.026	0.099	0.031	0.054
Pads per night	-0.095	-0.034	-0.060	-0.068
Bleeding amount				
Mild	0.076	0.051	0.058	0.066
Moderate	-0.130*	-0.195**	-0.143**	-0.165**
Heavy	-0.002	0.035	-0.019	0.004
Indicators for heavy menstrual bleeding				
Double protection	-0.099	-0.069	-0.079	-0.088
Night leak	0.023	0.078	0.047	0.052
Clots	-0.006	0.047	0.013	0.018
Anemia	-0.093	-0.046	-0.074	-0.076
Symptoms of menstruation after COVID-19				
Nausea and/or vomiting	0.071	0.123*	0.117*	0.110*
Constipation and/or diarrhea	-0.068	-0.044	-0.046	-0.056
Flatulence	-0.064	-0.006	-0.023	-0.034
Breast pain	-0.044	0.018	-0.005	-0.012
Fatigue	-0.079	-0.083	-0.076	-0.084
Appetite change	0.011	0.066	0.032	0.038
Headache	-0.002	0.022	-0.008	0.004
Urgency	0.093	0.130*	0.114*	0.119*
Mood swing	-0.032	-0.043	-0.001	-0.027
Anger	-0.016	0.003	0.008	-0.002
Acne	0.055	0.037	0.048	0.050
Irregular bleeding	-0.050	-0.037	-0.048	-0.048
Light or absent period	0.023	0.005	-0.005	0.008
Six-month absence	0.138**	0.125*	0.097	0.128*
Menstrual disorders treatment				
Unknown	-0.110*	-0.104*	-0.110*	-0.115*
Hormonal	0.024	0.021	0.020	0.023
Herbs	-0.124*	-0.088	-0.112*	-0.115*
Contraception	0.066	0.051	0.082	0.070
Surgery	0.057	0.035	0.042	0.048
Others	0.115	0.168**	0.128*	0.145**

COVID-19: coronavirus disease 2019; DASS: Depression, Anxiety, and Stress Scale 21 questionnaire.

\*, \*\* Correlation is significant at 0.05 and 0.01 level, respectively.

menstrual symptoms were significantly increased during the COVID-19 outbreak. Although some previous studies have shown the negative influence of stressful crises such as wars and earthquakes on menstruation,<sup>18,19</sup> the literature describing the impact of viral outbreaks on menstrual cycle function is very limited. To the best of our knowledge, no previous reports describing the impact of similar viral pandemics such as SARS and MERS on menstrual cycle were conducted. Furthermore, the effect of the COVID-19 outbreak on the menstrual cycle was mentioned briefly in some previous studies. For example, a

study has shown the significant increase in menstrual disorders during the first 6–12 months after COVID-19 appearance in Turkey.<sup>20</sup> Another study conducted in Jordan showed a reduction in menstrual abnormalities during the COVID-19 national lockdown but not after.<sup>21</sup> This research was carried out during the early phase of COVID-19 when there was low COVID-19-related morbidity and mortality. Compared to the current study, both studies investigated menstrual disorders in general without specifying the type of disorder in terms of menstrual cycle length, frequency, regularity, duration, amount of bleeding and menstrual

**Table 5.** The relationships of depression scores with menstrual characteristics of the study population after COVID-19 via multiple linear regression.

Menstrual characteristics	B	95% CI	SE	p values
Cycle length (days)	-0.015	-0.052-0.023	0.019	0.441
Bleeding days	0.147	-0.287-0.581	0.221	0.506
Heavy bleeding days number	-0.005	-0.294-0.283	0.147	0.972
Pads per day	0.067	-0.187-0.320	0.129	0.606
Pads per night	-0.772	-1.589-0.045	0.415	0.060
Bleeding amount				
Mild	1.451	-0.456-3.359	0.970	0.136
Moderate	-1.895	-3.341--0.448	0.736	0.010**
Heavy	1.310	-0.314-2.933	0.826	0.114
Indicators for heavy menstrual bleeding				
Double protection	-1.466	-2.948-0.015	0.754	0.050*
Night leak after	0.333	-1.137-1.803	0.748	0.656
Clots	-0.102	-1.882-1.678	0.905	0.910
Anemia	-1.530	-3.166-0.107	0.832	0.067
Symptoms of menstruation				
Nausea and/or vomiting	1.072	-0.434-2.579	0.766	0.162
Constipation and/or diarrhea	-1.285	-3.172-0.602	0.960	0.181
Flatulence	-1.730	-4.431-0.971	1.374	0.209
Breast pain	-7.7	-2.418-0.944	0.855	0.389
Fatigue	-3.761	-8.547-1.025	2.434	0.123
Appetite change	0.269	-2.223-2.760	1.267	0.832
Headache	-0.043	-1.814-1.729	0.901	0.962
Urgency	1.421	-0.115-2.958	0.781	0.070
Mood swing	-1.032	-4.299-2.235	1.662	0.535
Anger	-0.434	-3.182-2.315	1.398	0.757
Acne	1.315	-1.086-3.715	1.221	0.282
Irregular bleeding between period	-0.730	-2.207-0.748	0.751	0.332
Light or absent period	0.337	-1.156-1.829	0.759	0.658
Six-month absence	4.614	1.297-7.931	1.687	0.007**
Menstrual disorders treatment				
Unknown	-7.853	-14.963 - -0.743	3.616	0.030*
Hormonal	1.144	-3.655-5.944	2.441	0.640
Herbs	-2.039	-3.675 - -0.403	0.832	0.015*
Contraception	2.353	-1.332-6.402	1.967	0.198
Surgery	5.758	-4.315-15.832	5.124	0.262
Others	2.574	0.331-4.817	1.141	0.025*

CI: confidence interval; SE: standard error.

\* $p \leq 0.05$ .\*\* $p \leq 0.01$ .

symptoms. Moreover, recent studies reported that, following SARS-CoV-2 infection, women experienced lighter menstrual periods than usual and longer menstrual cycle length.<sup>22</sup> In addition, the effect of COVID-19 vaccinations on menstrual cycle characteristics was also evaluated. A recent report stated that large proportions of females encountered variable menstrual disturbances such as irregular cycles following COVID-19 vaccination. These menstrual disorders were observed more commonly after the second dose of the vaccine; however, most of these abnormalities resolved spontaneously and shortly after the second dose.<sup>23</sup>

The mental health of different populations during similar viral outbreaks such as SARS was previously assessed.<sup>24,25</sup> However, these studies employed different instruments from DASS-21 for the evaluation of mental health. These studies showed high levels of perceived stress during the SARS outbreak. In addition, a few studies characterized the mental status of students during the pandemic of COVID-19. For example, a report describing the mental status of Indian first-year medical students demonstrated that 10.80%, 17.20%, and 15.60% of students reported mild to severe depression, mild to extremely severe anxiety, and mild to moderate stress, respectively.<sup>26</sup>

**Table 6.** The relationships of anxiety scores with menstrual characteristics of the study population after COVID-19 via multiple linear regression.

Menstrual characteristics	B	95% CI	SE	p values
Cycle length (days)	-0.005	-0.040-0.029	0.017	0.759
Bleeding days	0.008	-0.393-0.409	0.204	0.970
Heavy bleeding days number	0.091	-0.175-0.358	0.135	0.499
Pads per day	0.230	-0.003-0.463	0.119	0.050*
Pads per night	-0.256	-1.013-0.501	0.385	0.507
Bleeding amount				
Mild	0.897	-0.867-2.661	0.897	0.318
Moderate	-2.619	-3.940- -1.298	0.672	> 0.001***
Heavy	25.613	1.132-4.094	0.753	> 0.001***
Indicators for heavy menstrual bleeding				
Double protection	-0.943	-2.315-0.428	0.698	0.177
Night leak	1.050	-0.304-2.404	0.688	0.128
Clots	0.767	-0.874-2.408	0.835	0.359
Anemia	-0.696	-2.212-0.820	0.771	0.368
Symptoms of menstruation				
Nausea and/or vomiting	1.706	0.322-3.090	0.704	0.016*
Consumption and/or diarrhea	-0.762	-2.506-0.983	0.887	0.319
Flatulence	-0.145	-2.643-2.353	1.271	0.909
Breast pain	0.277	-1.277-1.830	0.790	0.726
Fatigue	-3.652	-8.070-0.765	2.247	0.105
Appetite change	1.519	-0.776-3.815	1.167	0.194
Headache	0.54	-1.282-1.989	0.832	0.671
Urgency	1.837	0.424-3.249	0.718	0.011*
Mood swing	-1.301	-4.316-1.714	1.533	0.397
Anger	0.083	-2.455-2.620	1.291	0.949
Acne	0.824	-13.94-3.042	1.128	0.466
Irregular bleeding between period	-0.505	-1.870-0.860	0.694	0.467
Light or absent period	0.070	-1.308-1.448	0.701	0.924
Six-month absence	3.845	0.77-6.912	1.560	0.014*
Menstrual disorders treatment				
Unknown	-6.837	-13.406--0.268	3.341	0.040*
Hormonal	0.922	-3.509-5.353	2.254	0.683
Herbs	-1.334	-2.850-0.182	0.771	0.085
Contraception	1.799	-1.774-5.372-	1.817	0.323
Surgery	3.251	6.060-12.561	4.735	0.493
Others	3.486	1.431-5.540	1.045	0 > .001***

CI: confidence interval; SE: standard error.

\* $p \leq 0.05$ .\*\*\* $p \leq 0.001$ .

Furthermore, two previous studies conducted during the COVID-19 outbreak among Bangladeshi students showed that 52.2%, 58.1%, and 24.9% of participants experienced moderate to severe levels of depression, anxiety, and stress, respectively.<sup>9</sup> While 62.9%, 63.6%, and 58.6% of study population reported moderate to extremely severe depression, anxiety, and stress, respectively, in another report.<sup>10</sup> Similarly, the current data showed that 53.5% of Jordanian female students experienced mild to severe depression, and 53.2% of females reported mild to extremely severe anxiety but there was a lower incidence (35.8%) of mild to moderate stress in comparison to the

other studies. Although some studies assessed the frequency of COVID-19-mediated depression, anxiety, and stress via DASS-21,<sup>4</sup> none of these have provided a baseline for the mental health of participants before the pandemic of COVID-19 for comparison. Therefore, these studies suggest that the COVID-19 outbreak is the major cause of these mental issues without providing a control for thorough assessment. By contrast, the current study compared the prevalence of mental health disorders during the COVID-19 pandemic with 10 months prior to the pandemic, showing a significant increase in depression, anxiety, and stress disorders during the outbreak.



**Table 7.** The relationships of stress scores with menstrual characteristics of the study population after COVID-19 via multiple linear regression.

Menstrual characteristics	B	95% CI	SE	p values
Cycle length (days)	-0.014	-0.049–0.021	0.018	0.42
Bleeding days	0.071	-0.338–0.481	0.208	0.732
Heavy bleeding days number	-0.053	-0.324–0.219	-0.019	0.704
Pads per day	0.073	-0.166–0.312	0.122	0.55
Pads per night	-0.466	-1.238–0.306	-0.060	0.236
Bleeding amount				
Mild	1.049	-0.752–2.850	0.916	0.05*
Moderate	-1.961	-3.322 – -0.600	0.692	0.005**
Heavy	1.683	0.157–3.210	0.776	0.110
Indicators for heavy menstrual bleeding				
Double protection	-1.099	-2.499–0.301	0.712	0.124
Night leak after	0.653	-0.732–2.038	0.704	0.355
Clots	0.217	-1.461–1.895	0.853	0.800
Anemia	-1.144	-2.689–0.402	0.786	0.146
Symptoms of menstruation				
Nausea and/or vomiting	1.663	0.249–3.077	0.719	0.021*
Consumption and/or diarrhea	-0.811	-2.592–970	0.906	0.371
Flatulence	-0.579	-3.130–1.972	1.297	0.656
Breast pain	-0.087	-1.0673–1.500	0.807	0.914
Fatigue	-3.402	-7.916–1.111	2.296	0.139
Appetite change	0.747	-1.601–3.095	1.194	0.532
Headache	-0.133	-1.803–1.538	0.850	0.876
Urgency	1.656	0.211–3.101	0.735	0.025*
Mood swing	-0.036	-3.117–3.046	1.567	0.982
Anger	0.202	-2.389–2.793	1.318	0.878
Acne	1.087	-1.177–3.351	1.151	0.346
Irregular bleeding between period	-0.667	-2.060–.726	0.708	0.347
Light or absent period	-0.69	-1.476–1.339	0.716	0.924
Six-month absence	3.058	-0.084–6.201	1.598	0.05*
Menstrual disorders treatment				
Unknown	-7.393	-14.09–-0.689	3.410	0.031*
Hormonal	0.899	-3.626–5.425	2.302	0.696
Herbs	-1.734	-3.279–-0.189	0.786	0.028*
Contraception	2.970	-0.671–6.612	1.852	0.110
Surgery	3.954	-5.551–13.460	4.834	0.414
Others	2.706	0.594–4.817	1.074	0.012*

CI: confidence interval; SE: standard error.

\* $p \leq 0.05$ .\*\* $p \leq 0.01$ .

Many causes of depression, anxiety, and stress have been identified previously, with some being applicable to university students such as financial problems, sleeping disorders, extended screen time, loneliness, academic stress, and disturbances in mental health services during the COVID-19 crisis.<sup>10,27</sup> The main potential mechanism involved in mental health changes during the pandemic is high cortisol levels.<sup>28</sup> In addition, an immune-mediated cytokine storm among COVID-19 survivors might have resulted in mental health disorders.<sup>29</sup> However, it is difficult to conclude that immune-mediated change in mental health was an inevitable factor in this study, and this

hypothesis necessitates further investigation for confirmation. It is worth mentioning that it is difficult to predict how long COVID-19-related mental problems would continue in the future. Historically, the negative impact of similar viral outbreaks such as Ebola<sup>30</sup> and SARS<sup>31</sup> on mental health unfortunately lasted long after the outbreaks had resolved. This urgently calls for the establishment of variable centers offering the appropriate medical services to mitigate the long-term adverse impacts of COVID-19 on mental status.

Mental illnesses and menstrual aberrations are closely interrelated. Establishing the relationship between mental

disorders and menstrual abnormalities is vital for the evaluation of female reproductive function and introduction of appropriate health interventions. Many studies describe the association between mental distress and menstrual dysfunction. One study indicated that high-stress levels were linked with acyclic menstrual bleeding but not with variations in menstrual cycle length or changes in the amount of blood loss.<sup>32</sup> High-stress levels were also linked with decreased menstrual cycle length but not with absent menstrual cycles or long bleeding days,<sup>33</sup> and irregular and longer menstrual bleeding.<sup>34</sup> However, another study reported that there is no link between major depressive disorders and irregular, shortened or prolonged cycles while a relationship between anxiety disorders and irregular, shortened or prolonged cycles was identified.<sup>35</sup> The literature about association between COVID-19-associated depression, anxiety, and stress and menstrual patterns is limited, and we showed in this study a correlation between depression, anxiety, and stress with amenorrhea, heavy cycles, and menstrual characteristics during COVID-19.

Finally, it is worth mentioning that the current study has some limitations. With a self-administered survey, there is the potential for misunderstanding some survey questions and respondents may interpret the question in different ways, which may affect their response. Furthermore, this research was limited to women from medical schools, and future studies are recommended to employ women from the general population for better generalizability of the study results. In addition, there might be recall bias by the participants, which is related to their responses to the pre-pandemic questions of the survey. Finally, the current study employed only unmarried women; however, the single students were employed only for the reason that population of the undergraduate students in Jordan is almost single, where their age ranges between 18 and 24 years. The Jordanian society has witnessed recent changes and developments, socially and culturally, where pursuing university studies becomes a priority over getting married. For example, Al-Jefout et al.,<sup>36</sup> who conducted a study on dysmenorrhea prevalence among Jordanian medical students, have indicated that out of the 379 participants, only 1 student was married.<sup>36</sup> In addition, different studies in the past reported that married females show lower levels of psychological distress than unmarried ones.<sup>37-40</sup> As a result, in this research, we focused on more stress vulnerable population to identify the impact of COVID-19-related psychological distress on reproductive health of future doctors and -perhaps- mothers.

## Conclusion

This cross-sectional survey-based study evaluated in depth the impact of the COVID-19 pandemic-related mental health status on variable characteristics of the menstrual cycle. Our study is the first to investigate and compare the prevalence of menstrual and mental health disorders

during the COVID-19 pandemic with before the pandemic, showing changes in menstrual characteristics and increased depression, anxiety, and stress levels during the outbreak. Menstruation represents an important aspect of a woman's reproductive function throughout her life, which can be affected by stressful events, and abnormalities in the menstrual cycle can adversely affect the quality of women's life. Therefore, the evaluation of the pandemic-related stress impact on such critical reproductive function can highlight the importance of employing stress intervention measures (such as coping mechanisms) to alleviate the negative impact of COVID-19 pandemic-related stress on menstruation and women's mental health. This, in consequence, will help to improve the quality of women's life.

## Declarations

### *Ethics approval and consent to participate*

The study was approved by the Institutional Review Board of the Hashemite University (11/6/8/2020/2021). An electronic informed consent for participation in the study was obtained from all subjects involved in the study.

### *Consent for publication*

An electronic informed consent for publication of data was obtained from all subjects involved in the study.

### *Author contribution(s)*

**Iman Aolymat:** Conceptualization; Data curation; Formal analysis; Investigation; Methodology; Project administration; Resources; Software; Supervision; Validation; Visualization; Writing—original draft; Writing—review & editing.

**Mohammad Al-Tamimi:** Data curation; Formal analysis; Investigation; Methodology; Software; Validation; Visualization; Writing—original draft; Writing—review & editing.

**Hafez Almomani:** Formal analysis; Writing—original draft; Writing—review & editing.

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**Ebaa M Alzayadneh:** Formal analysis; Software; Writing—original draft; Writing—review & editing.

**Naser Al-Husban:** Formal analysis; Writing—review & editing.

**Sameer Al Haj Mahmoud:** Formal analysis; Writing—review & editing.

**Ayman Alsheikh:** Formal analysis; Writing—review & editing.

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### Availability of data and materials

The data presented in this study are available in this article.

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### Supplemental material

Supplemental material for this article is available online.

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