ORIGINAL RESEARCH ARTICLE

The association of the severity of Omicron with menstrual and premenstrual syndrome among reproductive age women in China: a cross-sectional study

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Abstract

This study aimed to investigate changes in menstruation and the association of the severity of Omicron with menstruation after the nationwide outbreak of COVID-19 in China. A cross-sectional study adopted an electronic questionnaire to conduct an anonymous online survey. The survey targeted women of reproductive age who had been infected with SARS-CoV-2, and were menstruating regularly in the six months prior to the infection, and experienced at least one menstrual cycle after the infection. The 737 included participants were divided into mild and severe groups based on the severity of the infection. Deviations in first menstrual cycle post-infection were reported in 46.4% of participants (mild group 40.1% vs. severe group 55.2%, P<0.05). Menstrual changes were predominantly a late menstrual period (mild group 25.3% vs. severe group 30.4%), a shorter duration of menstrual flow (mild group 10.4% vs. severe group 14.7%), and a decrease in menstrual flow volume (mild group 16% vs. severe group 21.6%). Premenstrual syndrome symptoms in a small number of women were worse compared with pre-infection, especially in the severe group. During the second menstrual period after infection, most participants reported their menstrual characteristics had returned to those of pre-infection (mild group 88% vs. severe group 80.2%, P<0.05). In this investigation, SARS-CoV-2 infection had a substantial effect on women's menstrual characteristics, and the changes were mostly transient. Women with more severe COVID-19 symptoms experienced more significant changes. The potential long-term effects of SARS-CoV-2 on female reproductive health require further observation and research. *(Afr J Reprod Health 2024; 28 [6]: 55-65).*

Keywords: Omicron, COVID-19, SARS-CoV-2, reproductive health

Résumé

Cette étude visait à étudier les changements dans la menstruation et l'association entre la gravité d'Omicron et la menstruation après l'épidémie nationale de COVID-19 en Chine. Une étude transversale a adopté un questionnaire électronique pour mener une enquête anonyme en ligne. L'enquête visait les femmes en âge de procréer qui avaient été infectées par le SRAS-CoV-2, qui avaient leurs règles régulièrement au cours des six mois précédant l'infection et qui ont connu au moins un cycle menstruel après l'infection. Les 737 participants inclus ont été divisés en groupes légers et sévères en fonction de la gravité de l'infection. Des écarts dans le premier cycle menstruel post-infection ont été signalés chez 46,4 % des participantes (groupe léger 40,1 % contre groupe sévère 55,2 %, P <0,05). Les changements menstruels étaient principalement une période menstruelle tardive (groupe léger 25,3 % contre groupe sévère 30,4 %), une durée plus courte du flux menstruel (groupe léger 10,4 % contre groupe sévère 14,7 %) et une diminution du volume du flux menstruel (groupe léger). 16 % contre groupe sévère 21,6 %). Les symptômes du syndrome prémenstruel chez un petit nombre de femmes étaient pires que ceux observés avant l'infection, en particulier dans le groupe sévère. Au cours de la deuxième période menstruelle après l'infection, la plupart des participantes ont déclaré que leurs caractéristiques menstruelles étaient revenues à celles d'avant l'infection (groupe léger 88 % contre groupe sévère 80,2 %, P <0,05). Dans cette enquête, l'infection par le SRAS-CoV-2 a eu un effet substantiel sur les caractéristiques menstruelles des femmes, et les changements ont été pour la plupart transitoires. Les femmes présentant des symptômes plus graves de la COVID-19 ont connu des changements plus importants. Les effets potentiels à long terme du SRAS-CoV-2 sur la santé reproductive des femmes nécessitent des observations et des recherches plus approfondies. *(Afr J Reprod Health 2024; 28 [6]: 55-65).*

Mots-clés: Omicron, COVID-19, SARS-CoV-2, santé reproductive

Introduction

Coronavirus disease 2019 (COVID-19) is a highly contagious infectious disease caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2)[1]. COVID-19 causes symptoms that range from mild respiratory illnesses to severe complications[2]. As to 7 January 2024, there have been more than 774 million confirmed cases of COVID-19 and over 7 million deaths globally, as reported by the World Health Organization [3]. The nationwide outbreak of Omicron in China occurred at the end of 2022, and the Omicron variant seems to cause less severe acute illnesses than Alpha and Delta[4-7].

Menstruation can reflect a woman's overall health. The monthly cycle is regulated by the hypothalamic-pituitary-ovarian axis and is a complicated hormonal process [8]. The menstrual cycle is sensitive to external factors, such as lifestyle, external stress, and medication use [9,10].

Previous studies have shown that menstrual changes can occur among women of reproductive age following infection with SARS-CoV-2[11-13], but the conclusions of such studies are short of unanimous. A systematic review found that COVID-19 can cause changes in menstrual volume and menstrual cycle, and that menstrual cycle changes were unrelated to the severity of COVID-19 [14]. However, a prospective study showed that SARS-CoV-2 infection was not associated with changes in menstrual cycle characteristics[15].

Our study investigated the impact of SARS-CoV-2 infection on menstruation and the association of the severity of COVID-19 with menstruation during the nationwide spread of coronavirus in China.

Methods

Study design and survey instrument

This was a cross-sectional study. The electronic questionnaire was designed by our research team after multiple rounds of discussion and a pilot survey. The questionnaire was written and distributed in Chinese, since Chinese is the mother tongue of the recruited women (English translation can be viewed in Table S1). The content of the questionnaire covered six sections: sociodemographic characteristics of participants, medical history and usage of medications and contraceptive devices, menstrual cycle information before infection, clinical characteristics of SARS-COV-2 infection, information about first menstruation post-infection compared with pre-infection, and general health during recovery from COVID-19. COVID-19 symptoms were classified into five levels: insignificant, slight, relatively severe, severe (requiring hospitalization), and very severe (requiring intensive care unit admission).

The electronic questionnaire was uploaded to Wenjuanxing (www.wjx.cn), which is one of the most popular online survey platforms in China. The study was approved by the ethics committee of Wenzhou Traditional Chinese Medicine Hospital (approval no. WZY2023-KT-007-001). Our findings are reported based on the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) checklist for cross-sectional studies (Table S2).

Participants and inclusion/exclusion criteria

Inclusion criteria were women 18 to 49 years old, infection with SARS-CoV-2, had at least one menstrual period after the infection, and had normal menstrual periods during the six months prior to infection.

Exclusion criteria were pregnancy or breastfeeding, polycystic ovarian syndrome, use of emergency contraceptives, progesterone, short- or long-acting contraceptives in the past six months, medicated intrauterine contraception (IUC), hyperthyroidism, hypothyroidism, hyperprolactinemia, hyperandrogenism, coagulopathy, or malignant tumor.

The survey was conducted from February 10, 2023 to March 15, 2023. Participants were recruited through hospital posters and the social media messaging app WeChat. Participation was voluntary and anonymous.

Data analysis

Data were summarized in an Excel spreadsheet. Statistical analysis was conducted with SPSS v.21 (IBM, Armonk, NY, USA). Descriptive analyses were presented as mean ± SD for continuous normal variables and median (interquartile range, IQR) for non-normal variables, and number (percentage) for categorical data. In two-group comparisons of

continuous data, the t-test was used for normal distribution, and non-parametric test was used for non-normal distribution. The chi-square test was used to describe the statistical differences between two groups of categorical data. *P*-values<0.05 were considered statistically significant.

Results

A total of 945 respondents completed the questionnaire. Based on the exclusion criteria, 208 respondents were eliminated. Finally, 737 respondents were included for analysis (Figure 1). At least 1233 menstrual cycles were reported by the included participants.

Grouping of respondents

The self-reported five levels of severity of COVID-19 symptoms were: insignificant (n = 48), slight (n = 383), relatively severe (n = 305), and severe requiring hospitalization (n = 1). To facilitate data analysis, respondents were divided into two groups based on the aforementioned symptom severity categories. Participants with insignificant and slight symptoms were classified as the mild group. Participants with relatively severe, severe, and very severe symptoms were classified as the severe group.

Sociodemographic, clinical and menstrual cycle information

Sociodemographic, clinical and menstrual characteristics of the participants were compiled (Table 1). Participants were mainly from Zhejiang Province, China. There were no significant differences between the mild and severe groups in terms of age, occupation, body mass index (BMI), number of COVID-19 vaccinations, age at menarche, menstrual cycle, and menstrual period in the 6 months before infection. However, there were significant differences in menstrual volume and dysmenorrhea symptoms between the two groups. Women with heavy menstrual flow volume in the severe group numbered more than those in the mild group (*P*=0.018), and dysmenorrhea scores were higher in the severe group (*P*<0.001).

Clinical characteristics of SARS-CoV-2 infection

Most participants were diagnosed with antigen detection (Table 2). All participants were infected with SARS-CoV-2 only once, except for three participants, who were infected twice.

There were no significant differences in the quantity of vaccine between the two groups.

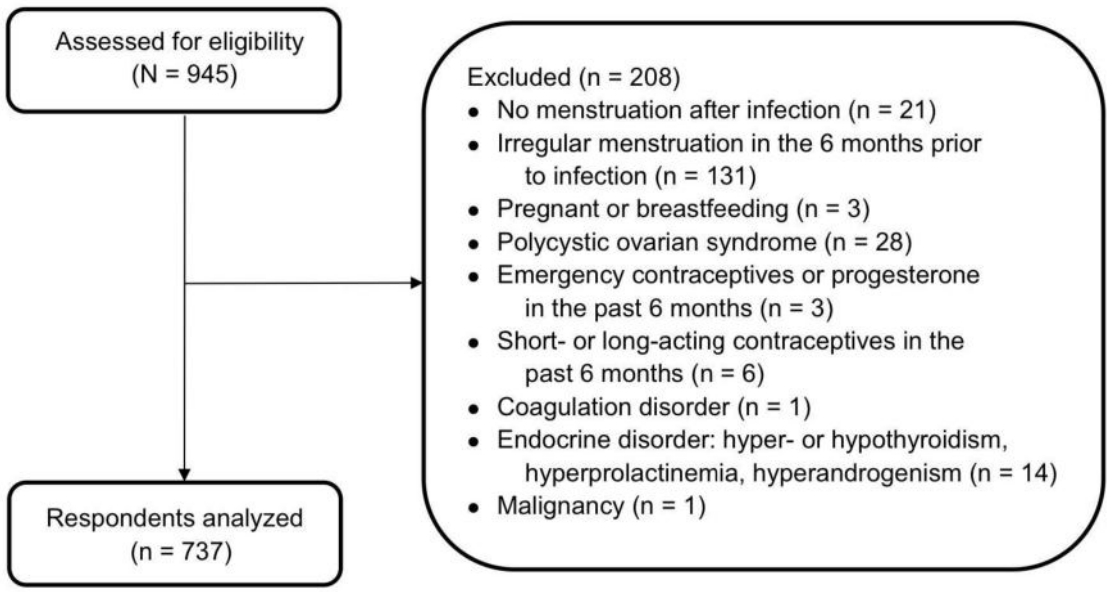

Figure 1: Flowchart of study

Table 1: Sociodemographic and clinical and menstrual characteristics of participant

	All participants (n=737)	Mild (n=431)	Severe (n=306)	*P*-value
Age (y), median (Q1,Q3)	20(19,22)	20(19,22)	20(19,22)	0.399
Province of residence, n(%)				<0.001
Zhejiang	643(87.2)	392(91.0)	251(82.0)	
Other	94(12.8)	39(9.0)	55(18.0)	
Occupation, n(%)				0.108
Student	643(87.2)	373(86.5)	270(88.2)	
Public official	34(4.6)	18(4.2)	16(5.2)	
Company employee	25(3.4)	17(3.9)	8(2.6)	
Other	35(4.8)	23(5.3)	12(3.9)	
BMI, median (Q1,Q3)	19.9(18.5,21.5)	19.9(18.4,21.5)	20.0(18.5,21.5)	0.472
Age at menarche(y), median (Q1,Q3)	13(12,14)	13(12,14)	13(12,14)	0.857
Number of COVID-19 vaccinations, median (Q1,Q3)	3(2,3)	3(2,3)	3(2,3)	0.537
Menstruation characteristics during the 6 months before infection				
Menstrual cycle, n(%)				0.770
Less than 21 days	20(2.7)	10(2.3)	10(3.3)	
21-27 days	312(42.3)	185(42.9)	127(41.5)	
28-35 days	389(52.8)	228(52.9)	161(52.6)	
More than 35days	16(2.2)	8(1.9)	8(2.6)	
Menstrual period, n(%)				0.528
Less than 3 days	21(2.8)	14(3.2)	7(2.3)	
3-7 days	652(88.5)	383(88.9)	269(87.9)	
More than 7 days	64(8.7)	34(7.9)	30(9.8)	
Menstrual blood volume, n(%)				0.018
Light	68(9.2)	39(9.0)	29(9.5)	
Medium	580(78.7)	352(81.7)	228(74.5)	
Heavy	89(12.1)	40(9.3)	49(16.0)	
Dysmenorrhea score, median (Q1,Q3)	50(10,70)	40(5,60)	50(20,77.3)	<0.001

However, there was a decreasing trend in the proportion of severe cases as the number of vaccines increased.

Among the various symptoms of COVID-19, the 10 most common symptoms were fever, fatigue, sore throat, body aches, headache, stuffy nose, dizziness, dry cough, runny nose, and productive cough. The frequency of clinical symptoms in the severe group was higher than in the mild group, except for conjunctivitis.

In 38.7% of the participants emotional changes due to COVID-19 were reported and included anxiety, fear, depression, among other mood changes. Anxiety was the most common emotional state (13.2% in the mild group vs. 38.9% in the severe group). The severe group had a higher incidence of mood changes compared with the mild group.

Menstrual characteristics during and post-infection

Slightly more than one third of the participants (34.1%) were infected with SARS-CoV-2 during menstruation (Table 3). There was no significant difference between the two groups, indicating that menstruating while infected had no significant relationship to the severity of COVID-19.

Slightly more than two thirds of participants (67.3%) experienced more than one menstrual period during or post-infection, and there was no statistical difference between the two groups. During the second menstrual period, 84.7% of

Table 2: Clinical characteristics of SARS-CoV-2 infection

	All participants (n=737)	Mild group (n=431)	Severe group (n=306)	*P*-value
Diagnosis of SARS-CoV-2 infection, n(%)				0.013
Antigen positive	601(81.5)	361(83.8)	240(78.4)	
Nucleic acid positive	93(12.6)	54(12.5)	39(12.7)	
Antigen and nucleic acid positive	43(5.8)	16(3.7)	27(8.8)	
Times infected, n(%)				1.000
Once	734(99.6)	429(99.5)	305(99.7)	
Twice	3(0.4)	2(0.5)	1(0.3)	
No.of vaccines	n(%)	n(%)	n(%)	0.313
0	12(100)	5(41.7)	7(58.3)	
1	8(100)	3(37.5)	5(62.5)	
2	219(100)	130(59.4)	89(40.6)	
3	488(100)	285(58.4)	203(41.6)	
4	10(100)	8(80.0)	2(20.0)	
Symptoms (top 10), n(%)				
Fever	600(81.4)	310(71.9)	290(94.8)	<0.001
Fatigue	489(66.4)	227(52.7)	262(85.6)	<0.001
Sore throat	440(59.7)	225(52.2)	215(70.3)	<0.001
Body aches	400(54.3)	169(39.2)	231(75.5)	<0.001
Headache	359(48.7)	149(34.6)	210(68.6)	<0.001
Stuffy nose	346(46.9)	163(37.8)	183(59.8)	<0.001
Dizziness	341(46.3)	146(33.9)	195(63.7)	<0.001
Dry cough	332(45.0)	155(36.0)	177(57.8)	<0.001
Runny nose	306(41.5)	141(32.7)	165(53.9)	<0.001
Productive cough	278(37.7)	124(28.8)	154(50.3)	<0.001
Emotional changes, n(%)				
Anxiety	176(23.9)	57(13.2)	119(38.9)	<0.001
Fear	71(9.6)	23(5.3)	48(15.7)	<0.001
Depression	53(7.2)	18(4.2)	35(11.4)	<0.001
Other emotions	103(14)	42(9.7)	62(20.3)	<0.001
No mood changes	452(61.3)	324(75.2)	128(41.8)	<0.001

Table3: Menstrual characteristics during and post COVID-19 infection

	All participants	Mild group	Severe group	*P*-value
Infection during menstruation, n(%)	n=737	n=431	n=306	0.123
No	486(65.9)	294(68.2)	192(62.7)	
Yes	251(34.1)	137(31.8)	114(37.3)	
Number of menstrual periods during and/or post-infection, n(%)	N =737	n=431	n=306	0.340
One	241(32.7)	147(34.1)	94(30.7)	
Two or more	496(67.3)	284(65.9)	212(69.3)	
During the second period, menstrual characteristics returned to those of pre-infection, n(%)	n=496	n=284	n=212	0.016
Yes	420(84.7)	250(88)	170(80.2)	
No	76(15.3)	34(12)	42(19.8)	

Table 4: Characteristics of first menstrual period post-infection vs. pre-infection

	All participants (n=737)	Mild group (n=431)	Severe group (n=306)	*P*-value
Menstrual cycle length, n(%)				<0.001
Unchanged	395(53.6)	258(59.9)	137(44.8)	
Shortened	125(17)	53(12.3)	72(23.5)	
Lengthened	202(27.4)	109(25.3)	93(30.4)	
Lengthened by more than a month	15(2)	11(2.6)	4(1.3)	
Menstrual flow duration, n(%)				0.004
Unchanged	567(76.9)	350(81.2)	217(70.9)	
Shortened	90(12.2)	45(10.4)	45(14.7)	
Prolonged	70(9.5)	29(6.7)	41(13.4)	
Prolonged bleeding	10(1.4)	7(1.6)	3(1)	
Flow volume, n(%)				0.05
Unchanged	527(71.5)	323(74.9)	204(66.7)	
Increased	75(10.2)	39(9)	36(11.8)	
Decreased	135(18.3)	69(16)	66(21.6)	
Dysmenorrhea, n(%)				0.012
Unchanged	541(73.4)	334(77.5)	207(67.6)	
Worse	163(22.1)	80(18.6)	83(27.1)	
Better	33(4.5)	17(3.9)	16(5.2)	
Fatigue, n(%)				<0.001
Unchanged	548(74.4)	359(83.3)	189(61.8)	
Worse	171(23.2)	66(15.3)	105(34.3)	
Better	18(2.4)	6(1.4)	12(3.9)	
Headache, n(%)				0.006
Unchanged	662(89.8)	400(92.8)	262(85.6)	
Worse	59(8)	25(5.8)	34(11.1)	
Better	16(2.2)	6(1.4)	10(3.3)	
Abdominal distension, n(%)				<0.001
Unchanged	590(80.1)	371(86.1)	219(71.6)	
Worse	134(18.2)	53(12.3)	81(26.5)	
Better	13(1.8)	7(1.6)	6(2)	
Premenstrual breast tenderness, n(%)				<0.001
Unchanged	598(81.1)	373(86.5)	225(73.5)	
Worse	119(16.1)	45(10.4)	74(24.2)	
Better	20(2.7)	13(3)	7(2.3)	
Premenstrual irritability, n(%)				0.024
Unchanged	619(84)	375(87)	244(79.7)	
Worse	106(14.4)	51(11.8)	55(18)	
Better	12(1.6)	5(1.2)	7(2.3)	
Premenstrual sadness and anxiety, n(%)				0.001
Unchanged	633(85.9)	386(89.6)	247(80.7)	
Worse	95(12.9)	39(9)	56(18.3)	
Better	9(1.2)	6(1.4)	3(1)	
Sleep quality during menstruation, n(%)				0.001
Unchanged	615(83.4)	377(87.5)	238(77.8)	
Worse	111(15.1)	48(11.1)	63(20.6)	
Better	11(1.5)	6(1.4)	5(1.6)	

Table 5: Health characteristics during recovery from COVID-19

	All participants (n=737)	Mild group (n=431)	Severe group (n=306)	*P*-value
Weight, n(%)				<0.001
No significant change	480(65.1)	311(72.2)	169(55.2)	
Weight increase	93(12.6)	39(9)	54(17.6)	
Weight loss	164(22.3)	81(18.8)	83(27.1)	
Physical energy, n(%)				<0.001
No significant change	326(44.2)	224(52)	102(33.3)	
Reduced energy	404(54.8)	203(47.1)	201(65.7)	
Improved enrgy	7(0.9)	4(0.9)	3(1)	
Sleep quality, n(%)				<0.001
No significant change	474(64.3)	306(71)	168(54.9)	
Worse	235(31.9)	110(25.5)	125(40.8)	
Better	28(3.8)	15(3.5)	13(4.2)	
Appetite, n(%)				<0.001
No significant change	543(73.7)	340(78.9)	203(66.3)	
Loss of appetite	135(18.3)	60(13.9)	75(24.5)	
Improved appetite	59(8)	31(7.2)	28(9.2)	

women's menstrual characteristics had returned to those of pre-infection, and the proportion of the severe group was less than the mild group (*P*=0.016).

Characteristics of first menstrual period post-infection

In terms of characteristics of the first menstrual period post-infection compared with pre-infection, the differences between the two groups were significant apart from menstrual volume (Table 4).

Menstrual cycle length in 46.4% of participants were altered, with the severe group experiencing deviations more than the mild group (mild group 40.1% vs. severe group 55.2%). There were more women whose periods came late than women whose periods came early (27.4% vs. 17%). In some women, their periods were late by over one month (2%). In 23.1% of participants, duration of menstrual flow was changed. There were more women whose flows were shortened than those whose flows were prolonged (12.2% vs. 9.5%). In terms of blood flow amount, 28.5% of participants noted a change in volume. More women had a decreased volume than those who experienced an increased volume (18.3% vs. 10.2%). A small number of participants had worse premenstrual syndrome (PMS) symptoms than prior to COVID-19, such as dysmenorrhea, fatigue, headache, abdominal distension, breast tenderness, irritability, sadness and anxiety, and insomnia. These changes were reported more often in the severe group than in the mild group (Table 4).

General health during COVID-19 recovery

Health characteristics during COVID-19 recovery were recorded (Table 5). Compared with pre-infection, there were significant differences in weight, physical energy, sleep, and diet between the two groups. Weight loss was experienced in 22.3% of all participants. More women in the severe group had weight loss than in the mild group (27.1% vs. 18.8%). Decreased physical energy occurred in 54.8% of all participants, with more women in the severe group experiencing reduced energy than in the mild group (65.7% vs. 47.1%). Sleep disturbance occurred in 31.9% of all participants. Women in the severe group were more affected than in the mild group (40.8% vs. 25.5%). The health characteristic that was least affected in the respondents was appetite. Women who had no change in appetite outnumbered those whose appetites were affected (73.7% vs. 26.3%).

Discussion

Nearly half of the participants experienced deviations during their first menstrual cycle after Omicron infection. Menstrual changes were primarily a lengthened menstrual cycle (period came late), fewer days of menstrual flow, and a decrease in menstrual flow volume. PMS symptoms

in a small number of women were worse compared with pre-infection, especially in the severe group. By the second menstrual period post-infection, the menstrual characteristics of the majority of women had recovered to those of pre-infection, but the recovery rate was lower in the severe group compared with the mild group. General health during recovery from Omicron was mainly characterized by reduced physical energy, sleep disturbance, and weight loss, with the severe group experiencing more pronounced symptoms compared with the mild group.

The mechanism of menstrual disorders from acute viral infections may involve immune system dysfunction and ovarian inflammation[16,17]. The menstrual cycle in women is regulated by hormones secreted by the hypothalamus, pituitary, and ovaries. Immune cells also participate in the regulation of the endocrine and ovarian microenvironment[18-20]. Furthermore, psychosocial stress may be associated with menstrual irregularities[21,22]. Approximately 40% of women experienced psychosocial stress such as anxiety and depression due to COVID-19. A study showed that depression and anxiety disorders are associated with dysfunction of the hypothalami-pituitary-adrenal axis, which can inhibit the surge of luteinizing hormone and impair ovarian function[23], and lead to menstrual changes. Other external factors such as infections and medications can induce menstrual disorders in women, and even conditions such as amenorrhea and abnormal uterine bleeding[16,24]. COVID-19 can cause hypopituitarism, which leads to functional pituitary deficiency through direct and indirect effects on the hypothalamic-pituitary-ovarian axis, ultimately resulting in an inappropriate adrenal stress response[25]. After SARS-CoV-2 infection, the body is in a stringent state, and reproductive organ functions are temporarily inhibited to ensure the normal activities of essential organs. Thus, this study observed that COVID-19 resulted in menstrual patterns characterized by lengthened menstrual cycles, fewer days of menstrual flow, and decreased menstrual flow volume. Additionally, general health conditions such as decreased physical energy, insomnia, and weight loss were observed. Therefore, changes in menstrual characteristics may be correlated with those of general health. Menstruation is not only a reflection of reproductive health, but also serves as a significant indicator of overall health.

Our results indicate that the menstrual changes caused by COVID-19 were transient. However, the mechanisms causing such deviations deserve further investigation. Hoffman et al. showed that SARS-CoV-2 needs to bind to angiotensin converting enzyme-2 (ACE2) receptor to enter host cells[26]. High levels of ACE2 are expressed in the ovaries, uterus, vagina, and placenta[27-29]. Angiotensin II (AngII), ACE2, and angiotensin-(1-7) (Ang-(1-7)) regulate the development and ovulation of follicles, thereby regulating the angiogenesis and degeneration of the corpus luteum, and ultimately affecting normal endometrial tissue changes and embryo development[30]. AngII affects the contraction of endometrial spiral arteries, while the dynamic balance between AngII and Ang-(1-7) regulates the regeneration of the endometrium and function of the uterine smooth muscle layer[31]. Additionally, Ang-(1-7) is localized in the endometrium throughout the menstrual cycle, mainly concentrated in the secretory and late phases of the glandular epithelium[28]. However, due to the cyclical shedding and renewal of the endometrium, the impact of viral infection on the endometrium and ovaries after infection is transient in nature.

Results showed that the vaccine had a protective trend in the severe cases, but there were no significant differences in two groups, which might relate to the small number of unvaccinated cases included in this study and the long time interval between the last vaccine dose and infection, resulting in a weakened protection.

Results from our study are consistent with two Chinese investigations, which showed that menstrual changes after being infected with SARS-CoV-2 are mainly characterized by a lengthened menstrual cycle and reduced menstrual volume [12,32]. In our study, changes in menstrual characteristics in the severe group were more significant compared with the mild group. Furthermore, there were fewer women in the severe group whose menstrual characteristics returned to those of pre-infection compared with the mild group. Our results on PMS symptoms concur with findings in other studies in that symptoms were worse post-infection compared with pre-infection[33,34]. There were inconsistent findings on the details of menstrual changes. One study indicated that menstrual changes were characterized by prolonged menstrual cycles, prolonged menstrual periods, and increased menstrual volume[13]. The different characteristics of

menstrual changes might related to the type of virus, race, and other factors.

Our study has some limitations. First, the survey was conducted online, and respondents were primarily young female students, mainly from Zhejiang Province, China. As such, the results do not fully reflect the menstrual characteristics of all women of childbearing age after being infected with SARS-CoV-2. Second, this study was a cross-sectional and retrospective study. One inclusion criterion was that respondents should have experienced at least one menstrual period after infection, which means that the time between infection and questionnaire completion was approximately one month or more, thus introducing recall bias. Third, the survey questions were subjective. Finally, our study did not include assessments of hormonal factors, such as anti-Müllerian hormone level, and antral follicle count to evaluate ovarian reserve. Deviations in these parameters can also cause menstrual changes.

Conclusion

This study indicates that Omicron has a significant influence on menstruation, but that changes were mostly temporary. Women with more severe symptoms tended to experience more significant changes in menstruation and had worse general health during recovery than women with mild symptoms. The potential long-term effects of SARS-CoV-2 on female reproductive health require further comprehensive observation and research.

Authors' contributions

Conceptualization: Chen NN, Zhao XP, Wang J. Ethical certification: Sun Y. Project implementation: Chen NN, Zhao XP, Sun Y, Wang J. Data analysis: Wang YY. Writing-original draft: Chen NN, Zhao XP. English writing: Su PP, Wang J. Writing–review & editing: Chen NN, Zhao XP, Sun Y, Wang J, Su PP, Wang YY.

Ethics approval and consent to participate

This study was performed in line with the principles of the Declaration of Helsinki. Approval was granted by the Ethics Committee of Wenzhou Traditional Chinese Medicine Hospital (Approval no. WZY2023-KT-007-001). Informed consent was exempt since the study was anonymous.

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Conflict of interest

The authors declare that they have no competing interests.

Data availability statement

The data that support this study are available in the article and accompanying online supplementary material.

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