

Association Between Loneliness, Premenstrual Symptoms, and Other Factors During the COVID-19 Pandemic: A Cross-Sectional Study with Japanese High School Students

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Purpose: Adolescence is a period of transition from childhood to adulthood where people are vulnerable to stress. The COVID-19 pandemic continues to cause sustained stress in the population. Since the COVID-19 pandemic, social isolation and loneliness have increased. Loneliness is associated with increased stress, psychological distress, and a higher risk of mental illnesses, such as depression. This study examined the association between loneliness, premenstrual symptoms, and other factors in the era of the COVID-19 pandemic among adolescent females in Japan.

Patients and Methods: A school-based cross-sectional survey of 1450 adolescent female students in Japan was conducted in mid-December of 2021. Specifically, paper-based questionnaires were distributed in class, and the responses were collected. The Premenstrual Symptoms Questionnaire (PSQ), 6-item Kessler Psychological Distress Scale, 3-item Revised UCLA Loneliness Scale (R-UCLA), and Fear of COVID-19 Scale were used as measurement tools. The prevalence of loneliness was defined as a total R-UCLA score ≥ 6 .

Results: The prevalence of loneliness was 29.0%. The prevalence of serious psychological distress was also high (8.2%), especially in the lonely group (16.0%). Multivariable regression analysis identified the following factors associated with loneliness: second year (odds ratio [OR] 1.53; 95% confidence interval [CI] 1.09–2.14), longer internet use (OR, 1.11; 95% CI, 1.02–1.20), total PSQ score (OR 1.08; 95% CI 1.06–1.11), and psychological distress (OR 1.05; 95% CI 1.01–1.08).

Conclusion: Adolescent females in Japan showed a high prevalence of loneliness. School year (2nd year), longer periods of internet use, premenstrual symptom severity, and psychological distress were independently associated with loneliness. For clinicians and school health professionals, special concern should be given to the psychological health of adolescent females during the COVID-19 pandemic.

Keywords: adolescent female, digital media, mental health, psychological distress, stress

Introduction

The outbreak of the coronavirus disease 2019 (COVID-19) has resulted in a global pandemic, and although conditions are better now than in the early days, it still has a significant impact on the physical and mental health of people worldwide.¹ Adolescence is the transition period from childhood to adulthood, where people are particularly vulnerable to stress. During the COVID-19 pandemic, adolescents are under great stress due to sudden school breaks, distance from society, domestic violence, and reduced family income.² Adolescent high school students are reportedly at high risk for psychological distress, depression, anxiety, loneliness, and trauma symptoms.³

Loneliness is an individual's subjective feeling of isolation and is recognized as an important health issue that is closely related to cardiovascular diseases and mental illnesses such as depression and anxiety.^{4,5} Loneliness in adolescence has also been reported as a risk factor for positive mental health.⁶ According to data from 37 Organization for Economic Co-operation and Development member countries, prior to the COVID-19 pandemic,

loneliness in adolescence was not only an important issue but had also been reported to be increasing worldwide since 2012.⁷ In particular, girls have reported more severe degrees of loneliness than boys. Although the precise cause is unknown, the spread of the internet, particularly smartphones, has been speculated to be a major factor in the weakening of human relationships.⁷ Since the COVID-19 pandemic, social distancing has been recognized as a way to prevent infection; however, this has reduced social interaction and increased social isolation and loneliness. A meta-analysis of 80 studies and a prospective longitudinal study on loneliness in adolescents during the COVID-19 pandemic showed that loneliness was associated with subsequent anxiety and depression.^{8,9} In these studies, girls were found to be more strongly affected than boys.

Unlike men, women have menstrual cycles and exhibit psychosomatic symptoms caused by hormonal fluctuations. Premenstrual symptoms are typical of these symptoms; specifically, they consist of a variety of mood, behavioral, and physical symptoms specific to the late luteal period.^{10,11} Premenstrual disorders (PMDs) consist of premenstrual syndrome (PMS) and premenstrual dysphoric disorder (PMDD) (a severe form of PMS with predominantly mental symptoms).¹² These are the pathological conditions associated with premenstrual symptoms. Not only do PMDs significantly impair women's quality of life, but a meta-analysis has shown a significant correlation with increased suicidal ideation with respect to PMDD.¹³ Our study of Japanese high school students revealed that PMDs are relatively common.¹⁴ The exact pathogenesis of PMDs is unknown, but stress has been suggested to be one of the triggers.^{15–17} The Great East Japan Earthquake that occurred in March 2011 caused extensive destruction, including tsunami damage, in the Tohoku region. In our previous study, we observed an exacerbation of premenstrual symptoms before and after the earthquake, as well as a correlation between earthquake-induced posttraumatic stress symptoms and the severity of premenstrual symptoms.¹⁸ Another study of Japanese high school students in 2020 found an association between COVID-19-induced posttraumatic stress symptoms and the severity of premenstrual symptoms.¹⁹

A systematic review and meta-analysis of studies of the general population showed increased psychological distress during the COVID-19 pandemic.²⁰ The association between severe psychological distress (SPD) and loneliness was shown in a previous report on psychological distress among Japanese pregnant women conducted in June 2021.²¹ Stressful living, coupled with vulnerability to stress, causes psychological distress and elevates the risk of psychiatric disorders, including depression and anxiety; however, its association with PMDs is unclear. Moreover, the relationship between loneliness and PMDs has not yet been investigated. Adolescent females, who are as vulnerable to stress as pregnant women, may also be more susceptible to psychological distress. During the COVID-19 pandemic as well, adolescent females can be assumed to be vulnerable to stress, and therefore, to experience high levels of psychological distress. Loneliness is enhanced by infection prevention measures. The association between psychological distress and loneliness, as well as loneliness and depression, suggests a possible relationship between loneliness and premenstrual symptoms, which is a disorder analogous to depression. Thus, a correlation between loneliness, psychological distress, and premenstrual symptoms can be postulated. Therefore, investigating the relationship between feelings of loneliness, premenstrual symptoms and psychological distress among high school students is necessary. This study aimed to (1) determine the level of loneliness among high school students during the COVID-19 pandemic, (2) test for whether loneliness is positively correlated with premenstrual symptoms, and (3) investigate associations between other related sociodemographic and psychological parameters, namely, school year, menstrual pain severity, age of menarche, internet use time, sleep time, psychological distress, and the fear of COVID-19.

Materials and Methods

Ethics Approval and Informed Consent

This study was conducted in accordance with the principles of the Declaration of Helsinki. The Ethics Committee of Kindai University approved the trial protocol (approval number: R03-174, approval date: October 14, 2021). The participating students provided informed consent before answering the survey.

Settings and Participants

We conducted a school-based survey of a sample of 1450 female Japanese students at two public high schools in Sendai, the largest city in the Tohoku region, from December 13 to 17, 2021. At this time, the fifth wave of COVID-19 infections had ended, and the number of infected patients began to increase rapidly toward the sixth wave. In Japan, schools were closed from March to May 2020, in the early stages of the pandemic; otherwise, only mild lockdowns were implemented. At the time of the survey, classes were conducted face-to-face, and no online classes were offered.

No personal information was collected in this survey. The ethics committee approved a waiver of parental informed consent because the students' intention to participate could be confirmed. The decision to not obtain parental informed consent was in accordance with the Ethical Guidelines for Medical and Health Research Involving Human Subjects enforced by Japan's Ministry of Education, Culture, Sports, Science and Technology and Japan's Ministry of Health, Labour and Welfare. The data were anonymized and contained no personally identifiable information about the participants. The survey was filled out, sealed in an envelope, and collected during the class. In all, 1175 students responded, and 275 students refused to participate. Out of the 1175 students, 987 had regular menstrual cycles (25 to 38 days) (Figure 1). As PMDs appear only during ovulatory cycles, those with normal menstrual cycles were selected. Furthermore, 907 students who completed all items of the Premenstrual Symptoms Questionnaire (PSQ), the 3-item Revised UCLA Loneliness Scale (R-UCLA), the 6-item Kessler Psychological Distress Scale (K6), the Fear of COVID-19 Scale (FCV-19S), and the Numerical Rating Scale (NRS) were selected. The inclusion criteria were having a menstrual cycle of 25 to 38 days and responding to all items of the PSQ, R-UCLA, K6, FCV-19S, and NRS. All those who did not meet the inclusion criteria were excluded.

Questionnaire

Premenstrual Symptoms Questionnaire

The PSQ was used to evaluate premenstrual symptoms.^{14,22} This questionnaire was developed in Japan and currently exists only in Japanese. The reliability and validity of the PSQ were fully evaluated.²³ The PSQ begins by asking,

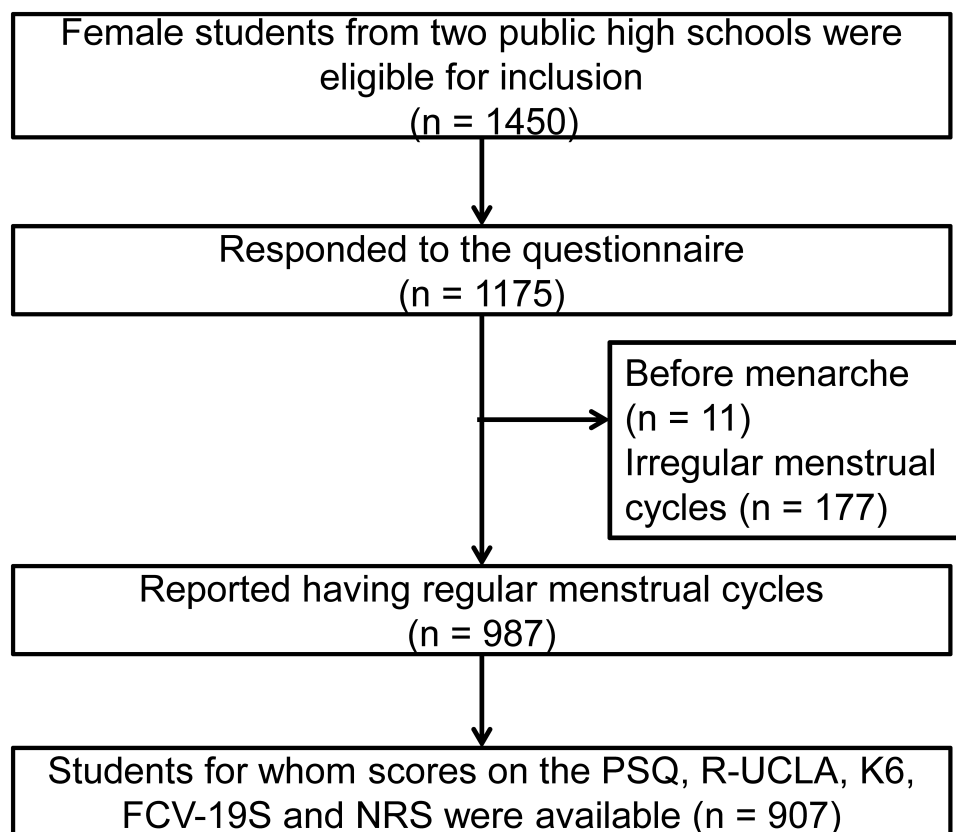


Figure 1 Flow chart of the study.

“Within the past three months, have you had any of the following premenstrual symptoms that begin in the week before menstruation and stop a few days after menstruation begins?” The questions on premenstrual symptoms comprised 11 items listed in the DSM PMDD diagnostic criteria. Furthermore, the PSQ asks whether the premenstrual symptoms experienced interfere with (a) Work performance and productivity and family responsibilities, (b) Social activities, or (c) Relationships with coworkers and family members. The severity of premenstrual symptoms and their interference with social activities were rated on a four-point scale (1 = not at all, 2 = mild, 3 = moderate, or 4 = severe). The total PSQ score was calculated as the sum of all 14 items. Therefore, the total PSQ score ranged from 14 to 56. In this study, Cronbach’s alpha coefficient of the PSQ was 0.935.

The 3-Item Revised UCLA Loneliness Scale

The Japanese version of the 3-item Revised UCLA Loneliness Scale (R-UCLA) was used to assess loneliness.²⁴ The reliability and validity of this scale have been well established.²⁴ The R-UCLA consists of three items, which are rated on a four-point scale (1 = not at all, 2 = almost never, 3 = sometimes, or 4 = always). The total R-UCLA score ranged from 3 to 12. In this study, the Cronbach’s alpha coefficient of the 3-item R-UCLA was 0.875. We classified students with a total R-UCLA score ≥ 6 as having loneliness, according to the criteria described previously.²⁵

The 6-Item Kessler Psychological Distress Scale

The Japanese version of the 6-item Kessler Psychological Distress Scale (K6) was used to assess psychological distress.²⁶ The original version was made in English, and the Japanese version, which has been checked for validity and reliability, was used in this study.²⁷ The K6 consists of six items scored on a five-point scale (0 = not at all, 1 = a little, 2 = yes, 3 = almost, or 4 = all). The total K6 score ranged from 0 to 24. The Cronbach’s alpha coefficient of the K6 was 0.921 in this study. SPD was defined by a total K6 score ≥ 13 .²⁸ Some past studies in Japan have used a cutoff point of 10 points, and this criterion was also adopted.^{21,29}

Fear of COVID-19 Scale

The Japanese version of the Fear of COVID-19 Scale (FCV-19S) was used to assess the fear of COVID-19.³⁰ The original version was made in English, and the Japanese version, which has been checked for validity and reliability, was used in this study.³¹ The FCV-19S consists of seven items, which are scored on a five-point scale (1 = strongly disagree, 2 = disagree, 3 = undecided, 4 = agree, or 5 = strongly agree). The total FCV-19S score ranges from 7 to 35. In this study, the Cronbach’s alpha coefficient for the FCV-19S was 0.817.

Other information collected on each participant included age, school grade level, body weight, height, age at menarche, days of menstrual cycle, internet usage, and sleeping time. Regarding the menstrual cycle, a cycle of 25–38 days was defined as a regular menstrual cycle. Body mass index (BMI; kg/m^2) was calculated by dividing weight in kilograms by height in meters squared.

Statistical Analysis

Cronbach’s α coefficient was calculated to assess the reliability of each scale (PSQ, K6, 3-item R-UCLA, and FCV-19S). Means and standard deviations were calculated for continuous variables, and proportions were calculated for categorical variables.

Since 2008, we have conducted an annual survey on menstruation using this school cohort. Therefore, the prevalence of irregular menstruation in this school cohort was compared with data from 2019 and 2020.^{19,23} The Cochran-Armitage trend test was performed for this comparison.

Correlations between the four psychological questionnaires (PSQ total score, K6 total score, total R-UCLA score, and total FCV-19S score) were examined by performing a Pearson’s correlation coefficient test.

Multivariable logistic regression analysis was performed to determine the factors significantly associated with loneliness. The school year was divided into two groups (2nd year and 1st plus 3rd year). The model included school year, BMI, age at menarche, menstrual pain intensity, internet usage, sleep time, PSQ total score, K6 total score, and total FCV-19S score. Statistical analyses were performed using JMP Pro 16.0.0 (SAS, Cary, NC, USA). Statistical significance was set at $p < 0.05$.

Results

As indicated by the flow of participants, a relatively high percentage of students (177, 15.1%) had irregular menstruation (Figure 1). Therefore, we compared the percentage of those with irregular menstruation with those with regular menstruation since the survey was conducted in 2019 before the pandemic. The percentage of menstrual irregularities has increased significantly since 2019 (Figure 2).

The participant characteristics are shown in Table 1. There were 644 participants in the non-lonely group (71.0%) and 263 in the lonely group (29.0%). The proportion of lonely and non-lonely groups differed by school year. Age ranges for each school year were as follows: first year (median 16, interquartile range [IQR] 15–16), second year (median 17, IQR 16–17), and third year (median 18, IQR 17–18). Results indicated that students showed higher rates of loneliness in the second than in the third year. The age at menarche was younger, and the internet use time was longer in the lonely than in the non-lonely group (mean (standard deviation): 12.0 (1.3) vs 12.3 (1.3); 3.29 (2.12) vs 2.65 (1.81), respectively). The lonely group had higher total PSQ, R-UCLA, and K6 scores than the non-lonely group. The percentage of those scoring ≥ 13 and ≥ 10 on the K6 cut-off was higher in the lonely than in the non-lonely group.

Furthermore, the correlations between the four psychological questionnaires used in this study were examined (Figure 3). There was a moderate correlation between the PSQ total score and K6 score and a mild correlation between the R-UCLA and PSQ total scores, as well as the K6 score.

Multivariable logistic regression analysis was performed to identify the factors significantly associated with loneliness (Table 2). These associated factors were more pronounced in the second year of school, with longer duration of internet use, higher total PSQ score, and higher K6 total score.

Discussion

Our results revealed a 29.0% prevalence of loneliness among female Japanese high school students. The results of a web-based survey of the general Japanese adult population from April to December 2020 that used the same scale as the current study showed that approximately 40% of the participants were in the loneliness group. However, a simple comparison cannot be made because the participants and the time of the survey are different, and the percentage of the loneliness group seems to be slightly lower in the present results. Nonetheless, at the time of the survey, face-to-face classes were being conducted in schools, and such a high rate of loneliness would be difficult to predict under mild social restrictions. Therefore, it should be noted that a significant percentage of adolescent females feel lonely.

Another important aspect of the present results is that the percentage of SPD (score of ≥ 13 on the K6) was remarkably high (8.2%) and even higher in the lonely group (16.0%). During the COVID-19 pandemic, Japan, unlike many

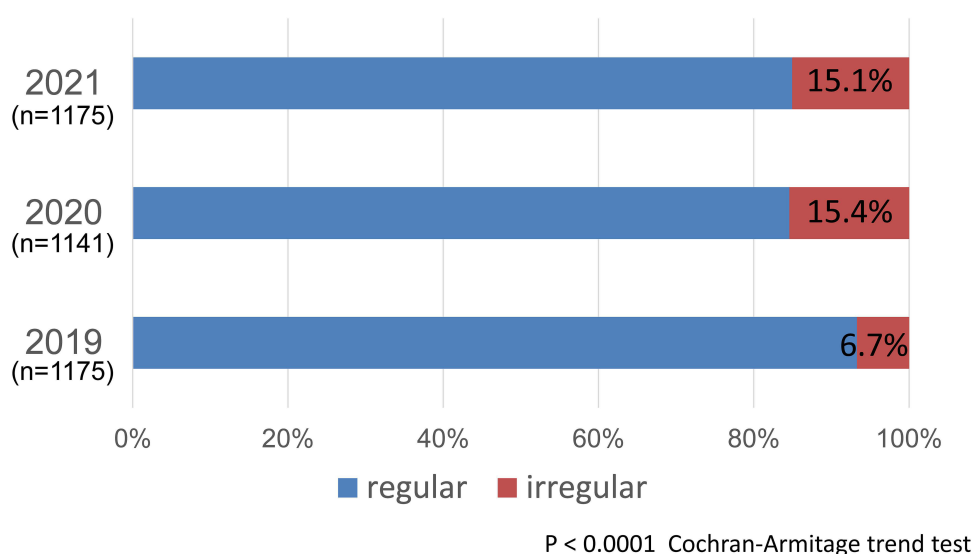


Figure 2 Comparison of menstrual irregularity among 2019, 2020, and 2021 groups. Each bar represents data in 2019, 2020, and 2021.

Table 1 Characteristics of Study Participants

Characteristic		Non-Lonely n=644	Lonely n=263
Age (years), mean (SD)	16.7 (1.0)	16.7 (1.0)	16.6 (1.0)
School year, number (%)			
First year	325 (35.8)	234 (72.0)	91 (28.0)
Second year	271 (29.9)	176 (64.9)	95 (35.1)
Third year	310 (34.2)	233 (75.2)	77 (24.8)
Missing	1 (0.1)		
BMI (kg/m ²), mean (SD)	20.3 (2.2)	20.2 (2.0)	20.5 (2.6)
Missing, number (%)	23 (2.5)		
Age at menarche (years), mean (SD)	12.2 (1.4)	12.3 (1.3)	12.0 (1.3)
Missing, number (%)	7 (0.8)		
Menstrual pain intensity, mean (SD)	4.7 (2.6)	4.6 (2.6)	4.9 (2.6)
Internet using time (hr), mean (SD)	2.84 (1.92)	2.65 (1.81)	3.29 (2.12)
Missing, number (%)	10 (1.1)		
Sleeping time (hr), mean (SD)	6.05 (0.97)	6.05 (0.94)	6.07 (1.04)
Missing, number (%)	6 (0.7)		
PSQ total, mean (SD)	25.3 (9.2)	23.3 (8.0)	30.3 (10.0)
R-UCLA, mean (SD)	4.4 (1.7)	3.5 (0.8)	6.6 (1.1)
K6, mean (SD)	4.1 (5.3)	3.1 (4.6)	6.4 (6.1)
13≥, number (%)	74 (8.2)	32 (5.0)	42 (16.0)
10≥, number (%)	140 (15.4)	60 (9.3)	80 (30.4)
FCV-19S, mean (SD)	14.9 (5.0)	14.7 (0.2)	15.3 (0.3)

Notes: Age ranges for each school year were as follows: first year (median 16, IQR 15–16), second year (median 17, IQR 16–17), and third year (median 18, IQR 17–18).

Abbreviations: SD, standard deviation; BMI, body mass index; PSQ, Premenstrual symptoms questionnaire; R-UCLA, 3-item Revised UCLA Loneliness Scale; K6, 6-item Kessler Psychological Distress Scale; FCV-19S, Fear of COVID-19 Scale; IQR, interquartile range.

American and European countries, did not impose a tight lockdown but rather a series of loose lockdowns. Except during the school closure period in the early stages of the pandemic, online classes were rarely conducted. Despite the far milder degree of lockdown, the suicide rate among young Japanese women increased sharply in 2020.³² A cohort study revealed that psychological distress is a major risk factor for suicide.³³ This data confirms that even 21 months after the start of the pandemic, Japanese adolescent females experienced great psychological distress. Stress leads to a range of irregular menstruation issues from ovarian dysfunction to hypothalamic action. The persistent increase in menstrual irregularities in 2020 and 2021 compared with 2019 before the pandemic may also be an indication of persistent stress.

Our results showed that for students in their 2nd school year, menstrual pain, internet usage, the severity of premenstrual symptoms, and psychological distress were independently associated with loneliness. Additionally, comparisons between school years showed that second-year students were more likely to be in the lonely group than third-year students. School education in Japan consists of six years of elementary school, three years of junior high school, and three years of high school. The transition from junior high to high school involves significant changes in the environment, with a large turnover of members of the same class. The second-year students at the time of this study were just entering their first year of high school and encountered a great deal of confusion, including lockdown in the early stages of the pandemic. At the beginning of high school, even though it was a critical time for building friendships, the lack of face-to-face classes and the suspension of club activities due to the pandemic caused a deficiency in personal relationships. Confusion at the start of high school may have created loneliness, which persisted unresolved in the second year. Repeated mild lockdowns are characteristic of the COVID-19 measures in Japan. A longitudinal study in Japan showed that in younger age groups (18–29 years), such repeated mild lockdowns have cumulative negative effects with respect to social isolation and loneliness.³⁴ Therefore, careful monitoring of the progress of this particular school year may be necessary in the future.

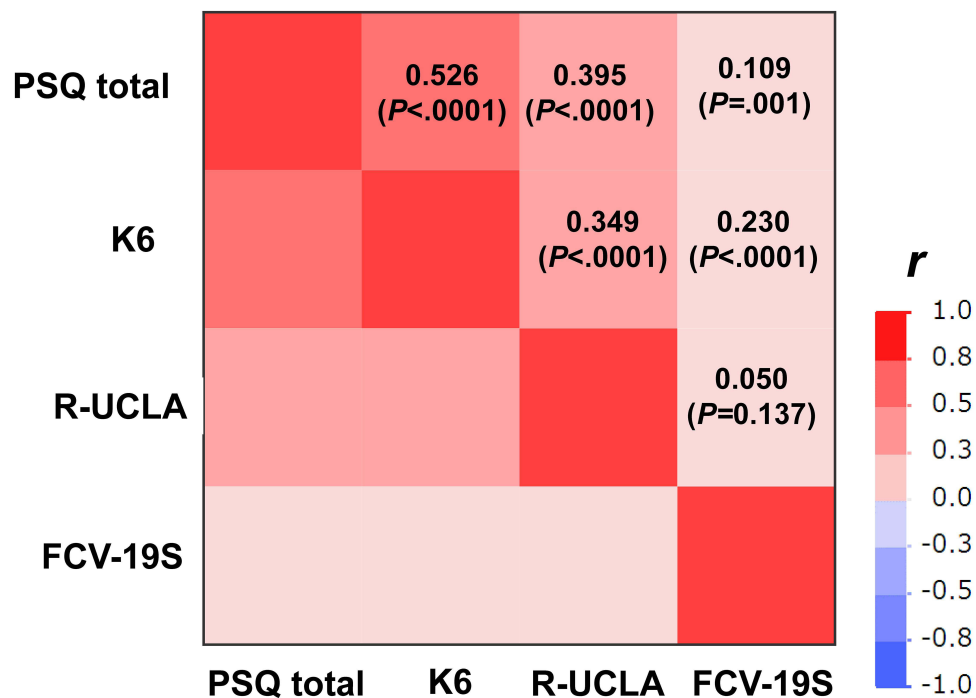


Figure 3 Correlations between the psychological questionnaires. In the heat map, red indicates a positive correlation and blue indicates a negative correlation. As indicated by the *r*-value bars, the darker the color, the higher the value of the correlation coefficient.
Abbreviations: PSQ, Premenstrual Symptoms Questionnaire; K6, 6-item Kessler Psychological Distress Scale; R-UCLA, 3-item Revised UCLA Loneliness Scale; FCV-19S, Fear of COVID-19 Scale.

With the widespread use of smartphones, adolescent relationships appear to have shifted to shallow online relationships.^{35,36} While digital media has many advantages, they also make relationships shallow and lead to loneliness.³⁷ The present results indicate that longer internet use is associated with loneliness, which is consistent with previous data. Although digital media is touted as an alternative to face-to-face relationships for the prevention of COVID-19 infections, it is important to note that internet use is independently associated with loneliness, even in this pandemic environment.

No studies have reported on the relationship between loneliness and premenstrual symptoms. The exact pathophysiology of PMDs remains unclear; however, the effectiveness of selective serotonin reuptake inhibitors (SSRIs) as

Table 2 Factors Associated with Loneliness

Characteristic	OR	95% CI
School year, 2nd year	1.53	1.09–2.14
BMI (kg/m ²)	1.03	0.96–1.11
Age at menarche	0.92	0.81–1.04
Menstrual pain intensity	0.92	0.86–0.99
Internet using time (hrs)	1.11	1.02–1.20
Sleep time (hrs)	1.08	0.92–1.28
PSQ total score	1.08	1.06–1.11
K6 total score	1.05	1.01–1.08
FCV-19S total score	1.00	0.97–1.04

Note: R² = 0.130.
Abbreviations: OR, odds ratio; CI, confidence interval; BMI, body mass index; PSQ, Premenstrual symptoms questionnaire; K6, 6-item Kessler Psychological Distress Scale; FCV-19S, Fear of COVID-19 Scale.

therapeutic agents is reportedly related to the brain transmitter serotonin.¹¹ Experiments using rat models of social isolation have reported that the serotonin 1A receptor agonist buspirone and the SSRI fluoxetine improve behavioral abnormalities caused by isolation.³⁸ From this, isolation and loneliness can be inferred to be associated with serotonin. In terms of pathophysiology, there may be similarities between PMDs and loneliness.

In our study, we found an association between loneliness and psychological distress. In addition to psychological distress being an obvious risk factor for suicide,³³ loneliness during the COVID-19 pandemic has also been reported to be a risk for suicide.³⁹ Given that adolescent girls are vulnerable, our findings regarding a high prevalence of loneliness and SPD in Japan warrant attention.

Multivariable analysis showed that menstrual pain was negatively correlated with loneliness, which seems to be a paradoxical result. The exacerbation of loneliness from restricted social activities due to severe menstrual pain is expected. Previous studies have reported that interpersonal disturbances from menstrual pain are due to negative emotions from menstrual pain, not the pain itself.⁴⁰ In the present study, this may have been because the results were corrected for psychological distress.

Our study had several limitations. First, because of the cross-sectional design, determining a causal relationship between loneliness and associated factors was not possible. Second, we collected data using a self-reported survey in a class. The survey did not include data on students who were absent from school, and since these students may have been absent because of depression, the survey may have underestimated their loneliness and psychological distress. In this regard, a report on Japanese adolescents used structural equation modeling to show that loneliness influences feelings of school refusal.⁴¹ Finally, this study was conducted only in Japan, which limits its generalizability to other countries. The increase in loneliness since 2012 has been reported to be a global problem, but the increase is only mild in Confucian countries, such as Japan, South Korea, and Hong Kong.⁷ In other English-speaking countries, loneliness is considered a more serious problem, and in countries where strict lockdown due to COVID-19 has been implemented, the impact of loneliness from social isolation is likely to be greater than that in Japan. However, since the questionnaires used in this survey (K6, R-UCLA, FCV-19S) were adapted from those used worldwide and translated into Japanese for validity and reliability, these results may be applicable to adolescent females in Japan as well as in other countries.

Conclusion

This study demonstrated an association between loneliness, premenstrual symptoms, and other psychological factors among Japanese adolescent females during the COVID-19 pandemic. For clinicians and school health professionals, special attention should be given to the psychological health of adolescent females during the COVID-19 pandemic. In addition, special attention should be paid to the progress of these particularly vulnerable populations.

Data Sharing Statement

The data obtained in this study are available from the corresponding author upon request.

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Author Contributions

All authors made a significant contribution to the work reported, whether in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

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