Original Report

Lifestyle Factors Associated with Premenstrual Syndrome: A Cross-sectional Study of Japanese High School Students

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A B S T R A C T

Study Objective: To investigate the relationships between premenstrual syndrome (PMS) and lifestyle, sleep, and dietary habits among Japanese high school students.
Design: Cross-sectional study.
Setting: Two public high schools in Sendai, the largest city in northeastern Japan.
Participants: A school-based survey was conducted among 1818 female Japanese high school students in 2015, and 1022 students with regular menstrual cycles (25-38 days) completed the questionnaire.
Interventions and Main Outcome Measures: Relationships between PMS and lifestyle, sleep, and dietary habits.
Results: The rates of moderate to severe PMS and premenstrual dysphoric disorder were 9.7% (99/1022) and 2.2% (22/1022), respectively. A total of 121 students (11.9%) were classified as having PMS—the PMS(+) group. Significant differences were observed between the PMS(+) group and those without PMS—the PMS(−) group—in age at menarche ($P = .022$), menstrual pain ($P < .001$), hypnagogic disorder ($P < .001$), long Internet use time ($P < .001$), eating breakfast ($P = .018$), chewing well ($P = .037$), and belonging to a sports club ($P = .046$). Multivariate analysis revealed that the risk factors for PMS were menstrual pain (odds ratio [OR], 4.74; 95% confidence interval [CI]: 2.83-7.95), hypnagogic disorder (OR, 2.22; 95% CI, 1.47-3.35), stress fracture (OR, 2.19; 95% CI, 1.21-3.98), and Internet use time (OR, 1.003; 95% CI, 1.001-1.005). Belonging to a sports club decreased the risk of PMS (OR, 0.57; 95% CI, 0.35-0.91).
Conclusion: Sleep, dietary habits, belonging to a sports club, and screen time affect PMS among high school students.
Key Words: Premenstrual syndrome, High school student, Lifestyle, Sleep, Dietary habits

Introduction

Premenstrual syndrome (PMS) and premenstrual dysphoric disorder (PMDD) are characterized by emotional, behavioral, and physical symptoms that occur during the late luteal phase of the menstrual cycle and terminate after the onset of menstruation. Epidemiological surveys have estimated that the frequency of premenstrual-related symptoms is quite high (80%-90%).[1] Other studies have reported that 5%-8% of reproductive-age women exhibit moderate to severe premenstrual symptoms that interfere with their daily activities.[2] This severe form of PMS is defined as PMDD in the *Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition*.[3] For PMDD to be diagnosed, key psychological symptoms, such as depressed mood, anxiety or tension, tearfulness, and anger or irritability, must be present. Such premenstrual disorders were originally considered to begin when women were in their early twenties, and, although the causes of PMS and PMDD have not been clearly elucidated, it has been suggested that the causes include hormonal changes, neurotransmitters, diet, stress, and lifestyle.[4]

Adolescence is a unique period in human development that creates significant psychological and physiological changes. Japanese high school students, in particular, have a different lifestyle from adults and are under a great deal of stress because of the long hours of studying for entrance examinations for high-ranking universities. Recently, with the spread of the Internet, personal computers, and smartphones, school-age students spend long periods of time looking at digital screens, a major communication tool in modern life. However, loss of control over Internet use has resulted in negative psychosocial consequences.[5] Moreover, one study showed screen time to be associated with adverse sleep outcomes in 90% of school-aged children and adolescents.[6] Eating breakfast has been reported to improve appetite, satiety, and diet quality, and this behavior might also support some aspects of sleep health in healthy young adults.[7]

Increasing evidence suggests that, of all of the neurotransmitters studied to date, serotonin might be the most important in the pathogenesis of PMS/PMDD.[8,9] One study has suggested that voluntary rhythmic movements such as chewing might increase brain serotonin.[10] Therefore, chewing well and eating speed might be related to the occurrence of PMS/PMDD.

The aim of the present study was to investigate the associations of various factors of school and domestic life with PMS among high school students.

The authors indicate no conflicts of interest.

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Materials and Methods

Ethics

This study was conducted in accordance with the principles outlined in the Declaration of Helsinki. Participating students provided informed consent before completing the survey. Their questionnaires were kept confidential. The Ethics Committee of Kindai University School of Medicine approved the study protocol (number 26-193).

Participants

A total of 1818 female students attending 2 high schools in Sendai city, the largest city in northeastern Japan, were surveyed in December 2015. The study questionnaires were distributed to all female students at each school by their home room teachers. The questionnaires were completed, sealed in envelopes, and collected in the class. Of the surveyed students, we excluded 21 who took hormonal agents. Ultimately, we selected the 1022 students who had regular menstrual cycles (25-38 days) and fully completed the survey. The students were asked to complete a self-administered questionnaire about their menstrual pain, premenstrual symptoms, personal lifestyle habits, and eating behaviors.

Eligible students were required to fulfil all of the following inclusion criteria: (1) regular menstrual cycles (25-38 days); (2) no hormonal drug use; and (3) fully completed the Premenstrual Symptoms Questionnaire (PSQ).

Questionnaire

We used the PSQ, which we developed in a previous study,[11] to screen for premenstrual symptoms. The PSQ reflects and translates the *Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition*[12] criteria into a rating scale with degrees of severity described in Japanese and is, in essence, equal to the Premenstrual Symptoms Screening Tool.[13] The PSQ asked, "Within the last three months, have you experienced the following premenstrual symptoms starting during the week before menses and remitting a few days after the onset of menses?" The premenstrual symptoms listed for this item are depressed mood; anxiety or tension; tearfulness; anger or irritability; decreased interest in work, home, or social activities; difficulty concentrating; fatigue or lack of energy; overeating or food cravings; insomnia or hypersomnia; feeling overwhelmed; and physical symptoms, such as tender breasts, feeling bloated, headache, joint or muscle pain, or weight gain. The PSQ also asked whether such premenstrual symptoms interfered with "work efficiency or productivity, or home responsibilities," "social life activities," or "relationships with coworkers or family."

Regarding the experience of these premenstrual symptoms, the PSQ asked respondents to choose from the categories of "not at all," "mild," "moderate," or "severe." We categorized the students into 3 groups according to the severity of premenstrual symptoms (PMDD, moderate to severe PMS, and no/mild PMS), using previously reported criteria.[11,14] We defined having PMDD as reporting at least 1 of the 4 core symptoms (depressed mood, anxiety or tension, tearfulness, and anger or irritability) as severe and at least 4 additional symptoms (for a total of 5 symptoms) as moderate to severe. To be classified as having PMDD, participants also had to report that their symptoms interfered severely with their ability to function in at least 1 of 3 domains. We defined having moderate to severe PMS as reporting at least 1 of the 4 core symptoms as moderate to severe and at least 4 additional symptoms as moderate to severe. To be classified as having moderate to severe PMS, participants also had to report that their symptoms interfered moderately or severely with their ability to function in at least 1 of 3 domains.

We also divided the students into 2 groups: the PMS(+) group, who had moderate to severe PMS or PMDD, and the PMS(−) group, who had no/mild PMS. Further, we asked the students about the severity of pain experienced during menses, with response categories of "not at all," "mild," "moderate," and "severe."

Additionally, we collected information about the participants' age, body weight, height, history of stress fracture diagnosed by a medical doctor, participation in sports clubs, sleep status, and Internet use time. We used the Japanese version of the Pittsburgh Sleep Quality Index[15] to assess sleep latency and efficiency, asking questions related to usual sleep habits during the past month only. We collected information on the following 4 items: (question 1) the time one goes to bed at night; (question 2 [Q2]) the period (in minutes) it takes one to fall asleep; (question 3) wake-up time in the morning; and (question 4) actual sleep time. Sleep latency was divided into 4 classes according to the criteria of the Japanese version of the Pittsburgh Sleep Quality Index: for Q2 between 0 and 15 minutes was classified as grade 1, for Q2 between 15 minutes and 30 minutes as grade 2, for Q2 between 30 and 60 minutes as grade 3, and Q2 more than 60 minutes as grade 4. Sleep efficiency (SE) was calculated as question 4/(question 3 − question 1) × 100 (%). Then, SE of 85% or more was classified as grade 1, SE of less than 85% and 75% or higher as grade 2, SE of less than 75% and 65% or higher as grade 3, and SE of less than 65% as grade 4. Thus, for sleep latency and efficiency, grade 1 is the best value, and grade 4 is the worst value. Internet use time was assessed as mean minutes per day. Belonging to a sports club comprised club activities in various school sports. History of stress fracture was operationalized as fracture resulting from excessive strain rather than from a specific injury. Body mass index (BMI) was calculated by dividing a participant's weight (in kilograms) by their height in meters squared.

We also collected information on dietary habits. Eating breakfast was measured as the number of times breakfast was consumed per week. This was categorized as eating breakfast less than once, once, twice, 3 times, 4 times, 5 times, 6 times, or every day during the week. The quality of chewing when eating was a subjective judgement made by the students and was classified into 6 categories: "well," "better than most," "average," "not well," "poorly," and "uncertain." Eating speed was also a subjective judgement,

for which students reported whether others had told them they "eat fast." Eating speed was classified into 6 types: "very fast," "fast," "average," "slow," "very slow," and "uncertain." Food allergy was operationalized as having been diagnosed with such an allergy in the past or at present or having had an allergic reaction to a substance ingested in food. These items were extracted from a brief, self-administered diet history questionnaire, which used the food frequency and the diet history methods to assess Japanese diets.[16]

Statistical Analyses

Statistical analyses were performed using JMP 13.0.0 (SAS Inc, Cary, NC). Data were expressed as mean ± SD. Statistical significance was set at P less than .05. The comparison of background characteristics of participants between the PMS(+) and the PMS(−) groups was evaluated using Student t test. The Mann-Whitney U test was used to test the associations of PMS with the severity of menstrual pain, hypnagogic disorder, SE, eating breakfast, quality of chewing when eating, and eating speed. The association of PMS with Internet use time was tested using Student t test, and associations with food allergy, belonging to a sports club, and stress fracture were tested using χ^2 tests.

Univariate and multivariate analyses were used to identify factors that were significantly associated with PMS. Students who reported moderate or severe menstrual pain were categorized as having menstrual pain. We categorized those who reported higher than grade 2 sleep latency as having hypnagogic disorder, those who reported very fast or fast eating speeds as having high eating speed, and those who reported chewing well or better than most as chewing well. We included school grade level, BMI, age at menarche, menstrual pain, hypnagogic disorder, SE, stress fracture, Internet use time, belonging to a sports club, eating breakfast, eating speed, quality of chewing when eating, and food allergy in the model. Variables that were predictive at a P less than .20 level were introduced into the stepwise model.

Results

The questionnaire was completed by a total of 1818 female high school students, 1022 of whom had regular menstrual cycles (25-38 days) and fully completed the survey. These students were classified into 2 groups according to premenstrual symptoms: 121 students (11.9%) were classified in the PMS(+) group, and 901 students (88.2%) were classified in the PMS(−) group (Fig. 1).

The participants' background characteristics are described in Table 1. The participants' mean age was 16.7 (±0.82) years (range, 15-19 years), and their mean BMI was 20.8 (±0.95; range, 15.1-46.9). Neither of these variables differed significantly between the PMS(+) and PMS(−) groups. The mean age at menarche was 12.2 (±0.04) years. First menstruation occurred significantly earlier in the PMS(+) group than in the PMS(−) group (P = .022).

A total of 131 (12.8%) of the students did not have menstrual pain, and 889 (87.0%) had mild to severe dysmenorrhea. The PMS(−) group had significantly less menstrual pain than did the PMS(+) group (P < .001). Hypnagogic disorder was significantly less common in the PMS(−) group than in the PMS(+) group (P < .001). The average Internet use time was 118 (±94.4) minutes. The average Internet use time of the PMS(+) group was significantly longer than that of the PMS(−) group (P < .001). The PMS(+) group ate breakfast fewer times per week than did the PMS(−) group (P = .018). The quality of chewing when eating was lower in the PMS(+) group than in the PMS(−) group (P = .037). Belonging to a sports club was more common in the PMS(−) group than in the PMS(+) group, and more students in the PMS(+) group had a history of stress fracture, compared with those in the PMS(−) group (P = .018).

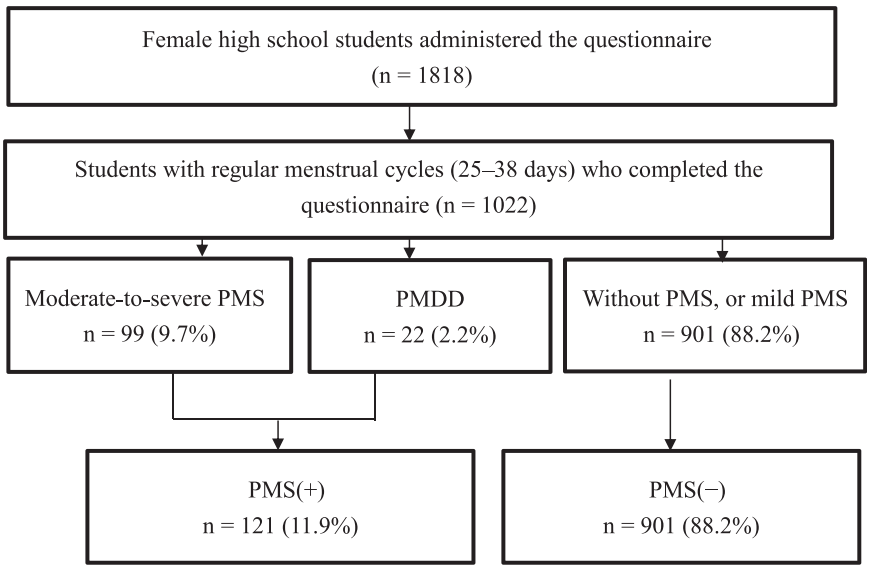

Fig. 1. Flow diagram of study participants. PMS, premenstrual syndrome; PMDD, premenstrual dysphoric disorder; PMS(+), the group who had moderate to severe PMS or PMDD; PMS(−), the group who had no/mild PMS.

Table 1
Characteristics of Study Participants

Characteristic	Total (N = 1022)	PMS(+) (n = 121)	PMS(−) (n = 901)	*P*
Mean age ± SD, years	16.7 ± 0.82	16.9 ± 0.90	16.7 ± 0.94	.068*
Mean BMI ± SD	20.8 ± 0.95	21.0 ± 4.11	20.8 ± 2.75	.428*
Mean age at menarche ± SD, years	12.2 ± 0.04	11.9 ± 0.13	12.3 ± 0.05	.022*
Menstrual pain, n (%)				<.001†
No pain	131 (12.8)	4 (3.3)	127 (14.1)	
Mild	345 (33.8)	15 (12.3)	330 (36.6)	
Moderate	407 (39.8)	58 (47.9)	349 (38.7)	
Severe	137 (13.4)	44 (36.4)	93 (10.3)	
Missing	2 (0.2)	0 (0)	2 (0.2)	
Hypnagogic disorder, n (%)				<.001†
Grade 1	661 (64.7)	54 (44.6)	607 (67.3)	
Grade 2	269 (26.3)	48 (39.7)	221 (24.5)	
Grade 3	57 (5.6)	17 (14.0)	40 (4.4)	
Grade 4	18 (1.8)	2 (1.7)	16 (1.8)	
Missing	17 (1.6)	0 (0)	17 (1.9)	
Sleep efficiency, n (%)				.094†
Grade 1	889 (87.0)	102 (84.3)	787 (87.3)	
Grade 2	88 (8.6)	15 (12.4)	73 (8.1)	
Grade 3	13 (1.3)	2 (1.7)	11 (1.2)	
Grade 4	11 (1.1)	2 (1.7)	9 (1.0)	
Missing	21 (2.1)	0 (0)	21 (2.3)	
Mean Internet use time ± SD, minutes	118 ± 94.4	164 ± 137	111 ± 94	<.001*
Eating breakfast (times per week), n (%)				.018†
Less than 1 time	65 (6.4)	6 (5.0)	59 (6.5)	
1 time	38 (3.7)	10 (8.3)	28 (3.1)	
2 times	37 (3.6)	4 (3.3)	33 (3.7)	
3 times	46 (4.5)	5 (4.1)	41 (4.6)	
4 times	32 (3.1)	7 (5.8)	25 (2.8)	
5 times	38 (3.7)	7 (5.8)	31 (3.4)	
6 times	35 (3.4)	4 (3.3)	31 (3.4)	
Every day	683 (66.8)	69 (57.0)	614 (68.1)	
Quality of chewing when eating, n (%)				.037†
Well	62 (6.1)	5 (4.1)	57 (6.3)	
Better than most	169 (16.5)	17 (14.0)	152 (16.9)	
Average	529 (51.8)	56 (46.3)	473 (52.5)	
Not well	187 (18.3)	30 (24.8)	157 (17.4)	
Poorly	49 (4.8)	7 (5.8)	42 (4.7)	
Uncertain	11 (1.1)	0 (0)	11 (1.2)	
Missing	15 (1.5)	6 (5.0)	9 (1.0)	
Eating speed, n (%)				.102†
Very fast	72 (7.0)	12 (9.9)	60 (6.7)	
Fast	321 (31.4)	42 (34.7)	279 (31.0)	
Average	313 (30.6)	31 (25.6)	282 (31.3)	
Slow	220 (21.5)	17 (14.0)	203 (22.5)	
Very slow	79 (7.7)	12 (9.9)	67 (7.4)	
Uncertain	1 (0.1)	0 (0)	1 (0.1)	
Missing	16 (1.6)	7 (5.8)	9 (1.0)	
Food allergy, n (%)				
No	861 (84.2)	95 (78.5)	766 (85.0)	.365‡
Yes	147 (14.4)	20 (16.5)	127 (14.1)	
Missing	14 (1.4)	6 (5.0)	8 (0.9)	
Belong to a sports club, n (%)				.018‡
No	553 (54.1)	78 (64.5)	475 (52.7)	
Yes	464 (45.4)	43 (35.5)	421 (46.7)	
Stress fracture, n (%)				.046‡
No	914 (89.4)	102 (84.3)	812 (90.1)	
Yes	107 (10.5)	19 (15.7)	88 (9.8)	

BMI, body mass index; PMS, premenstrual syndrome; PMS(+), the group who had moderate to severe PMS or premenstrual dysphoric disorder; PMS(−), the group who had no/mild PMS.
* *t* test.
† Mann-Whitney *U* test.
‡ χ^2 test.

The univariate analysis identified early age at menarche (odds ratio [OR], 1.19; 95% confidence interval [CI], 1.03-1.38), menstrual pain (OR, 5.55; 95% CI, 3.34-9.21), hypnagogic disorder (OR, 2.72; 95% CI, 1.85-4.00), Internet use time (OR, 1.004; 95% CI, 1.002-1.005), and stress fracture (OR, 1.72; 95% CI, 1-2.94) as risk factors for PMS. The factors associated with lower risk of PMS/PMDD were belonging to a sports club (OR, 0.52; 95% CI, 0.33-0.80), and eating breakfast (OR, 0.62; 95% CI, 0.42-0.92; Table 2).

The multivariate logistic analysis revealed that the risk factors for PMS were menstrual pain (OR, 4.74; 95% CI, 2.83-7.95), hypnagogic disorder (OR, 2.22; 95% CI, 1.47-3.35), Internet use time (OR, 1.003; 95% CI, 1.001-1.005), and stress fracture (OR, 2.19; 95% CI, 1.21-3.98). Belonging to a sports

Table 2
Univariate Analysis of Risk Factors for PMS

Risk Factor	OR	95% CI	*P*
School grade level	1.26	1.00-1.59	.053
BMI	1.02	0.97-1.09	.444
Early age at menarche	1.19	1.03-1.38	.020
Menstrual pain	5.55	3.34-9.21	<.001
Hypnagogic disorder	2.72	1.85-4.00	<.001
Sleep efficiency	1.58	0.92-2.69	.095
Internet use time	1.004	1.002-1.005	<.001
Eating breakfast every morning	0.62	0.42-0.92	.016
Chewing well	0.77	0.47-1.26	.303
High eating speed	1.47	0.99-2.17	.054
Food allergy	1.25	0.76-2.06	.378
Belonging to a sports club	0.52	0.33-0.80	.003
Stress fracture	1.72	1.00-2.94	.048

BMI, body mass index; CI, confidence interval; OR, odds ratio; PMS, premenstrual syndrome.

club decreased the risk of PMS/PMDD (OR, 0.57; 95% CI, 0.35-0.91; Table 3).

Discussion

This study showed that 121 students (12%) had moderate to severe PMS or PMDD. This outcome was equivalent to that shown in our previous study, in which the prevalence of moderate to severe PMS and PMDD among girls was 11.8%, which is higher than the prevalence of moderate to severe PMS and PMDD among adult Japanese women.[17]

In the present study, 87% of the participating students had menstrual pain, students in the PMS(+) group had more severe menstrual pain, and multivariate logistic analysis revealed menstrual pain to be a risk factor for PMS. The prevalence of PMDD and moderate to severe PMS increased with the severity of menstrual pain, showing a correlation between the severity of PMS/PMDD and menstrual pain among adolescents. These results are in line with our previous reports.[18]

Various factors of school and domestic life affect high school students. This study revealed that sleep problems, especially hypnagogic disorder, were a risk factor for PMS/PMDD. In a previous study, women with PMDD showed a decreased response to melatonin in the luteal phase, compared with the follicular phase of the menstrual cycle.[19]

Another previous study showed that women with PMDD were more likely to have Internet use disorder and had greater severity of this disorder, perceived stress, and impulsivity in the premenstrual phase, compared with the control group.[5] Approximately 93% of adolescents in the United States have been reported to use the Internet,[20] and approximately 70% of adolescents in Europe surf online for 2-4 hours per day.[21] Screen time has been found to be adversely associated with sleep outcomes (primarily shortened duration and delayed timing) in 90% of previous studies.[6]

Table 3
Multivariate Analysis of Risk Factors for PMS

Risk Factor	OR	95% CI	*P*
Menstrual pain	4.74	2.83-7.95	<.001
Hypnagogic disorder	2.22	1.47-3.35	<.001
Internet use time	1.003	1.001-1.005	<.001
Belonging to a sports club	0.57	0.35-0.91	.016
Stress fracture	2.19	1.21-3.98	.013

CI, confidence interval; OR, odds ratio; PMS, premenstrual syndrome.

In the present study, the students in the PMS(+) group ate breakfast fewer times per week and less often reported chewing well when eating, compared with the PMS(−) group. Breakfast consumption has been reported to improve appetite, satiety, and diet quality, and it might also support some aspects of sleep health in healthy young adults.[7] Therefore, it was assumed that having breakfast every day would improve PMS/PMDD as well as sleep dysfunction. Although the etiology of PMS is mostly uncertain, current evidence suggests that serotonin might be significant in the pathogenesis of PMS: reduction in brain serotonin neurotransmission is considered to lead to mood and behavioral signs associated with PMS, such as depressed mood and irritability.[22] Another study suggested that voluntary rhythmic movements such as chewing might increase brain serotonin.[10] The association between chewing and PMS/PMDD remains unknown, but serotonin change caused by chewing well might be related to PMS/PMDD.

The multivariate logistic analysis conducted in this study revealed that stress fracture was a risk factor for PMS/PMDD and that belonging to a sports club reduced the risk of PMS/PMDD. Premenstrual symptoms might affect athletic performance and are associated with the risk of stress fractures among adolescent athletes. Previous observational studies that examined the relationship between physical activity and PMS have reported inconsistent findings.[23,24] Moderate physical activity—short of the activity level of an athlete—might improve PMS/PMDD.

The standard treatment for PMS/PMDD should be considered pharmacological medication with combined oral contraceptives and selective serotonin reuptake inhibitors.[2] However, combined oral contraceptives are not common in Japan. According to a World Health Organization report,[25] women in Japan rarely select combined oral contraceptives as a method of contraception, with only 0.9% selecting this method, which is very low compared with other countries. Moreover, selective serotonin reuptake inhibitors are generally contraindicated for adolescents in Japan. Compared with these pharmacological medications, lifestyle modification is an easier approach and has no side effects. Treatment effects might also be enhanced by combining lifestyle modification with medication.

Our study had several limitations. The main limitation was that the study used self-report data, which are susceptible to recall bias. The second limitation was that the study had a cross-sectional design, so it was impossible to determine whether the risk factors identified were causes or effects of PMS. Third, we did not examine whether the participants were taking antidepressants, nonsteroidal anti-inflammatory drugs, or narcotics, or whether they had a history of mood disorder or other mental illness. The fourth limitation was that we did not collect information on the specific number of days for the duration the menstrual cycle or the interval between menses. The fifth limitation was that the study was conducted only in Japan. The lifestyle of Japanese high school students might be unique, so it is

likely that our data would not be applicable to other countries. However, spending long periods looking at digital screens and having sleep disorders are also common problems in developed countries other than Japan. Despite these limitations, the findings from our study have several strengths. The schools included in this study are comprehensive, so we consider the data to have been obtained from a relatively general adolescent population in Japan. Moreover, we collected data on a wide range of lifestyle variables that are closely related to school life.

This study indicates that sleep, dietary habits, belonging to a sports club, and screen time affect PMS in high school students. Interventions targeting students' daily lifestyles might be the safest treatment strategy for PMS. Further research using a prospective design is warranted to determine the effects of such a lifestyle intervention.

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