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Effect of sleep quality on the severity of perimenstrual symptoms in Japanese female students: A cross-sectional, online survey

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Abstract

Objectives: To investigate the relationship between sleep quality and perimenstrual symptoms among Japanese female students.

Design: Observational, cross-sectional, online survey

Setting: We used an online questionnaire to collate responses from Japanese female students on sleep quality and perimenstrual symptoms.

Participants: A total of 298 female students aged 18-25 years in Japan were included in this study.

Primary and secondary outcome measures: The Menstrual Distress Questionnaire (MDQ) was used to assess the severity of perimenstrual symptoms for three periods: premenstrual, menstrual, and postmenstrual, and the Japanese version of the Pittsburgh Sleep Quality Index was used to assess sleep quality. The MDQ scores were compared between two groups (normal-sleep quality and low-sleep quality) using Mann–Whitney U test. In addition, multiple logistic regression analysis was performed, and the MDQ subscales that showed significant differences between the groups were used as independent variables. The MDQ subscale that was strongly associated with sleep quality was calculated.

Results: Of the female students, 160 were classified into the normal-sleep quality group and 138 into the low-sleep quality group. The total MDQ scores were significantly higher in the low-sleep quality group at all phases of the menstrual cycle (respectively $p<0.05$). Among the MDQ subscales, “pain” during menstruation and “concentration” in the premenstrual and postmenstrual stages were associated with sleep quality (respectively $p<0.05$).

Conclusions: Improving sleep quality was one possible strategy to reduce the severity of perimenstrual symptoms. These results may provide useful information for Japanese female students who suffer from perimenstrual symptoms.

Strengths and limitations of this study

- This study conducts an online survey among female students aged 18-25 years in Japan.
- Participants in the study answered questions mainly related to sleep and to perimenstrual symptoms.
- Finally, 298 respondents were included in the final analysis, 160 were classified into the normal-sleep quality group and 138 into the low-sleep quality group.
- This study shows a relationship between sleep quality and perimenstrual symptoms among Japanese female students.
- The cross-sectional design cannot lead to causal relationship between sleep quality and perimenstrual symptoms.

Keywords: Sleep; Primary health care; Surveys and Questionnaires

Word count: 3020 words

INTRODUCTION

Perimenstrual symptoms are varied and comprise physical, emotional, and behavioral symptoms. They occur during premenstrual, menstrual, and postmenstrual periods. Approximately 16–91% of women experience perimenstrual symptoms, such as irritability, depression, weight gain, and back pain [1]. These are important health issues that can lead to a decline in the quality of life of young women including students [2]. Additionally, missing classes due to dysmenorrhea and other perimenstrual symptoms causes a decline in the academic performance of female students [3].

Unhealthy lifestyle habits can affect perimenstrual symptoms [4]. Throughout the menstrual cycle, changes in the secretion of female hormones, including estrogen and progesterone, occur [5]. These changes have various effects on a woman's body and mind, causing perimenstrual symptoms. An example of lifestyle influences on these symptoms is the consumption of trans-fatty acids, which are abundant in fast food and increase the levels of prostaglandins, consequently causing dysmenorrhea and highlighting that an unbalanced diet can lead to increased pain [4]. Exercise could also be associated with perimenstrual symptoms. Reportedly, the secretion of estradiol during exercise increases serotonin secretion, which reduces the negative effects of perimenstrual symptoms [6]. These reports suggest that lifestyle habits are related to perimenstrual symptoms in terms of hormone secretion.

Sleep, one of the lifestyle habits, is an important aspect of human life, with approximately one-third of life's existence spent sleeping [7]. The hypothalamus plays an important role in sleep and is a regulator of sleep and wakefulness [8]. It contains gonadotropin-releasing hormone (GnRH) neurons, which drive the menstrual cycle by secreting GnRH, which helps to regulate female hormone levels [9]. Additionally, a direct synaptic connection exists between the sleep center of the brain and GnRH neurons, and deep sleep activates GnRH pulse generators [10]. Thus, it is possible that sleep and perimenstrual symptoms, which are both regulated by the hypothalamus, may be closely related.

Sleep is characterized by sleep duration and quality, and distinguishing between these two characteristics is essential [11]. Compared with sleep quality, sleep duration assesses sleep objectively and refers to the duration of sleep [12]. In contrast, sleep quality is evaluated subjectively and is defined as a sense of rest upon waking and satisfaction with sleep [12]. Although some overlap exists between these two characteristics, they are considered distinct and independent [13]. Reportedly, short sleep duration (<6 hours/day) is associated with moderate to severe dysmenorrhea, revealing a relationship between sleep duration and perimenstrual symptoms [14]. However, no study has examined the relationship between sleep quality and perimenstrual symptoms. Therefore, this study aimed to examine the involvement of sleep quality in perimenstrual symptoms in Japanese female students and propose strategies to alleviate

perimenstrual symptoms.

METHODS

Patient and public involvement

The questionnaire design involved female students. After the questionnaire was drafted, it was pretested with 20 Japanese female students who were not included in the main study. The study was conducted with female students residing throughout Japan and was not restricted to any region, such as prefectures. We plan to widely disseminate the findings of this study to the public by sharing information on social media and so on.

Study design

An observational, cross-sectional, online survey of Japanese female students aged 18–25 years was conducted from November 8, 2022, to February 2, 2023, in Japan. The survey was conducted using Google Forms (Alphabet Inc., Mountain View, CA, USA). Before the survey questions began, a summary of the survey instructions, the purpose of the survey, the time required to complete it, and the following instructions to the participants were provided: participants can answer questions anonymously, answer just once, and could decline participation at any point during the survey. Participants agreed to participate in this study by checking a consent box before completing the questionnaire. Only those who consented to participate in the survey after reviewing the survey summary and instructions proceeded to answer the questions. The inclusion criteria were the following: (a) agreeing to participate in this study, (b) Japanese female students aged between 18 and 25 years, and (c) residing in Japan at the time of the survey. The exclusion criteria were as follows: (a) had a current or previous history of gynecological disorders or possible secondary dysmenorrhea [15], (b) had a current or previous history of psychiatric disorders, and (c) current history of daily hormonal pill intake. This study adhered to the recommendations of the Checklist for Reporting Results of Internet E-Surveys [16]. Furthermore, this study conformed to the guidelines of the Declaration of Helsinki and was approved by the Ethical Committee for Epidemiology, Hiroshima University (E-3791).

Question items

The question items were mainly related to sleep quality and the severity of perimenstrual symptoms. They included basic information and sociodemographic and lifestyle characteristics. Basic information included age, age at menarche, height and weight for body mass index (BMI; kg/m^2) calculation, current and previous history of

gynecological or psychiatric disorders, and medications for internal use related to these disorders. Sociodemographic characteristics included questions regarding part-time job (yes/no) and living status (alone/with others). Lifestyle characteristics included questions regarding alcohol intake (low/high: no alcohol consumption or up to 2 drinks per week/more), smoking (yes/no), breakfast (eating/not eating), eating between meals (eating/not eating), caffeine consumption (yes/no: ≥3 times/week), studying until bedtime (yes/no: ≥3 times/week), watching TV until bedtime (yes/no: ≥3 times/week), and screen time (min/day) related to leisure and study [17].

The Japanese version of the Pittsburgh Sleep Quality Index (PSQI-J) was used to rate sleep quality in the past month. The PSQI-J has been used and validated in a previous study that assessed sleep quality [18]. Participants answered questions regarding their sleep over the past month, and the overall score (range, 0–21) was calculated as the total score of seven factors presented in questions 1–7: subjective sleep quality, time to fall asleep, sleep duration, sleep efficiency, sleep difficulty, use of sleeping pills, and difficulty in staying awake during the day. Subjective sleep quality was assessed using one question rated on a 4-point Likert scale (very good, quite good, quite bad, and very bad). Time to fall asleep was assessed using two questions regarding the time from bedtime to falling asleep. Sleep duration was rated in 4 stages (>7 hours; >6 hours but ≤7 hours; ≥5 hours but ≤6 hours; and <5 hours). Sleep efficiency was calculated by dividing sleep duration by the total number of hours in bed. Sleep difficulty was assessed using nine questions regarding waking up in the middle of the night, difficulty falling asleep soon after going to bed, feeling cold, having bad dreams, getting up to use the restroom, difficulty in breathing correctly, snoring loudly and coughing, feeling pain, or having other reasons for sleep disorders. The use of sleeping pills and difficulty in staying awake during the day were rated on a 4-point Likert scale (not once, less than once per week, once or twice per week, and three or more times per week). A total PSQI-J score of 5 and below indicates normal sleep quality, and 6 and above indicates low sleep quality [18].

The Menstrual Distress Questionnaire (MDQ) has long been used as a measure to evaluate the severity of perimenstrual symptoms, and its validity has been confirmed [19]. The index assesses responses to 46 questions on eight subscales of perimenstrual symptoms [20]. Responses on the most recent symptoms were rated on a 6-point scale (1: no reaction at all, 6: acute or partially disabling). High scores indicated increased severity of perimenstrual symptoms. We used six subscales comprising pain, water retention, autonomic reaction, negative affect, concentration, and behavioral change; two subscales (mood elevation and control), with higher scores indicating better symptoms, were excluded. Each symptom was assessed for three periods: premenstrual, menstrual, and postmenstrual.

Statistical analysis

The respondents were divided into normal-sleep quality and low-sleep quality groups based on the PSQI-J cutoff value of 6 points [18]. Data collected from the survey were processed using IBM SPSS version 28.0 for Windows (IBM Japan Co., Ltd., Tokyo, Japan). Before conducting the analysis, the Shapiro–Wilk test was used to assess the normality of all data. Basic information and lifestyle characteristics, MDQ total scores, and subscales in each menstrual period were compared between both groups using the Mann–Whitney U test. Chi-square tests were used to assess sociodemographic and lifestyle characteristics. Multiple logistic regression analysis was conducted to identify the relationship between the MDQ subscale scores and sleep quality during each menstrual period (premenstrual, menstrual, and postmenstrual). For analysis, a PSQI-J score <6 was coded as 0, and a PSQI-J score ≥6 was coded as 1. Normal or low sleep quality was set as the dependent variable, and MDQ subscales with p-values <0.05 for the group comparison were set as independent variables. The variance inflation factor, a statistic used to measure possible multicollinearity among predictors or independent variables, was computed [21]. Odds ratios (OR) and 95% confidence intervals (CI) were also determined. Regarding sample size calculation, the number of participants per independent variable should be ≥10 based on a previous study [22]. In the present study, four to six MDQ subscales were used as independent variables. Therefore, it was necessary to include at least 60 participants each in the normal- or low-sleep quality groups. The significance level was set at 0.05.

RESULTS

The survey was distributed among 850 participants, and 366 of them (response rate: 43.1%) provided responses. Of the respondents, 68 were excluded (34 respondents had a current or previous history of gynecological disorders or possible secondary dysmenorrhea, 32 respondents were taking hormone medication, one respondent had a current or previous history of psychiatric disorders, and one respondent answered insufficiently). Thus, 298 respondents were included in the final analysis. Of the 298 participants, 160 were classified into the normal-sleep quality group and 138 into the low-sleep quality group based on the PSQI-J cutoff value points **(Figure 1)**.

Basic information and sociodemographic characteristics

No significant differences in age, age at menarche, BMI, part-time job, and living status were observed between the two groups, as shown in **Table 1**.

Table 1. Basic information and sociodemographic characteristics

Variables	Normal-sleep quality group (n=160)	Low-sleep quality group (n=138)	χ^2	p value	Effect size
Age (y.o.)	20.8 ± 1.4	20.7 ± 1.3		0.666	-0.025
Age at menarche (y.o.)	12.5 ± 1.7	12.5 ± 1.5		0.839	0.012
BMI (kg/m^2)	20.5 ± 2.6	20.8 ± 2.6		0.884	0.008
Part-time job					
Yes	135 (84.4)	123 (89.1)	1.442	0.230	0.070
No	25 (15.6)	15 (10.9)			
Living status					
Alone	57 (35.6)	46 (33.3)	0.172	0.678	0.024
With others	103 (64.4)	92 (66.7)			

BMI, body mass index; y.o., years old

Data are expressed as mean ± standard deviation, or n (%).

Lifestyle characteristics

As shown in **Table 2**, no significant differences in alcohol intake, smoking, eating between meals, caffeine consumption, studying until bedtime, watching TV until bedtime, and screen time were observed between the two groups. In contrast, a significant difference in breakfast consumption was observed between the two groups, with a significantly higher number of students eating breakfast in the normal-sleep quality group compared with that in the low-sleep quality group (p=0.023).

Table 2. Lifestyle characteristics

Variables	Normal-sleep quality group (n=160)	Low-sleep quality group (n=138)	χ^2	p value	Effect size
Alcohol intake					
Low	145 (90.6)	129 (93.5)	0.815	0.367	0.052
High	15 (9.4)	9 (6.5)			
Smoking					
No	152 (95.0)	133 (96.4)	0.337	0.562	0.034
Yes	8 (5.0)	5 (0.6)			
Breakfast					
Eating	114 (71.3)	81 (58.7)	5.163	0.023*	0.132
Not eating	46 (28.7)	57 (41.3)			
Eating between meals					
Eating	101 (63.1)	95 (68.8)	1.075	0.300	0.060
Not eating	59 (36.9)	43 (31.2)			
Caffeine consumption (≥3 times/week)					
Yes	74 (46.3)	57 (41.3)	0.736	0.391	0.050
No	86 (53.7)	81 (58.7)			
Studying until going to bed (≥3 times/week)					
Yes	37 (23.1)	32 (23.2)	0.000	0.990	0.001
No	123 (76.9)	106 (76.8)			

Watching TV until going to bed (≥3 times/week)					
Yes	44 (27.5)	29 (21.0)	1.685	0.194	0.075
No	116 (72.5)	109 (79.0)			
Screen time					
Leisure (min/day)	256.4 ± 204.2	252.1 ± 144.0		0.578	0.032
Study (min/day)	105.9 ± 129.8	107.1 ± 124.4		0.265	0.064

*Statistically significant

Data are expressed as n (%), or mean ± standard deviation.

Comparison of MDQ total scores and subscale scores between the two groups during the premenstrual, menstrual, and postmenstrual periods

Tables 3, 4, and **5** show the comparisons of the MDQ scores between the two groups in the three menstrual periods (premenstrual, menstrual, and postmenstrual). The premenstrual MDQ total scores (p=0.006) and scores for the subscales, including pain, negative affect, concentration, and behavioral change (p=0.016, p=0.025, p<0.001, and p=0.013, respectively), were significantly lower in the normal-sleep quality group than in the low-sleep quality group (**Table 3**). During the menstrual period, the MDQ total scores (p<0.001) and scores for all the subscales were significantly lower in the normal-sleep quality group than in the low-sleep quality group (water retention, p=0.002; other subscales, p<0.001; **Table 4**). The MDQ total scores (p=0.005) and subscale scores, including pain, negative affect, concentration, and behavioral change scores (p=0.027, p=0.011, p<0.001, and p=0.005, respectively), were significantly lower in the normal-sleep quality group than in the low-sleep quality group in the postmenstrual period (**Table 5**).

Table 3. Comparison of MDQ scores between normal-sleep quality and low-sleep quality groups during the premenstrual period

	Normal-sleep quality group (n=160)	Low-sleep quality group (n=138)	p value	Effect size
Total	68.5 ± 22.4	79.8 ± 37.6	0.006*	0.159
Pain	12.8 ± 6.6	15.1 ± 8.0	0.016*	0.139
Water retention	10.0 ± 5.0	11.0 ± 5.2	0.091	0.098
Autonomic reaction	5.5 ± 2.9	6.5 ± 4.0	0.050	0.113
Negative affect	15.8 ± 9.2	17.9 ± 10.0	0.025*	0.130
Concentration	12.8 ± 7.0	15.7 ± 8.5	<0.001*	0.192
Behavior change	11.6 ± 6.6	13.6 ± 7.3	0.013*	0.143

MDQ, Menstrual Distress Questionnaire

*Statistically significant

Data are expressed as mean ± standard deviation.

Table 4. Comparison of MDQ scores between normal-sleep quality and low-sleep quality groups during the menstrual period

	Normal-sleep quality group (n=160)	Low-sleep quality group (n=138)	p value	Effect size
Total	73.3 ± 34.2	93.7 ± 40.6	<0.001*	0.262
Pain	15.4 ± 7.6	19.8 ± 8.6	<0.001*	0.259
Water retention	9.3 ± 4.6	11.1 ± 5.2	0.002*	0.178
Autonomic reaction	6.2 ± 3.7	7.8 ± 4.6	<0.001*	0.198
Negative affect	15.6 ± 8.7	20.2 ± 10.6	<0.001*	0.230

Concentration	13.8 ± 7.7	18.3 ± 10.2	<0.001*	0.240
Behavior change	13.0 ± 6.9	16.6 ± 7.7	<0.001*	0.234

MDQ, Menstrual Distress Questionnaire

*Statistically significant

Data are expressed as mean ± standard deviation.

Table 5. Comparison of MDQ scores between normal-sleep quality and low-sleep quality groups during the postmenstrual period

	Normal-sleep quality group (n=160)	**Low-sleep quality group (n=138)**	**p value**	**Effect size**
Total	51.2 ± 24.6	60.2 ± 33.0	0.005*	0.164
Pain	9.9 ± 6.0	11.4 ± 7.2	0.027*	0.128
Water retention	6.8 ± 4.0	7.3 ± 3.9	0.086	0.099
Autonomic reaction	4.9 ± 2.1	5.7 ± 3.4	0.072	0.104
Negative affect	11.4 ± 6.3	13.2 ± 8.0	0.011*	0.147
Concentration	10.2 ± 4.2	12.8 ± 7.4	<0.001*	0.198
Behavior change	8.1 ± 4.6	9.8 ± 6.1	0.005*	0.163

MDQ, Menstrual Distress Questionnaire

*Statistically significant

Data are expressed as mean ± standard deviation.

Multiple logistic regression analysis

To show the associations of sleep quality with the MDQ subscales, multiple logistic regression analysis was performed (**Table 6**). The MDQ concentration score during the premenstrual period (β=0.068; p=0.034; OR, 1.070; 95% CI, 1.005–1.140), pain during menstruation (β=0.057; p=0.040; OR, 1.059; 95% CI, 1.003–1.117), and

concentration during the postmenstrual period (β=0.165; p=0.003; OR, 1.179; 95% CI, 1.058–1.313) were significantly associated with sleep quality.

Table 6. Multiple logistic regression analysis for the association of sleep quality with MDQ subscales

	β	SE	Wald	df	P value	OR	95% CI	
							Lower	Upper
Premenstrual								
Pain	0.022	0.026	0.722	1	0.396	1.022	0.972	1.075
Negative affect	-0.040	0.027	2.221	1	0.136	0.961	0.913	1.013
Concentration	0.068	0.032	4.493	1	0.034*	1.070	1.005	1.140
Behavior change	0.006	0.036	0.030	1	0.864	1.006	0.937	1.081
During menstruation								
Pain	0.057	0.028	4.229	1	0.040*	1.059	1.003	1.117
Water retention	-0.030	0.038	0.630	1	0.427	0.970	0.901	1.045
Autonomic reaction	-0.011	0.044	0.064	1	0.801	0.989	0.907	1.079
Negative affect	0.009	0.023	0.158	1	0.691	1.009	0.965	1.056
Concentration	0.029	0.026	1.215	1	0.270	1.029	0.978	1.083
Behavior change	-0.003	0.033	0.006	1	0.937	0.997	0.935	1.064
Postmenstrual								
Pain	-0.013	0.037	0.115	1	0.735	0.987	0.918	1.602
Negative affect	-0.082	0.043	3.540	1	0.060	0.922	0.846	1.003
Concentration	0.165	0.055	8.968	1	0.003*	1.179	1.058	1.313

Behavior change	0.024	0.063	0.140	1	0.709	1.024	0.904	1.159

Variation inflation factor (premenstrual): pain, 2.679; negative affect, 4.429; concentration, 4.167; behavior change, 4.569. During menstruation: pain, 3.668; water retention, 2.452; automatic reaction, 2.344; negative affect, 3.614; concentration, 3.812; behavior change, 4.212. Postmenstrual: pain, 3.872; negative affect, 5.161; concentration, 4.701; behavior change, 7.171

MDQ, Menstrual Distress Questionnaire; β, partial regression coefficient; SE, standard error; df, degree of freedom; OR, odds ratio; CI, confidence interval

*Statistically significant

DISCUSSION

The aim of this study was to investigate the relationship between sleep quality and perimenstrual symptoms among Japanese female students. The main results of this study revealed that the lower the sleep quality, the greater the severity of perimenstrual symptoms. Furthermore, among the MDQ components, significant associations with sleep quality were detected for pain during menstruation and concentration during the premenstrual and postmenstrual periods. The Japanese population is known to have poor sleep habits, and in particular, college students are prone to disrupting their sleeping habits [23]. Therefore, confirming whether sleep quality affects perimenstrual symptoms among Japanese female students and identifying perimenstrual symptoms that have a strong relationship with sleep quality are significant.

A previous study of female undergraduate and graduate students in Taiwan found that normal or low sleep quality was associated with the onset of perimenstrual symptoms, and 51.4% of female students were indicated to have normal sleep quality (PSQI <6) and 48.6% indicated to have low sleep quality (PSQI ≥6) [24]. These results indicate a relationship between sleep quality and perimenstrual symptoms. In our study, the severity of perimenstrual symptoms was lower in the normal-sleep quality group than in the low-sleep quality group, which is similar to the results of the previous study [24]. Moreover, 53.7% of the participants were classified into the normal-sleep quality group and 46.3% into the low-sleep quality group, suggesting no participant bias when investigating sleep quality compared with that in previous studies. The average MDQ scores in Japanese young women aged 18 years and older [6] are 57.2 points in the premenstrual, 63.0 points in the menstrual, and 42.5 in the postmenstrual periods. In the present study, the average MDQ total scores were 74.2 points in the premenstrual, 83.5 points in the menstrual, and 55.8 in the postmenstrual periods, which were higher than those reported in the previous study [6]. A higher percentage of female college students have severe perimenstrual symptoms [25], which may explain the relatively high MDQ total scores of our study.

The MDQ total scores and several subscale scores were higher in the lower-sleep quality group than in the normal-sleep quality group during all the menstrual periods. The most likely explanation for the association between sleep quality and perimenstrual symptoms is the influence of melatonin. Melatonin, which is responsible for inducing sleep, decreases with low sleep quality [26]. It is also involved in reproductive functions and plays a role in regulating the levels of estrogen and progesterone [27]. Thus, the decrease in melatonin secretion due to low sleep quality might have led to a disturbance in the regulatory mechanism of female hormone levels, which might have resulted in the higher severity of perimenstrual symptoms in the low-sleep quality group. However, we were unable to investigate changes in melatonin secretion in this study.

Multiple logistic regression analysis showed that the MDQ subscale during menstruation related to sleep quality was "pain." The results could indicate that sleep and dysmenorrhea are related. In dysmenorrhea without organic disease, the cause of pain could be excessive uterine contractions caused by prostaglandins released from the menstrual blood and uterine mucosa during menstruation. It is possible that the low-sleep quality group had more pain during menstruation because the prostaglandin system is activated when adequate sleep is not achieved [28].

The MDQ subscale in the premenstrual and postmenstrual periods related to sleep quality was "concentration." Female hormone levels are associated with cognitive function. For example, the change in estradiol levels with the menstrual cycle causes changes in cognitive function such as memory [29]. Additionally, rapid changes in hormone levels during pregnancy alter cognitive abilities [30]. These findings indicate that changes in female hormone levels are involved in memory and other cognitive functions. As discussed in the previous paragraph, decrease in sleep quality decreases the secretion of melatonin, which plays a role in regulating female hormones, suggesting that sleep quality may have a small effect on concentration, one of the perimenstrual symptoms.

Decreased sleep duration and long-term sleep deprivation are common in Japanese modern society. In a previous study involving Japanese college students, the mean sleep duration on weekdays was 5.9 hours; approximately 16% of the participants were categorized as evening-type individuals, and 56.1% felt sleepy during the day [23]. This seemingly represents the unhealthy sleeping habits of Japanese students. Perimenstrual symptoms are commonly experienced by female college students [25]. Based on the results of our study, which demonstrates a relationship between sleep quality and perimenstrual symptoms, the need to improve sleep quality among Japanese female students is high. Sleep problems are caused by the blue light emitted from mobile phones and personal computers [31], humidity in the bedroom, bedding, background noise, human voices, lighting, etc. [32]. Engaging in aerobic exercises and choosing appropriate bedding can improve sleep quality.

The present study had some limitations. First, the causal relationship between sleep quality and perimenstrual symptoms was not clarified. Second, the menstrual cycle at the time the participants completed the questionnaire was not considered, rendering this survey a cross-sectional one. However, the indicators used in this survey were established and confirmed to have no problems as retrospective formulas [28]. Third, since this was a retrospective study, recall bias might have occurred during the recall of perimenstrual symptoms and sleep conditions in each menstrual period. To minimize recall bias, respondents were asked to respond to items related to sleep conditions and perimenstrual symptoms within the last month. Finally, the secretion of melatonin and other body hormones was not measured. We intend to further investigate the relationship between sleep quality and perimenstrual symptoms by conducting an interventional study based on this survey's results.

We examined the association between sleep quality and perimenstrual symptoms among Japanese female students who were divided into normal- and low-sleep quality groups based on the cutoff values of the PSQI-J. The low-sleep quality group had higher total MDQ scores and several subscale scores compared with those of the normal-sleep quality group during the premenstrual, menstrual, and postmenstrual periods. In addition, multiple logistic regression analysis revealed that among the various menstrual symptoms, "concentration" during the premenstrual and postmenstrual periods and "pain" during menstruation were most strongly related to sleep quality. These results show that low sleep quality may lead to the worsening of perimenstrual symptoms, thus underscoring the importance for the management of women's health issues to improve sleep quality.

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Data availability statement

All data used and analyzed in this study are available from the corresponding author upon reasonable request.

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Competing interests

None declared

Author contributions

The study was designed by SO, NM, TT, RM, MK, SA, TN, and KN. Original drafting, reviewing, and editing of the manuscript were performed by SO, TT, and MR. The methodology was designed by SO, TT, and MR. Formal analysis was performed by SO. The research was supervised by YU. All authors read and approved the final manuscript.

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Figure legend

Figure. 1 Flowchart of this study

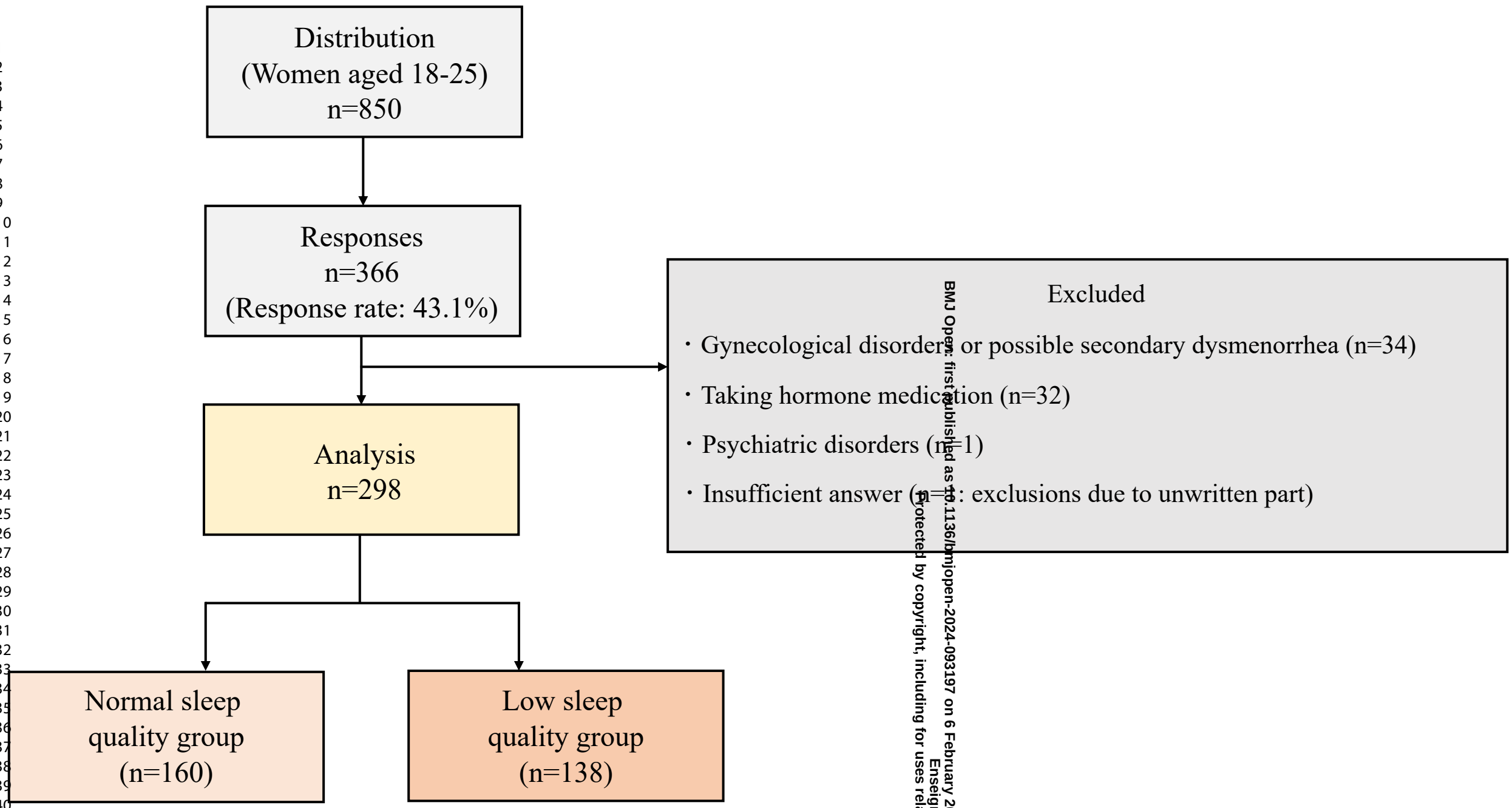

Figure. 1 Flowchart of this study

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Effect of sleep quality on the severity of perimenstrual symptoms in Japanese female students: A cross-sectional, online survey

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Abstract

Objectives: To investigate the relationship between sleep quality and perimenstrual symptoms among Japanese female students.

Design: Observational, cross-sectional, online survey

Setting: We used an online questionnaire to collate responses from Japanese female students on sleep quality and perimenstrual symptoms.

Participants: A total of 298 female students aged 18-25 years in Japan were included in this study.

Primary and secondary outcome measures: The Menstrual Distress Questionnaire (MDQ) was used to assess the severity of perimenstrual symptoms for three periods: premenstrual, menstrual, and postmenstrual, and the Japanese version of the Pittsburgh Sleep Quality Index was used to assess sleep quality. The MDQ scores were compared between two groups (normal-sleep quality and low-sleep quality) using Mann–Whitney U test. In addition, multiple logistic regression analysis was performed, and the MDQ subscales that showed significant differences between the groups were used as independent variables. The MDQ subscale that was strongly associated with sleep quality was calculated.

Results: Of the female students, 160 were classified into the normal-sleep quality group and 138 into the low-sleep quality group. The total MDQ scores were significantly higher in the low-sleep quality group at all phases of the menstrual cycle (respectively $p<0.05$). Among the MDQ subscales, “pain” during menstruation and “concentration” in the premenstrual and postmenstrual stages were associated with sleep quality (respectively $p<0.05$).

Conclusions: Improving sleep quality was one possible strategy to reduce the severity of perimenstrual symptoms. These results may provide useful information for Japanese female students who suffer from perimenstrual symptoms.

Strengths and limitations of this study

- This study conducts an online survey among female students aged 18-25 years in Japan.
- This study adhered to the recommendations of the Checklist for Reporting Results of Internet E-Surveys.
- Participants responded to the Japanese version of the Pittsburgh Sleep Quality Index (PSQI-J), a measure of sleep quality over the past month.
- Participants responded the Menstrual Distress Questionnaire (MDQ), which assessed perimenstrual symptoms across three phases: premenstrual, menstrual, and postmenstrual.

Keywords: Sleep; Primary health care; Surveys and Questionnaires

Word count: 4351 words

INTRODUCTION

Perimenstrual symptoms are varied and comprise physical, emotional, and behavioral symptoms. They occur during premenstrual, menstrual, and postmenstrual periods. Approximately 16–91% of women experience perimenstrual symptoms, such as irritability, depression, weight gain, and back pain [1]. These are important health issues that can lead to a decline in the quality of life of young women including students [2]. Additionally, missing classes due to dysmenorrhea and other perimenstrual symptoms causes a decline in the academic performance of female students [3].

Unhealthy lifestyle habits can affect perimenstrual symptoms [4]. Throughout the menstrual cycle, changes in the secretion of female hormones, including estrogen and progesterone, occur [5]. These changes have various effects on a woman's body and mind, causing perimenstrual symptoms. An example of lifestyle influences on these symptoms is the consumption of trans-fatty acids, which are abundant in fast food and increase the levels of prostaglandins, consequently causing dysmenorrhea and highlighting that an unbalanced diet can lead to increased pain [4]. Exercise could also be associated with perimenstrual symptoms. Reportedly, the secretion of estradiol during exercise increases serotonin secretion, which reduces the negative effects of perimenstrual symptoms [6]. These reports suggest that lifestyle habits are related to perimenstrual symptoms in terms of hormone secretion.

Sleep, one of the lifestyle habits, is an important aspect of human life, with approximately one-third of life's existence spent sleeping [7]. The hypothalamus plays an important role in sleep and is a regulator of sleep and wakefulness [8]. It contains gonadotropin-releasing hormone (GnRH) neurons, which drive the menstrual cycle by secreting GnRH, which helps to regulate female hormone levels [9]. Additionally, a direct synaptic connection exists between the sleep center of the brain and GnRH neurons, and deep sleep activates GnRH pulse generators [10]. Thus, it is possible that sleep and perimenstrual symptoms, which are both regulated by the hypothalamus, may be closely related.

Sleep is characterized by sleep duration and quality, and distinguishing between these two characteristics is essential [11]. Compared with sleep quality, sleep duration assesses sleep objectively and refers to the duration of sleep [12]. In contrast, sleep quality is evaluated subjectively and is defined as a sense of rest upon waking and satisfaction with sleep [12]. Although some overlap exists between these two characteristics, they are considered distinct and independent [13]. Reportedly, short sleep duration (<6 hours/day) is associated with moderate to severe dysmenorrhea, revealing a relationship between sleep duration and perimenstrual symptoms [14]. However, no study has examined the relationship between sleep quality and perimenstrual symptoms. Therefore, this study aimed to examine the involvement of sleep quality in perimenstrual symptoms in Japanese female students and propose strategies to alleviate

perimenstrual symptoms.

METHODS

Patient and public involvement

The questionnaire design involved female students. After the questionnaire was drafted, it was pretested with 20 Japanese female students who were not included in the main study. The study was conducted with female students residing throughout Japan and was not restricted to any region, such as prefectures. We plan to widely disseminate the findings of this study to the public by sharing information on social media and so on.

Study design

An observational, cross-sectional, online survey of Japanese female students aged 18–25 years was conducted from November 8, 2022, to February 2, 2023, in Japan. The survey was conducted using Google Forms (Alphabet Inc., Mountain View, CA, USA). An online survey was disseminated nationwide to female students aged 18–25 years using the URL of the questionnaire through a snowball sampling method, without identifying the geographical area. Before the survey questions began, a summary of the survey instructions, the purpose of the survey, the time required to complete it, and the following instructions to the participants were provided: participants can answer questions anonymously, answer just once, and could decline participation at any point during the survey. Responses were used solely for research purposes. Participants could commence the questionnaire after checking a consent box, thereby agreeing to participate in the study. Only those who consented to participate in the survey after reviewing the survey summary and instructions proceeded to answer the questions. Examples of statements were provided for questions that participants found difficult to understand, to prevent incorrect inputs. Data files containing responses were secured with a password to enhance protection. The inclusion criteria were the following: (a) agreeing to participate in this study, (b) Japanese female students aged between 18 and 25 years, and (c) residing in Japan at the time of the survey. The exclusion criteria were as follows: (a) had a current or previous history of gynecological disorders or possible secondary dysmenorrhea [15], (b) had a current or previous history of psychiatric disorders, and (c) current history of daily hormonal pill intake. Based on the self-reported responses of the participants, their eligibility for the inclusion and exclusion criteria were determined. This study adhered to the recommendations of the Checklist for Reporting Results of Internet E-Surveys [16]. Furthermore, this study conformed to the guidelines of the Declaration of Helsinki and was approved by the Ethical Committee for Epidemiology, Hiroshima University (E-3791).

Question items

The question items were mainly related to sleep quality and the severity of perimenstrual symptoms. They included basic information and sociodemographic and lifestyle characteristics. Basic information included age, age at menarche, height and weight for body mass index (BMI; kg/m^2) calculation, duration of dysmenorrhea, current and previous history of gynecological or psychiatric disorders, and medications for internal use related to these disorders. Sociodemographic characteristics included questions regarding part-time job (yes/no) and living status (alone/with others). Lifestyle characteristics included questions regarding alcohol intake (low/high: no alcohol consumption or up to 2 drinks per week/more), smoking (yes/no), breakfast (eating/not eating), eating between meals (eating/not eating), caffeine consumption (yes/no: ≥3 times/week), studying until bedtime (yes/no: ≥3 times/week), watching TV until bedtime (yes/no: ≥3 times/week), and screen time (min/day) related to leisure and study [17, 18].

The Japanese version of the Pittsburgh Sleep Quality Index (PSQI-J) was used to rate sleep quality in the past month. The PSQI-J has been used and validated in a previous study that assessed sleep quality [19, 20]. Participants answered questions regarding their sleep over the past month, and the overall score (range, 0–21) was calculated as the total score of seven factors presented in questions 1–7: subjective sleep quality, time to fall asleep, sleep duration, sleep efficiency, sleep difficulty, use of sleeping pills, and difficulty in staying awake during the day. Subjective sleep quality was assessed using one question rated on a 4-point Likert scale (very good, quite good, quite bad, and very bad). Time to fall asleep was assessed using two questions regarding the time from bedtime to falling asleep. Sleep duration was rated in 4 stages (>7 hours; >6 hours but ≤7 hours; ≥5 hours but ≤6 hours; and <5 hours). Sleep efficiency was calculated by dividing sleep duration by the total number of hours in bed. Sleep difficulty was assessed using nine questions regarding waking up in the middle of the night, difficulty falling asleep soon after going to bed, feeling cold, having bad dreams, getting up to use the restroom, difficulty in breathing correctly, snoring loudly and coughing, feeling pain, or having other reasons for sleep disorders. The use of sleeping pills and difficulty in staying awake during the day were rated on a 4-point Likert scale (not once, less than once per week, once or twice per week, and three or more times per week). A total PSQI-J score of 5 and below indicates normal sleep quality, and 6 and above indicates low sleep quality [19].

The Menstrual Distress Questionnaire (MDQ) has long been used as a measure to evaluate the severity of perimenstrual symptoms, and its Japanese version has been validated [21, 22]. The index assesses responses to 46 questions on eight subscales of perimenstrual symptoms [23]. Responses on the most recent symptoms were rated on a

6-point scale (1: no reaction at all, 6: acute or partially disabling). High scores indicated increased severity of perimenstrual symptoms. We used six subscales comprising pain, water retention, autonomic reaction, negative affect, concentration, and behavioral change; two subscales (mood elevation and control), with higher scores indicating better symptoms, were excluded. Each symptom was assessed for three periods: premenstrual, menstrual, and postmenstrual.

Statistical analysis

The respondents were divided into normal-sleep quality and low-sleep quality groups based on the PSQI-J cutoff value of 6 points [19]. Data collected from the survey were processed using IBM SPSS version 28.0 for Windows (IBM Japan Co., Ltd., Tokyo, Japan). Before conducting the analysis, the Shapiro–Wilk test was used to assess the normality of all data. Basic information and lifestyle characteristics, MDQ total scores, and subscales in each menstrual period were compared between both groups using the Mann–Whitney U test. The required sample size was calculated using G*Power 3.1. The analysis, with an effect size of d=0.5 and an alpha level of α=0.05, indicated a statistical power of 0.801, with each group requiring a sample size of 67. Chi-square tests were used to assess sociodemographic and lifestyle characteristics. Effect sizes were calculated to assess not only whether the differences and associations were statistically significant but also the practical significance of these effects. Specifically, the phi coefficient "φ" was used for the chi-square test and the correlation coefficient (r) for the Mann-Whitney U test as indicators of effect size. These effect size measures provided additional context, contributing to the interpretation of the magnitude of the observed effects and their practical relevance beyond mere statistical significance. Multiple logistic regression analysis was conducted separately for each menstrual phase (premenstrual, menstrual, and postmenstrual) to identify the relationship between the MDQ subscale scores and sleep quality. For analysis, a PSQI-J score <6 was coded as 0, and a PSQI-J score ≥6 was coded as 1. Normal or low sleep quality was set as the dependent variable, and MDQ subscales demonstrated statistically significant differences (p-values <0.05) between the normal and low sleep quality groups in group comparisons were selected as independent variables for the analysis (crude model). Additionally, adjustments were made for age (adjusted model), as hormonal balance changes with age [24]. The variance inflation factor, a statistic used to measure possible multicollinearity among predictors or independent variables, was computed [25]. Multiple variables were employed as independent variables, and to address the potential issue of multiple comparisons, Bonferroni correction was applied. Odds ratios (OR) were determined only for the logistic regression analysis to assess the strength and direction of the associations. For all statistical tests, 95% confidence intervals (CI) were calculated to evaluate the precision and reliability of the estimates. Regarding sample size calculation, the number of participants per

independent variable should be ≥10 based on a previous study [26]. In the present study, four to seven MDQ subscales were used as independent variables. Therefore, it was necessary to include at least 70 participants each in the normal- or low-sleep quality groups. The significance level was set at 0.05.

RESULTS

The survey was distributed among 850 participants, and 366 of them (response rate: 43.1%) provided responses. Of the respondents, 68 were excluded (34 respondents had a current or previous history of gynecological disorders or possible secondary dysmenorrhea, 32 respondents were taking hormone medication, one respondent had a current or previous history of psychiatric disorders, and one respondent answered insufficiently). Thus, 298 respondents were included in the final analysis. Of the 298 participants, 160 were classified into the normal-sleep quality group and 138 into the low-sleep quality group based on the PSQI-J cutoff value points **(Figure 1**).

Basic information, sociodemographic characteristics, and lifestyle characteristics

No significant differences in age, age at menarche, BMI, part-time job, and living status were observed between the two groups, as shown in **Table 1**.

As shown in **Table 1**, no significant differences in alcohol intake, smoking, eating between meals, caffeine consumption, studying until bedtime, watching TV until bedtime, and screen time were observed between the two groups. In contrast, a significant difference in breakfast consumption was observed between the two groups, with a significantly higher number of students eating breakfast in the normal-sleep quality group compared with that in the low-sleep quality group (p=0.023).

Table 1. Basic information, sociodemographic characteristics, and lifestyle characteristics

Variables	Normal-sleep quality group (n=160)	Low-sleep quality group (n=138)	χ^2	p value	Effect size	95% CI	
						Lower	Upper
Age (y.o.)	20.8 ± 1.4	20.7 ± 1.3		0.666	-0.025	0.000	0.000
Age at menarche (y.o.)	12.5 ± 1.7	12.5 ± 1.5		0.839	0.012	0.000	0.000
BMI (kg/m^2)	20.5 ± 2.6	20.8 ± 2.6		0.884	0.008	-0.521	0.459
Part-time job							
Yes	135 (84.4)	123 (89.1)	1.442	0.230	0.070	0.004	0.168
No	25 (15.6)	15 (10.9)					
Living status							
Alone	57 (35.6)	46 (33.3)	0.172	0.678	0.024	0.002	0.143
With others	103 (64.4)	92 (66.7)					
Alcohol intake							
Low	145 (90.6)	129 (93.5)	0.815	0.367	0.052	0.003	0.169
High	15 (9.4)	9 (6.5)					
Smoking							
No	152 (95.0)	133 (96.4)	0.337	0.562	0.034	0.002	0.149
Yes	8 (5.0)	5 (0.6)					
Breakfast							
Eating	114 (71.3)	81 (58.7)	5.163	0.023*	0.132	0.016	0.245
Not eating	46 (28.7)	57 (41.3)					
Eating between meals							
Eating	101 (63.1)	95 (68.8)	1.075	0.300	0.060	0.004	0.172
Not eating	59 (36.9)	43 (31.2)					

Caffeine consumption (≥3 times/week)							
Yes	74 (46.3)	57 (41.3)	0.736	0.391	0.050	0.031	0.234
No	86 (53.7)	81 (58.7)					
Studying until going to bed (≥3 times/week)							
Yes	37 (23.1)	32 (23.2)	0.000	0.990	0.001	0.016	0.183
No	123 (76.9)	106 (76.8)					
Watching TV until going to bed (≥3 times/week)							
Yes	44 (27.5)	29 (21.0)	1.685	0.194	0.075	0.023	0.206
No	116 (72.5)	109 (79.0)					
Screen time							
Leisure (min/day)	256.4 ± 204.2	252.1 ± 144.0		0.578	0.032	-30.000	30.000
Study (min/day)	105.9 ± 129.8	107.1 ± 124.4		0.265	0.064	-20.000	0.000

*Statistically significant

BMI, body mass index; y.o., years old; CI, confidence interval

Data are expressed as mean ± standard deviation, or n (%).

Comparison of MDQ total scores and subscale scores between the two groups during the premenstrual, menstrual, and postmenstrual periods

Figure 2 shows the comparison of the total MDQ scores. The mean total MDQ scores for the normal-sleep quality group and low-sleep quality group were 68.5 points (SD=22.4) and 79.8 points (SD=37.6), respectively, during the premenstrual phase (p=0.006, 95%CI: –16.000, 2.000). During menstruation, the mean total MDQ scores for the

normal-sleep quality group and low-sleep quality group were 73.3 points (SD=34.2) and 93.7 points (SD=40.6), respectively (p<0.001, 95%CI: –29.000, 11.000). The mean total MDQ scores in the postmenstrual phase were 51.2 points (SD=24.6) in the normal-sleep quality group and 60.2 points (SD=33.0) in the low-sleep quality group (p=0.005, 95%CI: –6.000, 0.000).

Figure 3 presents the results of the comparison of MDQ subscale scores during the premenstrual phase. The mean MDQ subscale scores in the normal-sleep quality group and low-sleep quality group of the various items were as follows: pain, 12.8 points (SD=6.6) and 15.1 points (SD=8.0), respectively, (p=0.016, 95%CI: –3.000, 0.000); water retention, 10.0 points (SD=5.0) and 11.0 points (SD=5.2), respectively, (p=0.091, 95%CI: –2.000, 0.000); automatic reaction, 5.5 points (SD=2.9) and 6.5 points (SD=4.0), respectively, (p=0.050, 95%CI: 0.000, 0.000); negative affect, 15.8 points (SD=9.2) and 17.9 points (SD=10.0), respectively, (p=0.025, 95%CI: –3.000, 0.000); concentration, 12.8 points (SD=7.0) and 15.7 points (SD=8.5), respectively, (p<0.001, 95%CI: –3.000, 0.000); and behavioral change, 11.6 points (SD=6.6) and 13.6 points (SD=7.3), respectively, (p=0.013, 95%CI: –3.000, 0.000).

Figure 4 shows the results of the comparison of MDQ subscale scores during menstruation. In the normal-sleep quality group and low-sleep quality group, the mean MDQ subscale scores of the various items were as follows: pain, 15.4 points (SD=7.6) and 19.8 points (SD=8.6), respectively, (p<0.001, 95%CI: –7.000, –2.000); water retention, 9.3 points (SD=4.6) and 11.1 points (SD=5.2), respectively, (p=0.002, 95%CI: –3.000, –1.000); automatic reaction, 6.2 points (SD=3.7) and 7.8 points (SD=4.6), respectively, (p<0.001, 95%CI: –1.000, 0.000); negative affect, 15.6 points (SD=8.7) and 20.2 points (SD=10.6), respectively, (p=0.025, 95%CI: –6.000, –2.000); concentration, 13.8 points (SD=7.7) and 18.3 points (SD=10.2), respectively, (p<0.001, 95%CI: –5.000, –1.000); and behavioral change, 13.0 points (SD=6.9) and 16.6 points (SD=7.7), respectively, (p<0.001, 95%CI: –5.000, –2.000).

Figure 5 provides the results of the comparison of MDQ subscale scores in the postmenstrual phase. In the normal-sleep quality group and low-sleep quality group, the mean of the MDQ subscale scores for the items are as follows: pain, 9.9 points (SD=6.0) and 11.4 points (SD=7.2), respectively, (p=0.027, 95%CI: –1.000, 0.000); water retention, 6.8 points (SD=4.0) and 7.3 points (SD=3.9), respectively, (p=0.086, 95%CI: –1.000, 0.000); automatic reaction, 4.9 points (SD=2.1) and 5.7 points (SD=3.4), respectively, (p=0.072, 95%CI: 0.000, 0.000); negative affect, 11.4 points (SD=6.3) and 13.2 points (SD=8.0), respectively, (p=0.011, 95%CI: 0.000, 0.000); concentration, 10.2 points (SD=4.2) and 12.8 points (SD=7.4), respectively, (p<0.001, 95%CI: –1.000, 0.000); and behavioral change, 8.1 points (SD=4.6) and 9.8 points (SD=6.1), respectively, (p=0.005, 95%CI: –1.000, 0.000).

Multiple logistic regression analysis

To show the associations of sleep quality with the MDQ subscales, multiple logistic regression analysis in the crude model was performed (**Table 3**). The MDQ concentration score during the premenstrual period (β=0.068; p=0.034; OR, 1.070; 95% CI, 1.005–1.140), pain during menstruation (β=0.057; p=0.040; OR, 1.059; 95% CI, 1.003–1.117), and concentration during the postmenstrual period (β=0.165; p=0.003; OR, 1.179; 95% CI, 1.058–1.313) were significantly associated with sleep quality.

Furthermore, to assess the relationship between sleep quality and MDQ subscales, multiple logistic regression analysis was conducted in the adjusted model (**Table 4**). In the premenstrual phase, a significant relationship with sleep quality was identified for concentration (β=0.071; p=0.028; OR, 1.073; 95% CI: 1.008, 1.143). During menstruation, a significant relationship with sleep quality was detected for pain (β=0.058; p=0.038; OR, 1.059; 95% CI: 1.003, 1.118). The MDQ concentration score during the postmenstrual phase was significantly associated with sleep quality (β=0.164; p=0.003; OR, 1.178; 95% CI: 1.058, 1.312).

Table 3. Multiple logistic regression analysis for the association of sleep quality with MDQ subscales in the crude model

	β	SE	Wald	df	P value	OR	95% CI	
							Lower	Upper
Premenstrual								
Pain	0.022	0.026	0.722	1	0.396	1.022	0.972	1.075
Negative affect	-0.040	0.027	2.221	1	0.136	0.961	0.913	1.013
Concentration	0.068	0.032	4.493	1	0.034*	1.070	1.005	1.140
Behavioral change	0.006	0.036	0.030	1	0.864	1.006	0.937	1.081
During menstruation								

Pain	0.057	0.028	4.229	1	0.040*	1.059	1.003	1.117
Water retention	-0.030	0.038	0.630	1	0.427	0.970	0.901	1.045
Autonomic reaction	-0.011	0.044	0.064	1	0.801	0.989	0.907	1.079
Negative affect	0.009	0.023	0.158	1	0.691	1.009	0.965	1.056
Concentration	0.029	0.026	1.215	1	0.270	1.029	0.978	1.083
Behavioral change	-0.003	0.033	0.006	1	0.937	0.997	0.935	1.064
Postmenstrual								
Pain	-0.013	0.037	0.115	1	0.735	0.987	0.918	1.602
Negative affect	-0.082	0.043	3.540	1	0.060	0.922	0.846	1.003
Concentration	0.165	0.055	8.968	1	0.003*	1.179	1.058	1.313
Behavioral change	0.024	0.063	0.140	1	0.709	1.024	0.904	1.159

Variation inflation factor (premenstrual): pain, 2.679; negative affect, 4.429; concentration, 4.167; behavioral change, 4.569. During menstruation: pain, 3.668; water retention, 2.452; automatic reaction, 2.344; negative affect, 3.614; concentration, 3.812; behavioral change, 4.212. Postmenstrual: pain, 3.872; negative affect, 5.161; concentration, 4.701; behavioral change, 7.171

MDQ, Menstrual Distress Questionnaire; β, partial regression coefficient; SE, standard error; df, degree of freedom; OR, odds ratio; CI, confidence interval

*Statistically significant

Table 4. Multiple logistic regression analysis for the association of sleep quality with MDQ subscales in the adjusted model

	β	**SE**	**Wald**	**df**	**P value**	**OR**	**95% CI**	
							Lower	**Upper**
Premenstrual								

Pain	0.022	0.026	0.747	1	0.387	1.023	0.972	1.076
Negative affect	-0.041	0.027	2.373	1	0.123	0.960	0.911	1.011
Concentration	0.071	0.032	4.808	1	0.028*	1.073	1.008	1.143
Behavioral change	0.008	0.036	0.047	1	0.828	1.008	0.938	1.083
Age	-0.085	0.090	0.904	1	0.342	0.918	0.770	1.095
During menstruation								
Pain	0.058	0.028	4.304	1	0.038*	1.059	1.003	1.118
Water retention	-0.034	0.038	0.781	1	0.377	0.967	0.897	1.042
Autonomic reaction	-0.009	0.044	0.044	1	0.835	0.991	0.908	1.081
Negative affect	0.009	0.023	0.137	1	0.712	1.009	0.964	1.055
Concentration	0.028	0.026	1.200	1	0.273	1.029	0.978	1.083
Behavioral change	0.000	0.033	0.000	1	0.996	1.000	0.937	1.067
Age	-0.089	0.092	0.924	1	0.336	0.915	0.764	1.096
Postmenstrual								
Pain	-0.015	0.038	0.151	1	0.698	0.986	0.916	1.061
Negative affect	-0.082	0.043	3.600	1	0.058	0.921	0.846	1.003
Concentration	0.164	0.055	8.925	1	0.003*	1.178	1.058	1.312
Behavioral change	0.026	0.064	0.169	1	0.681	1.027	0.906	1.163
Age	-0.043	0.091	0.221	1	0.638	0.958	0.802	1.144

Variation inflation factor (premenstrual): pain, 2.679; negative affect, 4.431; concentration, 4.167; behavioral change, 4.589; age, 1.012. During menstruation: pain, 3.668; water retention, 2.474; automatic reaction, 2.349; negative affect, 3.616; concentration, 3.813; behavioral change, 4.236; age, 1.016. Postmenstrual: pain, 3.924; negative affect, 5.162; concentration, 4.708; behavioral change, 7.219; age, 1.024.

MDQ, Menstrual Distress Questionnaire; β, partial regression coefficient; SE, standard error; df, degree of freedom;

OR, odds ratio; CI, confidence interval

*Statistically significant

DISCUSSION

The aim of this study was to investigate the relationship between sleep quality and perimenstrual symptoms among Japanese female students. The main findings of this study revealed that lower sleep quality was associated with increased severity of perimenstrual symptoms. Furthermore, among the MDQ components, significant associations with sleep quality were observed for pain during menstruation and concentration during the premenstrual and postmenstrual periods. The Japanese population is known to have poor sleep habits, and in particular, college students are prone to disrupting their sleeping habits [27]. Therefore, confirming whether sleep quality is associated with perimenstrual symptoms among Japanese female students and identifying perimenstrual symptoms most strongly related to sleep quality are important.

First, this study compares its results with previous research investigating the association between sleep quality and perimenstrual symptoms. In a study among female university students, comparing PSQI scores with and without dysmenorrhea showed that the group with dysmenorrhea had higher PSQI scores and lower sleep quality ($p<0.05$) [28]. In another study focusing on premenstrual syndrome (PMS), women with severe PMS had lower subjective sleep quality in the late luteal phase [29]. As seen in previous studies, some investigations have explored the relationship between perimenstrual symptoms and sleep quality. However, no studies have definitively confirmed which symptoms are particularly relevant among the various perimenstrual symptoms. This study not only examined the association between perimenstrual symptoms and sleep quality but also identified which symptoms were most strongly associated with sleep quality during each menstrual cycle. By focusing on specific perimenstrual symptoms, such as pain during menstruation and concentration difficulties during the premenstrual and postmenstrual phases, this study provides a more detailed understanding of the relationship between sleep quality and perimenstrual symptoms.

A previous study of female undergraduate and graduate students in Taiwan found that normal or low sleep quality was associated with the onset of perimenstrual symptoms, and 51.4% of female students were indicated to have normal sleep quality (PSQI <6) and 48.6% indicated to have low sleep quality (PSQI ≥6) [30]. These results suggest a relationship between sleep quality and perimenstrual symptoms. In our study, the severity of perimenstrual symptoms was lower in the normal-sleep quality group than in the low-sleep quality group, which is similar to the results of the previous study [30]. Moreover, 53.7% of the participants were classified into the normal-sleep quality group and 46.3%

into the low-sleep quality group, suggesting no participant bias when investigating sleep quality compared with that in previous studies. The average MDQ scores in Japanese young women aged 18 years and older [6] are 57.2 points in the premenstrual, 63.0 points in the menstrual, and 42.5 in the postmenstrual periods. In the present study, the average MDQ total scores were 74.2 points in the premenstrual, 83.5 points in the menstrual, and 55.8 in the postmenstrual periods, which were higher than those reported in the previous study [6]. A higher percentage of female college students have severe perimenstrual symptoms [31], which may explain the relatively high MDQ total scores of our study.

The MDQ total scores and several subscale scores were higher in the lower-sleep quality group than in the normal-sleep quality group during all the menstrual periods. The most likely explanation for the association between sleep quality and perimenstrual symptoms is the influence of melatonin. Melatonin, which is responsible for inducing sleep, decreases with low sleep quality [32]. It is also involved in reproductive functions and plays a role in regulating the levels of estrogen and progesterone [33]. Thus, the decrease in melatonin secretion due to low sleep quality might have led to a disturbance in the regulatory mechanism of female hormone levels, which might have resulted in the higher severity of perimenstrual symptoms in the low-sleep quality group. However, these discussions are predominantly speculative, since this was a cross-sectional study based on an online survey, making it impossible to measure melatonin secretion or variations.

Multiple logistic regression analysis showed that the MDQ subscale during menstruation related to sleep quality was “pain,” suggesting a relationship between sleep and dysmenorrhea. In dysmenorrhea without organic disease, the cause of pain could be excessive uterine contractions caused by prostaglandins released from the menstrual blood and uterine mucosa during menstruation. It is possible that the low-sleep quality group had more pain during menstruation because the prostaglandin system is activated when adequate sleep is not achieved [34].

The MDQ subscale in the premenstrual and postmenstrual periods related to sleep quality was “concentration.” Female hormone levels are associated with cognitive function. For example, the change in estradiol levels with the menstrual cycle causes changes in cognitive function such as memory [35]. Additionally, rapid changes in hormone levels during pregnancy alter cognitive abilities [36]. These findings indicate that changes in female hormone levels are involved in memory and other cognitive functions. As discussed in the previous paragraph, decrease in sleep quality decreases the secretion of melatonin, which plays a role in regulating female hormones, suggesting that sleep quality may be linked to concentration, a perimenstrual symptom.

Decreased sleep duration and long-term sleep deprivation are common in Japanese modern society. In a previous study involving Japanese college students, the mean sleep duration on weekdays was 5.9 hours; approximately 16% of the participants were categorized as evening-type individuals, and 56.1% felt sleepy during the day [27]. This seemingly represents the unhealthy sleeping habits of Japanese students. Perimenstrual symptoms are commonly experienced by

female college students [31]. Based on the results of our study, which demonstrates a relationship between sleep quality and perimenstrual symptoms, the need to improve sleep quality among Japanese female students is high. Sleep problems are caused by the blue light emitted from mobile phones and personal computers [37], humidity in the bedroom, bedding, background noise, human voices, lighting, etc. [38]. Particularly, the age group targeted in this study is one where smartphone usage is prevalent, making the issue of blue light exposure an important concern. About two hours before bedtime, the secretion of melatonin, a hormone that promotes sleep, begins. Exposure to light or the use of smartphones during this period, which emits blue light, has been reported to suppress the secretion of melatonin. This suppression disrupts the sleep-wake cycle, causing a delay in sleep onset and hindering the ability to fall asleep [39]. Consequently, minimizing blue light exposure from smartphone use at night could be a beneficial intervention. However, considering contemporary trends, it would be challenging to propose restrictions on smartphone use for students. Previous studies have demonstrated that regular aerobic exercise, such as walking or cycling, can enhance sleep quality by regulating circadian rhythms and decreasing sleep onset latency. Based on the results of a study by Lu in 2023, aerobic exercise significantly improved sleep quality in a sample of 719 college students, with a regression coefficient of −0.37 ($p < 0.001$), as determined by regression analysis [40]. Additionally, optimizing the sleep environment, such as using comfortable bedding and controlling room temperature, has been linked to better sleep quality and efficiency. In a study by Bert et al, it was found that switching to a new bedding system significantly improved sleep quality and comfort with improvements becoming more prominent over time [41]. These findings suggest that the use of appropriate bedding could be an important factor in enhancing sleep quality. Along with reducing blue light exposure, such interventions may offer effective strategies for improving sleep among young adults.

The present study had some limitations. First, the causal relationship between sleep quality and perimenstrual symptoms was not clarified. Second, the menstrual cycle at the time the participants completed the questionnaire was not considered, rendering this survey a cross-sectional one. However, the indicators used in this survey were established and confirmed to have no problems as retrospective formulas [22]. Third, since this was a retrospective study, recall bias might have occurred during the recall of perimenstrual symptoms and sleep conditions in each menstrual period. To minimize recall bias, respondents were asked to respond to items related to sleep conditions and perimenstrual symptoms within the last month. Fourth, the survey utilized a snowball sampling method, raising questions about the potential lack of randomness and the representativeness of the sample in terms of individual status. Although the survey was broadly disseminated to mitigate regional or demographic biases, the snowball sampling approach may have introduced selective bias, as participants likely shared the questionnaire with individuals possessing similar characteristics. A fifth limitation of this study is the relatively low response rate of 43.1% for the online survey. Although the questionnaires were

distributed without geographical limitations, these fourth and fifth limitations may indicate particular characteristics of the respondents. As such, the results should be interpreted cautiously, and future studies with higher response rates and more representative samples are necessary to confirm these findings. Finally, the secretion of melatonin and other body hormones was not measured. Measuring these variables could yield objective data to enhance the understanding of the physiological mechanisms underlying the relationship between sleep quality and perimenstrual symptoms. Given these limitations, future research should focus on conducting longitudinal or experimental studies to explore the causal relationships between sleep quality and perimenstrual symptoms. Expanding the sample size to incorporate a more diverse population is essential, accounting for factors such as lifestyle, education level, and other characteristics that could influence the results. Additionally, incorporating objective measurements of sleep and hormonal levels, such as melatonin secretion, would provide clearer insights into the physiological mechanisms involved. These steps would bolster the validity and generalizability of future findings.

We examined the association between sleep quality and perimenstrual symptoms among Japanese female students who were divided into normal- and low-sleep quality groups based on the cutoff values of the PSQI-J. The low-sleep quality group had higher total MDQ scores and several subscale scores compared with those of the normal-sleep quality group during the premenstrual, menstrual, and postmenstrual periods. In addition, multiple logistic regression analysis revealed that among the various menstrual symptoms, “concentration” during the premenstrual and postmenstrual periods and “pain” during menstruation were most strongly related to sleep quality. These results show that low sleep quality may be associated with worsening perimenstrual symptoms and suggest the importance of considering and addressing these relationships in the management of women's health issues.

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Data availability statement

All data used and analyzed in this study are available from the corresponding author upon reasonable request.

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Competing interests

None declared

Author contributions

The study was designed by SO, NM, TT, RM, MK, SA, TN, and KN. Original drafting, reviewing, and editing of the manuscript were performed by SO, TT, and MR. The methodology was designed by SO, TT, and MR. Formal analysis was performed by SO. The research was supervised by YU. All authors read and approved the final manuscript. Sakura Oda / SO is the guarantor.

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Figure legend

Figure. 1 Flowchart of this study

Figure. 2 Comparison of MDQ total scores

Figure. 3 Comparison of MDQ subscale scores: premenstrual

Figure. 4 Comparison of MDQ subscale scores: during menstruation

Figure. 5 Comparison of MDQ subscale scores: postmenstrual

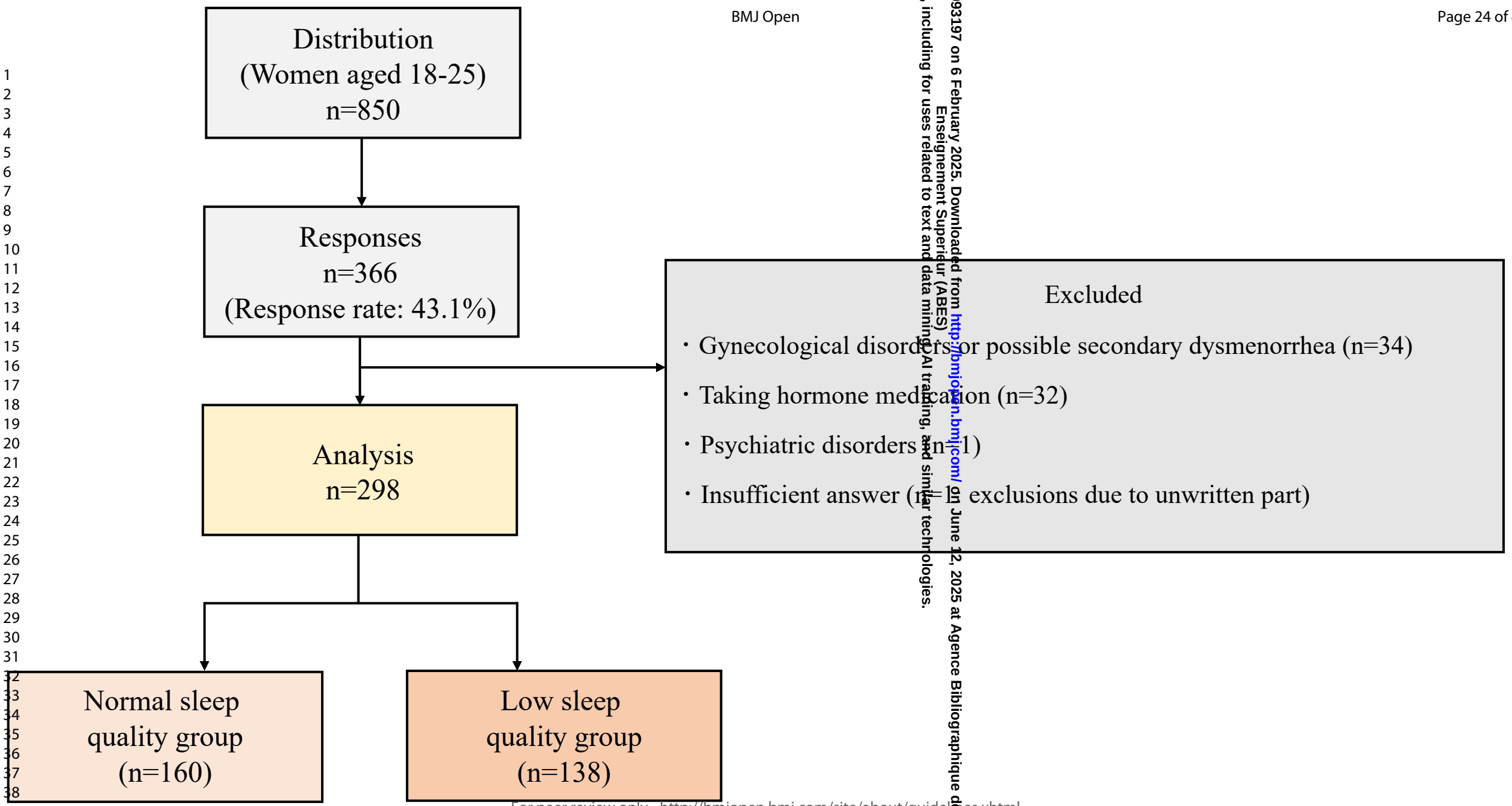

Figure. 1 Flowchart of this study

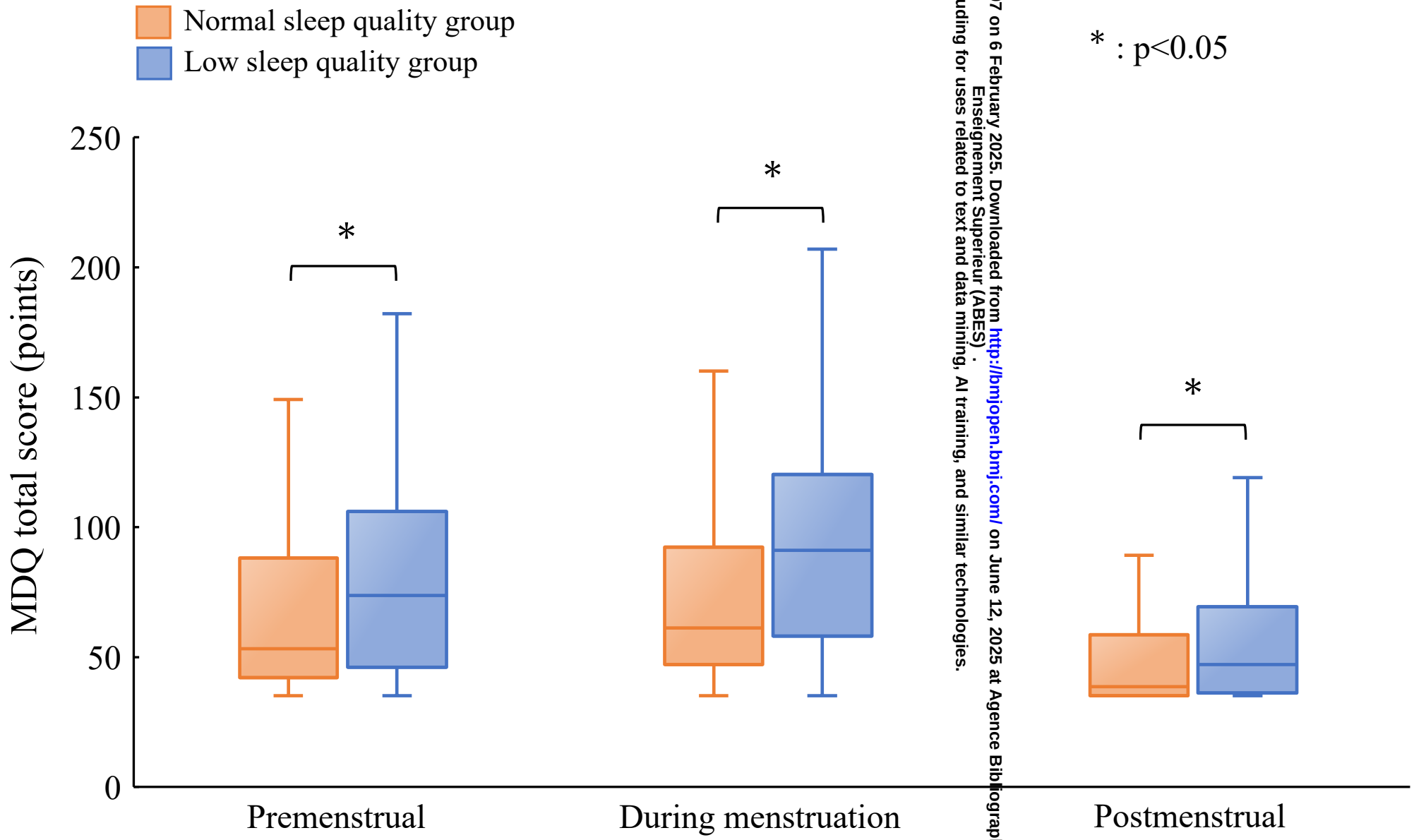

Figure. 2 Comparison of MDQ total scores

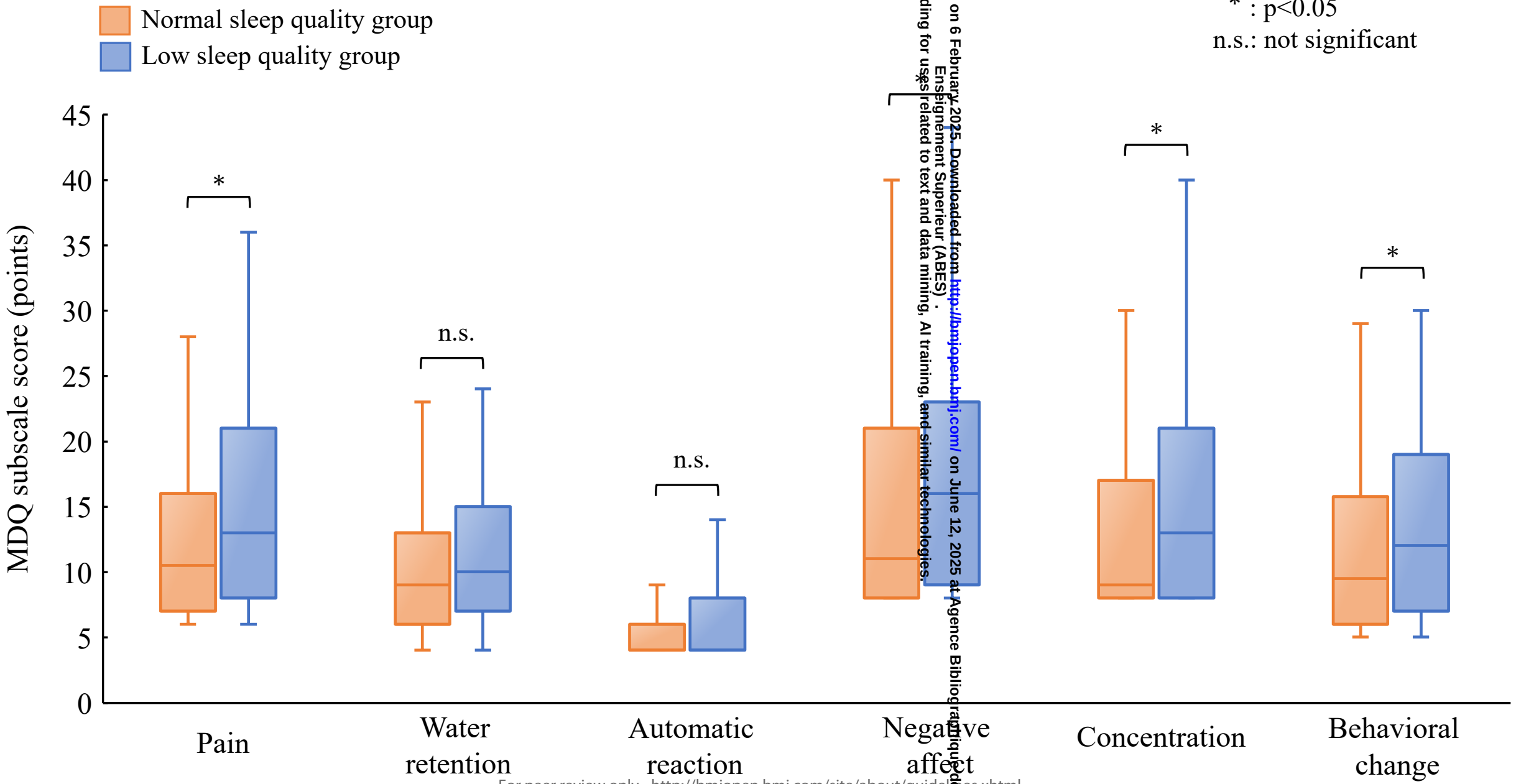

Figure. 3 Comparison of MDQ subscale scores: premenstrual

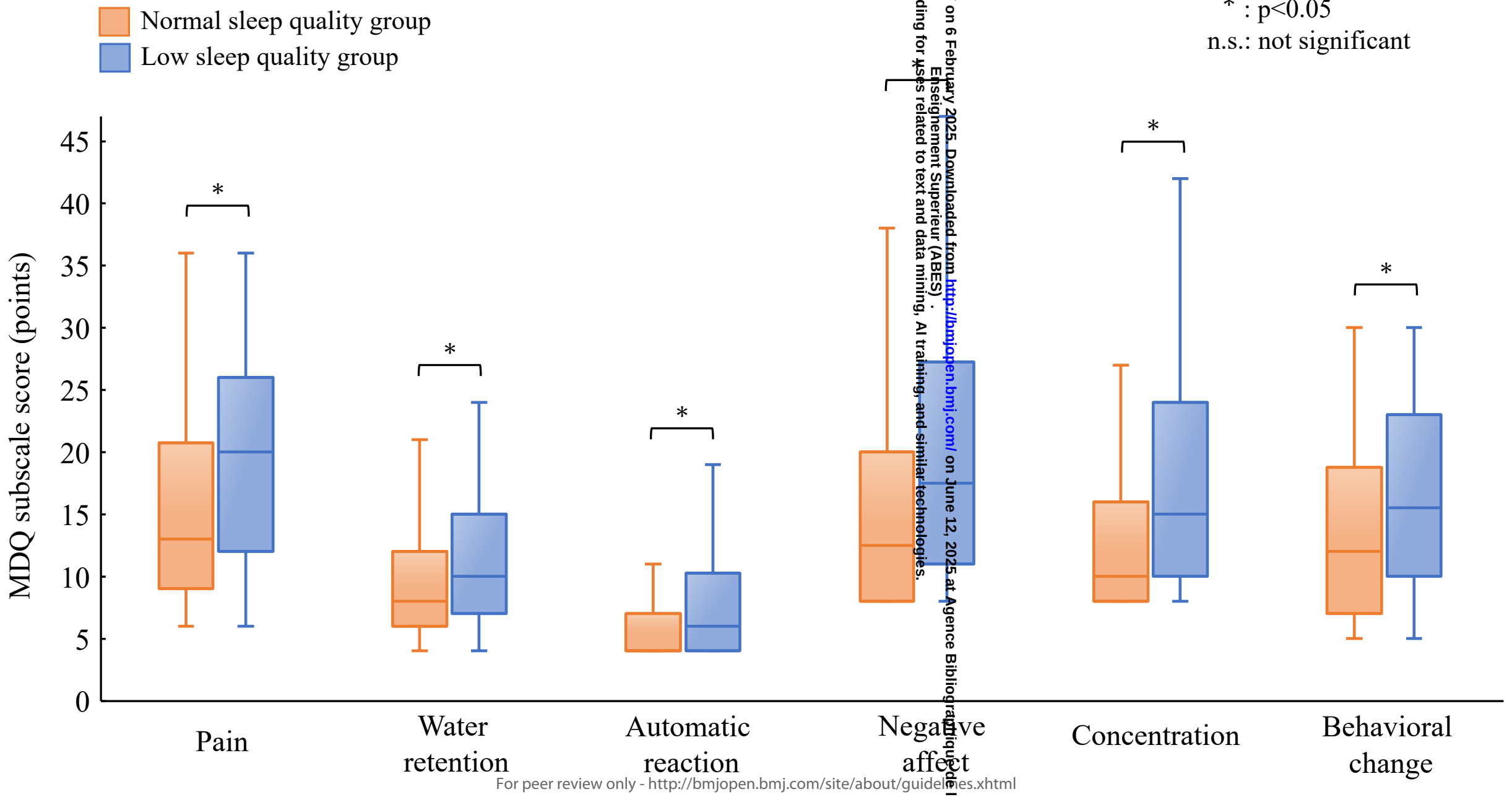

Figure. 4 Comparison of MDQ subscale scores: during menstruation

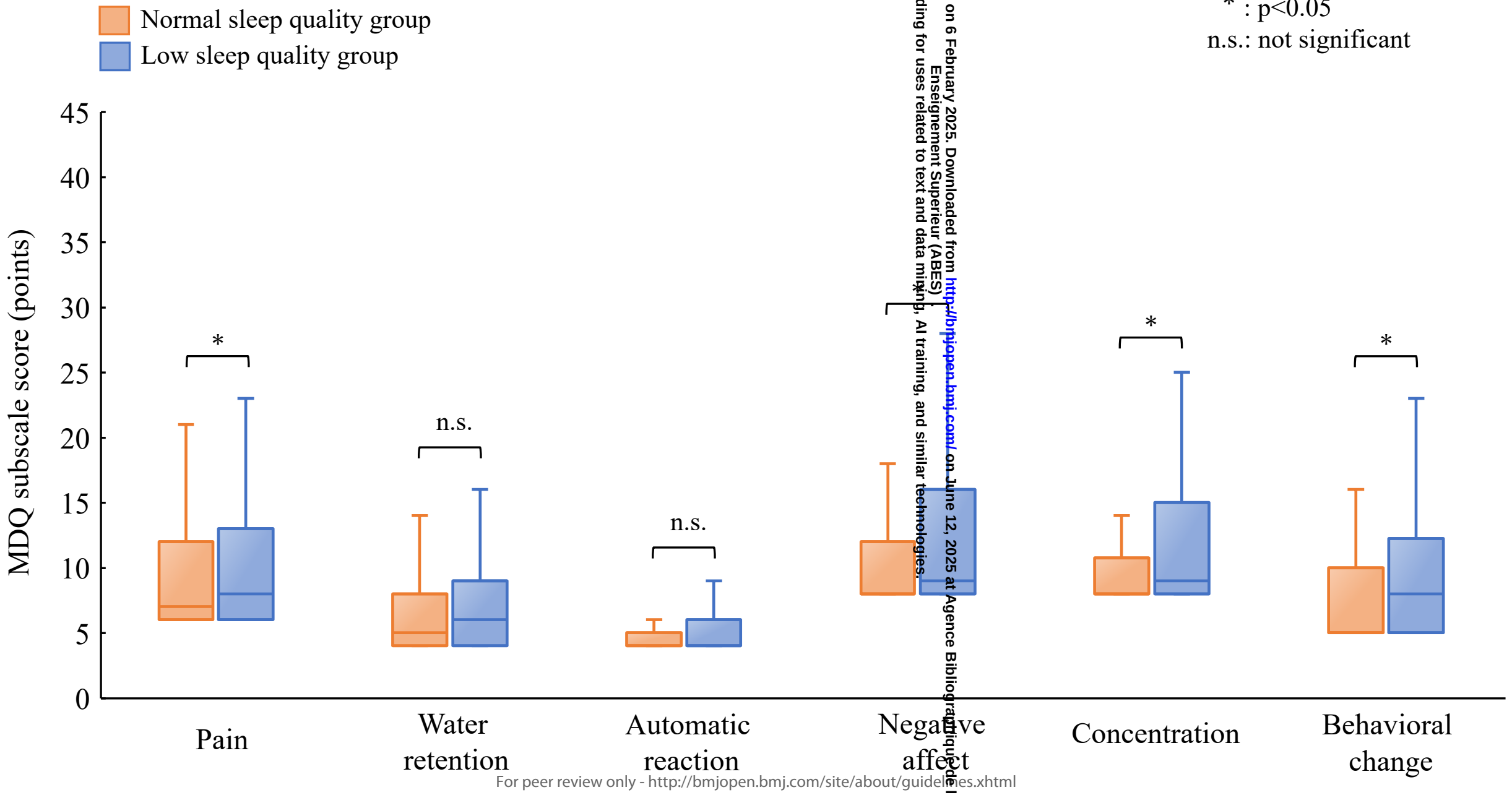

Figure. 5 Comparison of MDQ subscale scores: postmenstrual

Survey on perimenstrual symptoms and sleep in young women

Introduction

Many women experience various menstrual symptoms, such as dysmenorrhea and premenstrual syndrome (PMS), with an estimated prevalence of up to 80% among women. In addition, the impact of these symptoms on academic performance, quality of life, and socioeconomic losses has become a significant issue. Therefore, menstrual-related symptoms can be considered a critical problem that needs to be addressed.

Sleep, as an important lifestyle factor, accounts for approximately one-third of a person's life and is known to have various effects on both physical and mental health. Previous studies have highlighted issues such as short sleep duration and poor sleep quality among young women. These findings indicate the need to raise awareness about the importance of ensuring adequate sleep time and improving sleep quality in future health education programs for young women.

However, the relationship between menstrual symptoms and sleep has not been fully explored. Therefore, the purpose of this study is to investigate the relationship between menstrual symptoms and sleep among young women by surveying the current situation of these issues.

Survey Information

The survey takes approximately 20 minutes to complete. The target participants for this survey are women aged 18 to 25 years.

Please review the purpose and content of the survey below, and if you are willing to participate, proceed with the questions after providing your consent. You may stop the survey at any time; however, once the survey is submitted, it cannot be retracted. We appreciate your cooperation.

If you have any questions or comments regarding the content of this survey, please contact us at the information provided below.

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Please read the following items and the consent information carefully. If you agree to the contents, please check the "Consent to Participate" box and proceed with the questions.

---

1. Purpose and Significance of the Study

Many women experience various menstrual symptoms, such as dysmenorrhea and premenstrual syndrome (PMS), with an estimated prevalence of up to 80%. In addition, the impact of these symptoms on academic performance, quality of life, and socioeconomic losses has become a significant issue. Therefore, menstrual-related symptoms can be considered a critical problem that needs to be addressed. Sleep, which is an important lifestyle factor, accounts for approximately one-third of a person's life and is known to have various effects on both physical and mental health. Previous studies have highlighted issues such as short sleep duration and poor sleep quality among young women. These findings indicate the need to raise awareness about the importance of ensuring adequate sleep time and improving sleep quality in future health education programs for young women. However, the relationship between menstrual symptoms and sleep has not been fully explored. Therefore, the purpose of this study is to investigate the relationship between menstrual symptoms and sleep among young women by surveying the current situation of these issues.

2. Methods and Content

This survey will be conducted using Google Forms. The questionnaire includes basic information (age, height, weight, medication status, part-time job status, etc.), information about menstrual symptoms, and questions related to daily life (sleep, mental health, subjective well-being, anxiety, and lifestyle habits).

3. Possibility of Research Publication

We will handle personal information with the utmost care, and all responses will be kept confidential. This survey is anonymous, so responses will not be shared or disclosed in a way that could identify individuals. The responses will not affect your academic performance or workplace evaluations, and no one, including instructors, workplace representatives, or researchers, will know who has participated. Please feel free to answer honestly about your symptoms. The results of the survey may be presented at conferences or published in academic papers, but all personal identifiers will be excluded. We will ensure privacy and will not use the data for any purposes other than research. As this is an anonymous survey, the aggregated results will be reported on the homepage of the Hiroshima University Sports Rehabilitation

Consent to participate

☐ I agree to participate in the research

■ Basic information

・Age (○○ years)：_____

※Fill in the figures only

・Height (○○ cm) ：_____

※Fill in figures only (to one decimal place)

・Weight (○○ kg) ：_____

※Fill in figures only (to one decimal place)

・Current affiliation

□High school student
□Vocational student
□University student

・Current housemates

□Not living together (living alone)
□Family (living at home)
□Spouse, partner
□Friends, roommates
□Other

・Are you currently taking any ongoing medication?

□Yes
□No

・If you answered that you are taking any medication on an ongoing basis, please indicate the type of medication.

・Please indicate if you are currently being treated for any diseases.

・Do you currently have a part-time job?

□Yes
□No

▪Over the past week, how many minutes on average per day did you spend looking at a screen for leisure activities (such as videos, chatting, games, etc.)? (◯ minutes)Please enter the numerical value only.
For iPhone users: Please refer to the average screen time for the past 7 days.
For Android users: Please install the free app "Digitox" from Google Play (https://play.google.com/store/apps/details?id=phosphorus.app.usage.screen.time) and refer to the weekly average usage time.

▪Over the past week, how many minutes on average per day did you spend looking at a screen for studying or work? (◯ minutes)

Please enter the numerical value only.
For iPhone users: Please refer to the average screen time for the past 7 days.
For Android users: Please install the free app "Digitox" from Google Play (https://play.google.com/store/apps/details?id=phosphorus.app.usage.screen.time) and refer to the weekly average usage time.

・This refers to the time spent sitting or lying down every day (during work, study, leisure, etc.). This includes all time spent at a desk, chatting with friends, reading, sitting, lying down while watching TV, and so on. Please do not include sleep time. On weekdays, how many minutes in total do you usually spend sitting or lying down? (e.g., 180)
Please enter the numerical value only.

_____

・On weekends, how many minutes in total do you usually spend sitting or lying down in a day?
Please enter the numerical value only.

_____

・Please indicate how often you study or read until just before going to bed.

□None at all
□1~2 days a week
□At least three times a week

・Please indicate how often you watch TV until just before going to bed

□None at all
□1~2 days a week
□At least three times a week

・Please indicate how often you drink drinks containing caffeine (e.g. coffee, black tea, green tea, energy drinks).
□None at all
□1~2 days a week
□At least three times a week

■ About menstruation

・At what stage of your menstrual cycle are you currently (at the time of completing the questionnaire)?

□During menstruation
□Immediately after the end of menstruation - a few days later
□Ovulatory phase (from a few days after the end of menstruation to 1 week before the expected week of menstruation)
□Pre-menstrual (1 week before expected menstruation)
□No menstruation for the last three months or more

・At what age did you have your first menstruation? (○ years old) ：

_____

※Fill in the figures only

・Do you have dysmenorrhea?

□No I don't
□A little, but it does not interfere with daily life
□Pain is so severe that it interferes with daily life, but no medication is being taken
□Pain so severe that it interferes with daily life and requires medication

・If you answered that you have dysmenorrhea, how long does the pain last?

□Half day
□One day
□Two days
□Three days
□More than four days

・If you answered that you need to take medication in the two previous questions, please indicate the type of medication

※Multiple answers allowed
□Painkillers prescribed in hospital
□Over-the-counter painkillers
□Low-dose oral contraceptive pill
□Traditional Chinese medicine
□Other

■ Perimenstrual symptoms ※Created with reference to previous studies

Please answer the following questions about your **postmenstrual state** (Similar questions continue to be asked about premenstrual and during menstruation).

	1 Not applicable at all	2	3	4	5	6 Quite applicable
Weight gain	□	□	□	□	□	□
Insomnia	□	□	□	□	□	□
Crying	□	□	□	□	□	□
Lowered school or work performance	□	□	□	□	□	□
Muscle stiffness	□	□	□	□	□	□
Forgetfulness	□	□	□	□	□	□
Confusion	□	□	□	□	□	□
Take naps; stay in bed	□	□	□	□	□	□
Headache	□	□	□	□	□	□
Skin disorders	□	□	□	□	□	□
Loneliness	□	□	□	□	□	□
Feeling of suffocation	□	□	□	□	□	□
Affectionate	□	□	□	□	□	□
Orderliness	□	□	□	□	□	□
Stay at home	□	□	□	□	□	□
Cramps	□	□	□	□	□	□
Dizziness, faintness	□	□	□	□	□	□

Excitement	☐	☐	☐	☐	☐	☐
Chest pains	☐	☐	☐	☐	☐	☐
Avoid social activities	☐	☐	☐	☐	☐	☐
Anxiety	☐	☐	☐	☐	☐	☐
Backache	☐	☐	☐	☐	☐	☐
Cold sweats	☐	☐	☐	☐	☐	☐
Lowered judgment	☐	☐	☐	☐	☐	☐
Fatigue	☐	☐	☐	☐	☐	☐
Nausea, vomiting	☐	☐	☐	☐	☐	☐
Restlessness	☐	☐	☐	☐	☐	☐
Hot flashes	☐	☐	☐	☐	☐	☐
Difficulty concentrating	☐	☐	☐	☐	☐	☐
Painful breasts	☐	☐	☐	☐	☐	☐
Feelings of well-being	☐	☐	☐	☐	☐	☐
Ringing in the ears	☐	☐	☐	☐	☐	☐
Distractible	☐	☐	☐	☐	☐	☐
Swelling	☐	☐	☐	☐	☐	☐
Accidents	☐	☐	☐	☐	☐	☐
Irritability	☐	☐	☐	☐	☐	☐
General aches and pains	☐	☐	☐	☐	☐	☐
Mood swings	☐	☐	☐	☐	☐	☐
Heart pounding	☐	☐	☐	☐	☐	☐
Depression	☐	☐	☐	☐	☐	☐
Decreased efficiency	☐	☐	☐	☐	☐	☐
Lowered motor coordination	☐	☐	☐	☐	☐	☐
Numbness, tingling	☐	☐	☐	☐	☐	☐
Tension	☐	☐	☐	☐	☐	☐
Blind spots, fuzzy vision	☐	☐	☐	☐	☐	☐
Bursts of energy, activity	☐	☐	☐	☐	☐	☐

Please answer the following questions about your **premenstrual state**

	1 Not applicable at all	2	3	4	5	6 Quite applicable
Weight gain	☐	☐	☐	☐	☐	☐
Insomnia	☐	☐	☐	☐	☐	☐
Crying	☐	☐	☐	☐	☐	☐
Lowered school or work performance	☐	☐	☐	☐	☐	☐
Muscle stiffness	☐	☐	☐	☐	☐	☐
Forgetfulness	☐	☐	☐	☐	☐	☐
Confusion	☐	☐	☐	☐	☐	☐
Take naps; stay in bed	☐	☐	☐	☐	☐	☐
Headache	☐	☐	☐	☐	☐	☐
Skin disorders	☐	☐	☐	☐	☐	☐
Loneliness	☐	☐	☐	☐	☐	☐
Feeling of suffocation	☐	☐	☐	☐	☐	☐
Affectionate	☐	☐	☐	☐	☐	☐
Orderliness	☐	☐	☐	☐	☐	☐
Stay at home	☐	☐	☐	☐	☐	☐
Cramps	☐	☐	☐	☐	☐	☐
Dizziness, faintness	☐	☐	☐	☐	☐	☐
Excitement	☐	☐	☐	☐	☐	☐
Chest pains	☐	☐	☐	☐	☐	☐
Avoid social activities	☐	☐	☐	☐	☐	☐
Anxiety	☐	☐	☐	☐	☐	☐
Backache	☐	☐	☐	☐	☐	☐
Cold sweats	☐	☐	☐	☐	☐	☐
Lowered judgment	☐	☐	☐	☐	☐	☐
Fatigue	☐	☐	☐	☐	☐	☐
Nausea, vomiting	☐	☐	☐	☐	☐	☐
Restlessness	☐	☐	☐	☐	☐	☐
Hot flashes	☐	☐	☐	☐	☐	☐
Difficulty concentrating	☐	☐	☐	☐	☐	☐

Painful breasts	☐	☐	☐	☐	☐	☐
Feelings of well-being	☐	☐	☐	☐	☐	☐
Ringing in the ears	☐	☐	☐	☐	☐	☐
Distractible	☐	☐	☐	☐	☐	☐
Swelling	☐	☐	☐	☐	☐	☐
Accidents	☐	☐	☐	☐	☐	☐
Irritability	☐	☐	☐	☐	☐	☐
General aches and pains	☐	☐	☐	☐	☐	☐
Mood swings	☐	☐	☐	☐	☐	☐
Heart pounding	☐	☐	☐	☐	☐	☐
Depression	☐	☐	☐	☐	☐	☐
Decreased efficiency	☐	☐	☐	☐	☐	☐
Lowered motor coordination	☐	☐	☐	☐	☐	☐
Numbness, tingling	☐	☐	☐	☐	☐	☐
Tension	☐	☐	☐	☐	☐	☐
Blind spots, fuzzy vision	☐	☐	☐	☐	☐	☐
Bursts of energy, activity	☐	☐	☐	☐	☐	☐

Please answer the following questions about your **during menstruation state**

	1 Not applicable at all	2	3	4	5	6 Quite applicable
Weight gain	☐	☐	☐	☐	☐	☐
Insomnia	☐	☐	☐	☐	☐	☐
Crying	☐	☐	☐	☐	☐	☐
Lowered school or work performance	☐	☐	☐	☐	☐	☐
Muscle stiffness	☐	☐	☐	☐	☐	☐
Forgetfulness	☐	☐	☐	☐	☐	☐
Confusion	☐	☐	☐	☐	☐	☐
Take naps; stay in bed	☐	☐	☐	☐	☐	☐

Headache	☐	☐	☐	☐	☐	☐
Skin disorders	☐	☐	☐	☐	☐	☐
Loneliness	☐	☐	☐	☐	☐	☐
Feeling of suffocation	☐	☐	☐	☐	☐	☐
Affectionate	☐	☐	☐	☐	☐	☐
Orderliness	☐	☐	☐	☐	☐	☐
Stay at home	☐	☐	☐	☐	☐	☐
Cramps	☐	☐	☐	☐	☐	☐
Dizziness, faintness	☐	☐	☐	☐	☐	☐
Excitement	☐	☐	☐	☐	☐	☐
Chest pains	☐	☐	☐	☐	☐	☐
Avoid social activities	☐	☐	☐	☐	☐	☐
Anxiety	☐	☐	☐	☐	☐	☐
Backache	☐	☐	☐	☐	☐	☐
Cold sweats	☐	☐	☐	☐	☐	☐
Lowered judgment	☐	☐	☐	☐	☐	☐
Fatigue	☐	☐	☐	☐	☐	☐
Nausea, vomiting	☐	☐	☐	☐	☐	☐
Restlessness	☐	☐	☐	☐	☐	☐
Hot flashes	☐	☐	☐	☐	☐	☐
Difficulty concentrating	☐	☐	☐	☐	☐	☐
Painful breasts	☐	☐	☐	☐	☐	☐
Feelings of well-being	☐	☐	☐	☐	☐	☐
Ringing in the ears	☐	☐	☐	☐	☐	☐
Distractible	☐	☐	☐	☐	☐	☐
Swelling	☐	☐	☐	☐	☐	☐
Accidents	☐	☐	☐	☐	☐	☐
Irritability	☐	☐	☐	☐	☐	☐
General aches and pains	☐	☐	☐	☐	☐	☐
Mood swings	☐	☐	☐	☐	☐	☐
Heart pounding	☐	☐	☐	☐	☐	☐
Depression	☐	☐	☐	☐	☐	☐
Decreased efficiency	☐	☐	☐	☐	☐	☐
Lowered motor coordination	☐	☐	☐	☐	☐	☐
Numbness, tingling	☐	☐	☐	☐	☐	☐

Tension	□	□	□	□	□	□
Blind spots, fuzzy vision	□	□	□	□	□	□
Bursts of energy, activity	□	□	□	□	□	□

■ Sleep quality ※Created with reference to previous studies

Instructions: The following questions relate to your usual sleep habits during the past month only. Your answers should indicate the most accurate reply for the majority of days and nights in the past month. Please answer all questions.

・During the past month, what time have you usually gone to bed at night? *Please indicate after 24:00 as in the example (e.g. 24:00 → 0:00, 25:00 → 1:00).

_____

・During the past month, how long (in minutes) has it usually taken you to fall asleep each night? (○minutes) Fill in the figures only.

_____

・During the past month, what time have you usually gotten up in the morning?

_____

・During the past month, how many hours of actual sleep did you get at night? *This does not include the time spent in bed awake. (○ minutes)

_____

② During the past month, how often have you had trouble sleeping because you... Please select the most applicable one.

・Cannot get to sleep within 30 minutes

□Not during the past month
□Less than once a week
□Once or twice a week
□Three or more times a week

・Wake up in the middle of the night or early morning

□Not during the past month
□Less than once a week
□Once or twice a week
□Three or more times a week

・Have to get up to use the bathroom

□Not during the past month
□Less than once a week
□Once or twice a week
□Three or more times a week

・Cannot breathe comfortably

□Not during the past month
□Less than once a week
□Once or twice a week
□Three or more times a week

・Cough or snore loudly

□Not during the past month
□Less than once a week
□Once or twice a week
□Three or more times a week

・Feel too cold

□Not during the past month

□Less than once a week
□Once or twice a week
□Three or more times a week

・Feel too hot

□Not during the past month
□Less than once a week
□Once or twice a week
□Three or more times a week

・Have bad dreams

□Not during the past month
□Less than once a week
□Once or twice a week
□Three or more times a week

・Have pain

□Not during the past month
□Less than once a week
□Once or twice a week
□Three or more times a week

・Other reason(s), please describe: _____

□Not during the past month
□Less than once a week
□Once or twice a week
□Three or more times a week

・During the past month, how often have you taken medicine to help you sleep (prescribed or "over the counter")?

□Not during the past month

□Less than once a week
□Once or twice a week
□Three or more times a week

・During the past month, how often have you had trouble staying awake while driving, eating meals, or engaging in social activity?
□Not during the past month
□Less than once a week
□Once or twice a week
□Three or more times a week

・During the past month, how much of a problem has it been for you to keep up enough enthusiasm to get things done?
□No problem at all
□Only a very slight problem
□Somewhat of a problem
□A very big problem

・During the past month, how would you rate your sleep quality overall?
□Very good
□Fairly good
□Fairly bad
□Very bad

■ Experience of visiting a gynecologist

・Have you ever visited a gynecologist?
□yes, I have
□No, I haven't

・If you have been diagnosed by a gynecologist, please state the name of the diagnosis:

■ Lifestyle: Please answer yes or no to the following ※Created with reference to previous studies

・Have an exercise routine at least twice a week and for at least 30 minutes a day

□Yes
□No

・Eat breakfast at least 5 days a week

□Yes
□No

・No snacking and night eating habits

□Yes (not in the habit of eating snacks or evening meals)
□No (habit of snacking or eating evening meals)

・Sleeping for more than 7 hours

□Yes
□No

・Never smoked or quit the habit.

□Yes
□No

・Little or moderate alcohol consumption (2~4 days off per week)

□Yes (do not drink alcohol or drink the right amount)
□No (amount and frequency of alcohol consumption)

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Effect of sleep quality on the severity of perimenstrual symptoms in Japanese female students: A cross-sectional, online survey

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Effect of sleep quality on the severity of perimenstrual symptoms in Japanese female students: A cross-sectional, online survey

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Abstract

Objectives: To investigate the relationship between sleep quality and perimenstrual symptoms among Japanese female students.

Design: Observational, cross-sectional, online survey

Setting: We used an online questionnaire to collate responses from Japanese female students on sleep quality and perimenstrual symptoms.

Participants: A total of 298 female students aged 18-25 years in Japan were included in this study.

Primary and secondary outcome measures: The Menstrual Distress Questionnaire (MDQ) was used to assess the severity of perimenstrual symptoms for three periods: premenstrual, menstrual, and postmenstrual, and the Japanese version of the Pittsburgh Sleep Quality Index was used to assess sleep quality. The MDQ scores were compared between two groups (normal-sleep quality and low-sleep quality) using Mann–Whitney U test. In addition, multiple logistic regression analysis was performed, and the MDQ subscales that showed significant differences between the groups were used as independent variables. The MDQ subscale that was strongly associated with sleep quality was calculated.

Results: Of the female students, 160 were classified into the normal-sleep quality group and 138 into the low-sleep quality group. The total MDQ scores were significantly higher in the low-sleep quality group at all phases of the menstrual cycle (respectively $p<0.05$). Among the MDQ subscales, “pain” during menstruation and “concentration” in the premenstrual and postmenstrual stages were associated with sleep quality (respectively $p<0.05$).

Conclusions: Improving sleep quality was one possible strategy to reduce the severity of perimenstrual symptoms. These results may provide useful information for Japanese female students who suffer from perimenstrual symptoms.

Strengths and limitations of this study

- This study conducts an online survey among female students aged 18-25 years in Japan.
- This study adhered to the recommendations of the Checklist for Reporting Results of Internet E-Surveys.
- As this study involved a retrospective online survey about past sleep quality and perimenstrual symptoms, recall bias may have influenced the findings in this study.
- Since it was a cross-sectional study, the causal relationship between sleep quality and perimenstrual symptoms could not be clearly established

Keywords: Sleep; Primary health care; Surveys and Questionnaires

Word count: 4351 words

INTRODUCTION

Perimenstrual symptoms are varied and comprise physical, emotional, and behavioral symptoms. They occur during premenstrual, menstrual, and postmenstrual periods. Approximately 16–91% of women experience perimenstrual symptoms, such as irritability, depression, weight gain, and back pain [1]. These are important health issues that can lead to a decline in the quality of life of young women including students [2]. Additionally, missing classes due to dysmenorrhea and other perimenstrual symptoms causes a decline in the academic performance of female students [3].

Unhealthy lifestyle habits can affect perimenstrual symptoms [4]. Throughout the menstrual cycle, changes in the secretion of female hormones, including estrogen and progesterone, occur [5]. These changes have various effects on a woman's body and mind, causing perimenstrual symptoms. An example of lifestyle influences on these symptoms is the consumption of trans-fatty acids, which are abundant in fast food and increase the levels of prostaglandins, consequently causing dysmenorrhea and highlighting that an unbalanced diet can lead to increased pain [4]. Exercise could also be associated with perimenstrual symptoms. Reportedly, the secretion of estradiol during exercise increases serotonin secretion, which reduces the negative effects of perimenstrual symptoms [6]. These reports suggest that lifestyle habits are related to perimenstrual symptoms in terms of hormone secretion.

Sleep, one of the lifestyle habits, is an important aspect of human life, with approximately one-third of life's existence spent sleeping [7]. The hypothalamus plays an important role in sleep and is a regulator of sleep and wakefulness [8]. It contains gonadotropin-releasing hormone (GnRH) neurons, which drive the menstrual cycle by secreting GnRH, which helps to regulate female hormone levels [9]. Additionally, a direct synaptic connection exists between the sleep center of the brain and GnRH neurons, and deep sleep activates GnRH pulse generators [10]. Thus, it is possible that sleep and perimenstrual symptoms, which are both regulated by the hypothalamus, may be closely related.

Sleep is characterized by sleep duration and quality, and distinguishing between these two characteristics is essential [11]. Compared with sleep quality, sleep duration assesses sleep objectively and refers to the duration of sleep [12]. In contrast, sleep quality is evaluated subjectively and is defined as a sense of rest upon waking and satisfaction with sleep [12]. Although some overlap exists between these two characteristics, they are considered distinct and independent [13]. Reportedly, short sleep duration (<6 hours/day) is associated with moderate to severe dysmenorrhea, revealing a relationship between sleep duration and perimenstrual symptoms [14]. However, no study has examined the relationship between sleep quality and perimenstrual symptoms. Therefore, this study aimed to examine the involvement of sleep quality in perimenstrual symptoms in Japanese female students and propose strategies to alleviate

perimenstrual symptoms.

METHODS

Patient and public involvement

The questionnaire design involved female students. After the questionnaire was drafted, it was pretested with 20 Japanese female students who were not included in the main study. The study was conducted with female students residing throughout Japan and was not restricted to any region, such as prefectures. We plan to widely disseminate the findings of this study to the public by sharing information on social media and so on.

Study design

An observational, cross-sectional, online survey of Japanese female students aged 18–25 years was conducted from November 8, 2022, to February 2, 2023, in Japan. The survey was conducted using Google Forms (Alphabet Inc., Mountain View, CA, USA). An online survey was disseminated nationwide to female students aged 18–25 years using the URL of the questionnaire through a snowball sampling method, without identifying the geographical area. Before the survey questions began, a summary of the survey instructions, the purpose of the survey, the time required to complete it, and the following instructions to the participants were provided: participants can answer questions anonymously, answer just once, and could decline participation at any point during the survey. Responses were used solely for research purposes. Participants could commence the questionnaire after checking a consent box, thereby agreeing to participate in the study. Only those who consented to participate in the survey after reviewing the survey summary and instructions proceeded to answer the questions. Examples of statements were provided for questions that participants found difficult to understand, to prevent incorrect inputs. Data files containing responses were secured with a password to enhance protection. The inclusion criteria were the following: (a) agreeing to participate in this study, (b) Japanese female students aged between 18 and 25 years, and (c) residing in Japan at the time of the survey. The exclusion criteria were as follows: (a) had a current or previous history of gynecological disorders or possible secondary dysmenorrhea [15], (b) had a current or previous history of psychiatric disorders, and (c) current history of daily hormonal pill intake. Based on the self-reported responses of the participants, their eligibility for the inclusion and exclusion criteria were determined. This study adhered to the recommendations of the Checklist for Reporting Results of Internet E-Surveys [16]. Furthermore, this study conformed to the guidelines of the Declaration of Helsinki and was approved by the Ethical Committee for Epidemiology, Hiroshima University (E-3791).

Question items

The question items were mainly related to sleep quality and the severity of perimenstrual symptoms. They included basic information and sociodemographic and lifestyle characteristics. Basic information included age, age at menarche, height and weight for body mass index (BMI; kg/m^2) calculation, duration of dysmenorrhea, current and previous history of gynecological or psychiatric disorders, and medications for internal use related to these disorders. Sociodemographic characteristics included questions regarding part-time job (yes/no) and living status (alone/with others). Lifestyle characteristics included questions regarding alcohol intake (low/high: no alcohol consumption or up to 2 drinks per week/more), smoking (yes/no), breakfast (eating/not eating), eating between meals (eating/not eating), caffeine consumption (yes/no: ≥3 times/week), studying until bedtime (yes/no: ≥3 times/week), watching TV until bedtime (yes/no: ≥3 times/week), and screen time (min/day) related to leisure and study [17, 18].

The Japanese version of the Pittsburgh Sleep Quality Index (PSQI-J) was used to rate sleep quality in the past month. The PSQI-J has been used and validated in a previous study that assessed sleep quality [19, 20]. Participants answered questions regarding their sleep over the past month, and the overall score (range, 0–21) was calculated as the total score of seven factors presented in questions 1–7: subjective sleep quality, time to fall asleep, sleep duration, sleep efficiency, sleep difficulty, use of sleeping pills, and difficulty in staying awake during the day. Subjective sleep quality was assessed using one question rated on a 4-point Likert scale (very good, quite good, quite bad, and very bad). Time to fall asleep was assessed using two questions regarding the time from bedtime to falling asleep. Sleep duration was rated in 4 stages (>7 hours; >6 hours but ≤7 hours; ≥5 hours but ≤6 hours; and <5 hours). Sleep efficiency was calculated by dividing sleep duration by the total number of hours in bed. Sleep difficulty was assessed using nine questions regarding waking up in the middle of the night, difficulty falling asleep soon after going to bed, feeling cold, having bad dreams, getting up to use the restroom, difficulty in breathing correctly, snoring loudly and coughing, feeling pain, or having other reasons for sleep disorders. The use of sleeping pills and difficulty in staying awake during the day were rated on a 4-point Likert scale (not once, less than once per week, once or twice per week, and three or more times per week). A total PSQI-J score of 5 and below indicates normal sleep quality, and 6 and above indicates low sleep quality [19].

The Menstrual Distress Questionnaire (MDQ) has long been used as a measure to evaluate the severity of perimenstrual symptoms, and its Japanese version has been validated [21, 22]. The index assesses responses to 46 questions on eight subscales of perimenstrual symptoms [23]. Responses on the most recent symptoms were rated on a

6-point scale (1: no reaction at all, 6: acute or partially disabling). High scores indicated increased severity of perimenstrual symptoms. We used six subscales comprising pain, water retention, autonomic reaction, negative affect, concentration, and behavioral change; two subscales (mood elevation and control), with higher scores indicating better symptoms, were excluded. Each symptom was assessed for three periods: premenstrual, menstrual, and postmenstrual.

Statistical analysis

The respondents were divided into normal-sleep quality and low-sleep quality groups based on the PSQI-J cutoff value of 6 points [19]. Data collected from the survey were processed using IBM SPSS version 28.0 for Windows (IBM Japan Co., Ltd., Tokyo, Japan). Before conducting the analysis, the Shapiro–Wilk test was used to assess the normality of all data. Basic information and lifestyle characteristics, MDQ total scores, and subscales in each menstrual period were compared between both groups using the Mann–Whitney U test. The required sample size was calculated using G*Power 3.1. The analysis, with an effect size of d=0.5 and an alpha level of α=0.05, indicated a statistical power of 0.801, with each group requiring a sample size of 67. Chi-square tests were used to assess sociodemographic and lifestyle characteristics. Effect sizes were calculated to assess not only whether the differences and associations were statistically significant but also the practical significance of these effects. Specifically, the phi coefficient "φ" was used for the chi-square test and the correlation coefficient (r) for the Mann-Whitney U test as indicators of effect size. These effect size measures provided additional context, contributing to the interpretation of the magnitude of the observed effects and their practical relevance beyond mere statistical significance. Multiple logistic regression analysis was conducted separately for each menstrual phase (premenstrual, menstrual, and postmenstrual) to identify the relationship between the MDQ subscale scores and sleep quality. For analysis, a PSQI-J score <6 was coded as 0, and a PSQI-J score ≥6 was coded as 1. Normal or low sleep quality was set as the dependent variable, and MDQ subscales demonstrated statistically significant differences (p-values <0.05) between the normal and low sleep quality groups in group comparisons were selected as independent variables for the analysis (crude model). Additionally, adjustments were made for age (adjusted model), as hormonal balance changes with age [24]. The variance inflation factor, a statistic used to measure possible multicollinearity among predictors or independent variables, was computed [25]. Multiple variables were employed as independent variables, and to address the potential issue of multiple comparisons, Bonferroni correction was applied. Odds ratios (OR) were determined only for the logistic regression analysis to assess the strength and direction of the associations. For all statistical tests, 95% confidence intervals (CI) were calculated to evaluate the precision and reliability of the estimates. Regarding sample size calculation, the number of participants per

independent variable should be ≥10 based on a previous study [26]. In the present study, four to seven MDQ subscales were used as independent variables. Therefore, it was necessary to include at least 70 participants each in the normal- or low-sleep quality groups. The significance level was set at 0.05.

RESULTS

The survey was distributed among 850 participants, and 366 of them (response rate: 43.1%) provided responses. Of the respondents, 68 were excluded (34 respondents had a current or previous history of gynecological disorders or possible secondary dysmenorrhea, 32 respondents were taking hormone medication, one respondent had a current or previous history of psychiatric disorders, and one respondent answered insufficiently). Thus, 298 respondents were included in the final analysis. Of the 298 participants, 160 were classified into the normal-sleep quality group and 138 into the low-sleep quality group based on the PSQI-J cutoff value points **(Figure 1**).

Basic information, sociodemographic characteristics, and lifestyle characteristics

No significant differences in age, age at menarche, BMI, part-time job, and living status were observed between the two groups, as shown in **Table 1**.

As shown in **Table 1**, no significant differences in alcohol intake, smoking, eating between meals, caffeine consumption, studying until bedtime, watching TV until bedtime, and screen time were observed between the two groups. In contrast, a significant difference in breakfast consumption was observed between the two groups, with a significantly higher number of students eating breakfast in the normal-sleep quality group compared with that in the low-sleep quality group (p=0.023).

Table 1. Basic information, sociodemographic characteristics, and lifestyle characteristics

Variables	Normal-sleep quality group (n=160)	Low-sleep quality group (n=138)	χ^2	p value	Effect size	95% CI	
						Lower	Upper
Age (y.o.)	20.8 ± 1.4	20.7 ± 1.3		0.666	-0.025	0.000	0.000
Age at menarche (y.o.)	12.5 ± 1.7	12.5 ± 1.5		0.839	0.012	0.000	0.000
BMI (kg/m^2)	20.5 ± 2.6	20.8 ± 2.6		0.884	0.008	-0.521	0.459
Part-time job							
Yes	135 (84.4)	123 (89.1)	1.442	0.230	0.070	0.004	0.168
No	25 (15.6)	15 (10.9)					
Living status							
Alone	57 (35.6)	46 (33.3)	0.172	0.678	0.024	0.002	0.143
With others	103 (64.4)	92 (66.7)					
Alcohol intake							
Low	145 (90.6)	129 (93.5)	0.815	0.367	0.052	0.003	0.169
High	15 (9.4)	9 (6.5)					
Smoking							
No	152 (95.0)	133 (96.4)	0.337	0.562	0.034	0.002	0.149
Yes	8 (5.0)	5 (0.6)					
Breakfast							
Eating	114 (71.3)	81 (58.7)	5.163	0.023*	0.132	0.016	0.245
Not eating	46 (28.7)	57 (41.3)					
Eating between meals							
Eating	101 (63.1)	95 (68.8)	1.075	0.300	0.060	0.004	0.172
Not eating	59 (36.9)	43 (31.2)					

Caffeine consumption (≥3 times/week)							
Yes	74 (46.3)	57 (41.3)	0.736	0.391	0.050	0.031	0.234
No	86 (53.7)	81 (58.7)					
Studying until going to bed (≥3 times/week)							
Yes	37 (23.1)	32 (23.2)	0.000	0.990	0.001	0.016	0.183
No	123 (76.9)	106 (76.8)					
Watching TV until going to bed (≥3 times/week)							
Yes	44 (27.5)	29 (21.0)	1.685	0.194	0.075	0.023	0.206
No	116 (72.5)	109 (79.0)					
Screen time							
Leisure (min/day)	256.4 ± 204.2	252.1 ± 144.0		0.578	0.032	-30.000	30.000
Study (min/day)	105.9 ± 129.8	107.1 ± 124.4		0.265	0.064	-20.000	0.000

*Statistically significant

BMI, body mass index; y.o., years old; CI, confidence interval

Data are expressed as mean ± standard deviation, or n (%).

Comparison of MDQ total scores and subscale scores between the two groups during the premenstrual, menstrual, and postmenstrual periods

Figure 2 shows the comparison of the total MDQ scores. The mean total MDQ scores for the normal-sleep quality group and low-sleep quality group were 68.5 points (SD=22.4) and 79.8 points (SD=37.6), respectively, during the premenstrual phase (p=0.006, 95%CI: –16.000, 2.000). During menstruation, the mean total MDQ scores for the

normal-sleep quality group and low-sleep quality group were 73.3 points (SD=34.2) and 93.7 points (SD=40.6), respectively (p<0.001, 95%CI: –29.000, 11.000). The mean total MDQ scores in the postmenstrual phase were 51.2 points (SD=24.6) in the normal-sleep quality group and 60.2 points (SD=33.0) in the low-sleep quality group (p=0.005, 95%CI: –6.000, 0.000).

Figure 3 presents the results of the comparison of MDQ subscale scores during the premenstrual phase. The mean MDQ subscale scores in the normal-sleep quality group and low-sleep quality group of the various items were as follows: pain, 12.8 points (SD=6.6) and 15.1 points (SD=8.0), respectively, (p=0.016, 95%CI: –3.000, 0.000); water retention, 10.0 points (SD=5.0) and 11.0 points (SD=5.2), respectively, (p=0.091, 95%CI: –2.000, 0.000); automatic reaction, 5.5 points (SD=2.9) and 6.5 points (SD=4.0), respectively, (p=0.050, 95%CI: 0.000, 0.000); negative affect, 15.8 points (SD=9.2) and 17.9 points (SD=10.0), respectively, (p=0.025, 95%CI: –3.000, 0.000); concentration, 12.8 points (SD=7.0) and 15.7 points (SD=8.5), respectively, (p<0.001, 95%CI: –3.000, 0.000); and behavioral change, 11.6 points (SD=6.6) and 13.6 points (SD=7.3), respectively, (p=0.013, 95%CI: –3.000, 0.000).

Figure 4 shows the results of the comparison of MDQ subscale scores during menstruation. In the normal-sleep quality group and low-sleep quality group, the mean MDQ subscale scores of the various items were as follows: pain, 15.4 points (SD=7.6) and 19.8 points (SD=8.6), respectively, (p<0.001, 95%CI: –7.000, –2.000); water retention, 9.3 points (SD=4.6) and 11.1 points (SD=5.2), respectively, (p=0.002, 95%CI: –3.000, –1.000); automatic reaction, 6.2 points (SD=3.7) and 7.8 points (SD=4.6), respectively, (p<0.001, 95%CI: –1.000, 0.000); negative affect, 15.6 points (SD=8.7) and 20.2 points (SD=10.6), respectively, (p=0.025, 95%CI: –6.000, –2.000); concentration, 13.8 points (SD=7.7) and 18.3 points (SD=10.2), respectively, (p<0.001, 95%CI: –5.000, –1.000); and behavioral change, 13.0 points (SD=6.9) and 16.6 points (SD=7.7), respectively, (p<0.001, 95%CI: –5.000, –2.000).

Figure 5 provides the results of the comparison of MDQ subscale scores in the postmenstrual phase. In the normal-sleep quality group and low-sleep quality group, the mean of the MDQ subscale scores for the items are as follows: pain, 9.9 points (SD=6.0) and 11.4 points (SD=7.2), respectively, (p=0.027, 95%CI: –1.000, 0.000); water retention, 6.8 points (SD=4.0) and 7.3 points (SD=3.9), respectively, (p=0.086, 95%CI: –1.000, 0.000); automatic reaction, 4.9 points (SD=2.1) and 5.7 points (SD=3.4), respectively, (p=0.072, 95%CI: 0.000, 0.000); negative affect, 11.4 points (SD=6.3) and 13.2 points (SD=8.0), respectively, (p=0.011, 95%CI: 0.000, 0.000); concentration, 10.2 points (SD=4.2) and 12.8 points (SD=7.4), respectively, (p<0.001, 95%CI: –1.000, 0.000); and behavioral change, 8.1 points (SD=4.6) and 9.8 points (SD=6.1), respectively, (p=0.005, 95%CI: –1.000, 0.000).

Multiple logistic regression analysis

To show the associations of sleep quality with the MDQ subscales, multiple logistic regression analysis in the crude model was performed (**Table 3**). The MDQ concentration score during the premenstrual period (β=0.068; p=0.034; OR, 1.070; 95% CI, 1.005–1.140), pain during menstruation (β=0.057; p=0.040; OR, 1.059; 95% CI, 1.003–1.117), and concentration during the postmenstrual period (β=0.165; p=0.003; OR, 1.179; 95% CI, 1.058–1.313) were significantly associated with sleep quality.

Furthermore, to assess the relationship between sleep quality and MDQ subscales, multiple logistic regression analysis was conducted in the adjusted model (**Table 4**). In the premenstrual phase, a significant relationship with sleep quality was identified for concentration (β=0.071; p=0.028; OR, 1.073; 95% CI: 1.008, 1.143). During menstruation, a significant relationship with sleep quality was detected for pain (β=0.058; p=0.038; OR, 1.059; 95% CI: 1.003, 1.118). The MDQ concentration score during the postmenstrual phase was significantly associated with sleep quality (β=0.164; p=0.003; OR, 1.178; 95% CI: 1.058, 1.312).

Table 3. Multiple logistic regression analysis for the association of sleep quality with MDQ subscales in the crude model

	β	SE	Wald	df	P value	OR	95% CI	
							Lower	Upper
Premenstrual								
Pain	0.022	0.026	0.722	1	0.396	1.022	0.972	1.075
Negative affect	-0.040	0.027	2.221	1	0.136	0.961	0.913	1.013
Concentration	0.068	0.032	4.493	1	0.034*	1.070	1.005	1.140
Behavioral change	0.006	0.036	0.030	1	0.864	1.006	0.937	1.081
During menstruation								

Pain	0.057	0.028	4.229	1	0.040*	1.059	1.003	1.117
Water retention	-0.030	0.038	0.630	1	0.427	0.970	0.901	1.045
Autonomic reaction	-0.011	0.044	0.064	1	0.801	0.989	0.907	1.079
Negative affect	0.009	0.023	0.158	1	0.691	1.009	0.965	1.056
Concentration	0.029	0.026	1.215	1	0.270	1.029	0.978	1.083
Behavioral change	-0.003	0.033	0.006	1	0.937	0.997	0.935	1.064
Postmenstrual								
Pain	-0.013	0.037	0.115	1	0.735	0.987	0.918	1.602
Negative affect	-0.082	0.043	3.540	1	0.060	0.922	0.846	1.003
Concentration	0.165	0.055	8.968	1	0.003*	1.179	1.058	1.313
Behavioral change	0.024	0.063	0.140	1	0.709	1.024	0.904	1.159

Variation inflation factor (premenstrual): pain, 2.679; negative affect, 4.429; concentration, 4.167; behavioral change, 4.569. During menstruation: pain, 3.668; water retention, 2.452; automatic reaction, 2.344; negative affect, 3.614; concentration, 3.812; behavioral change, 4.212. Postmenstrual: pain, 3.872; negative affect, 5.161; concentration, 4.701; behavioral change, 7.171

MDQ, Menstrual Distress Questionnaire; β, partial regression coefficient; SE, standard error; df, degree of freedom; OR, odds ratio; CI, confidence interval

*Statistically significant

Table 4. Multiple logistic regression analysis for the association of sleep quality with MDQ subscales in the adjusted model

	β	**SE**	**Wald**	**df**	**P value**	**OR**	**95% CI**	
							Lower	**Upper**
Premenstrual								

Pain	0.022	0.026	0.747	1	0.387	1.023	0.972	1.076
Negative affect	-0.041	0.027	2.373	1	0.123	0.960	0.911	1.011
Concentration	0.071	0.032	4.808	1	0.028*	1.073	1.008	1.143
Behavioral change	0.008	0.036	0.047	1	0.828	1.008	0.938	1.083
Age	-0.085	0.090	0.904	1	0.342	0.918	0.770	1.095
During menstruation								
Pain	0.058	0.028	4.304	1	0.038*	1.059	1.003	1.118
Water retention	-0.034	0.038	0.781	1	0.377	0.967	0.897	1.042
Autonomic reaction	-0.009	0.044	0.044	1	0.835	0.991	0.908	1.081
Negative affect	0.009	0.023	0.137	1	0.712	1.009	0.964	1.055
Concentration	0.028	0.026	1.200	1	0.273	1.029	0.978	1.083
Behavioral change	0.000	0.033	0.000	1	0.996	1.000	0.937	1.067
Age	-0.089	0.092	0.924	1	0.336	0.915	0.764	1.096
Postmenstrual								
Pain	-0.015	0.038	0.151	1	0.698	0.986	0.916	1.061
Negative affect	-0.082	0.043	3.600	1	0.058	0.921	0.846	1.003
Concentration	0.164	0.055	8.925	1	0.003*	1.178	1.058	1.312
Behavioral change	0.026	0.064	0.169	1	0.681	1.027	0.906	1.163
Age	-0.043	0.091	0.221	1	0.638	0.958	0.802	1.144

Variation inflation factor (premenstrual): pain, 2.679; negative affect, 4.431; concentration, 4.167; behavioral change, 4.589; age, 1.012. During menstruation: pain, 3.668; water retention, 2.474; automatic reaction, 2.349; negative affect, 3.616; concentration, 3.813; behavioral change, 4.236; age, 1.016. Postmenstrual: pain, 3.924; negative affect, 5.162; concentration, 4.708; behavioral change, 7.219; age, 1.024.

MDQ, Menstrual Distress Questionnaire; β, partial regression coefficient; SE, standard error; df, degree of freedom;

OR, odds ratio; CI, confidence interval

*Statistically significant

DISCUSSION

The aim of this study was to investigate the relationship between sleep quality and perimenstrual symptoms among Japanese female students. The main findings of this study revealed that lower sleep quality was associated with increased severity of perimenstrual symptoms. Furthermore, among the MDQ components, significant associations with sleep quality were observed for pain during menstruation and concentration during the premenstrual and postmenstrual periods. The Japanese population is known to have poor sleep habits, and in particular, college students are prone to disrupting their sleeping habits [27]. Therefore, confirming whether sleep quality is associated with perimenstrual symptoms among Japanese female students and identifying perimenstrual symptoms most strongly related to sleep quality are important.

First, this study compares its results with previous research investigating the association between sleep quality and perimenstrual symptoms. In a study among female university students, comparing PSQI scores with and without dysmenorrhea showed that the group with dysmenorrhea had higher PSQI scores and lower sleep quality ($p<0.05$) [28]. In another study focusing on premenstrual syndrome (PMS), women with severe PMS had lower subjective sleep quality in the late luteal phase [29]. As seen in previous studies, some investigations have explored the relationship between perimenstrual symptoms and sleep quality. However, no studies have definitively confirmed which symptoms are particularly relevant among the various perimenstrual symptoms. This study not only examined the association between perimenstrual symptoms and sleep quality but also identified which symptoms were most strongly associated with sleep quality during each menstrual cycle. By focusing on specific perimenstrual symptoms, such as pain during menstruation and concentration difficulties during the premenstrual and postmenstrual phases, this study provides a more detailed understanding of the relationship between sleep quality and perimenstrual symptoms.

A previous study of female undergraduate and graduate students in Taiwan found that normal or low sleep quality was associated with the onset of perimenstrual symptoms, and 51.4% of female students were indicated to have normal sleep quality (PSQI <6) and 48.6% indicated to have low sleep quality (PSQI ≥6) [30]. These results suggest a relationship between sleep quality and perimenstrual symptoms. In our study, the severity of perimenstrual symptoms was lower in the normal-sleep quality group than in the low-sleep quality group, which is similar to the results of the previous study [30]. Moreover, 53.7% of the participants were classified into the normal-sleep quality group and 46.3%

into the low-sleep quality group, suggesting no participant bias when investigating sleep quality compared with that in previous studies. The average MDQ scores in Japanese young women aged 18 years and older [6] are 57.2 points in the premenstrual, 63.0 points in the menstrual, and 42.5 in the postmenstrual periods. In the present study, the average MDQ total scores were 74.2 points in the premenstrual, 83.5 points in the menstrual, and 55.8 in the postmenstrual periods, which were higher than those reported in the previous study [6]. A higher percentage of female college students have severe perimenstrual symptoms [31], which may explain the relatively high MDQ total scores of our study.

The MDQ total scores and several subscale scores were higher in the lower-sleep quality group than in the normal-sleep quality group during all the menstrual periods. The most likely explanation for the association between sleep quality and perimenstrual symptoms is the influence of melatonin. Melatonin, which is responsible for inducing sleep, decreases with low sleep quality [32]. It is also involved in reproductive functions and plays a role in regulating the levels of estrogen and progesterone [33]. Thus, the decrease in melatonin secretion due to low sleep quality might have led to a disturbance in the regulatory mechanism of female hormone levels, which might have resulted in the higher severity of perimenstrual symptoms in the low-sleep quality group. However, these discussions are predominantly speculative, since this was a cross-sectional study based on an online survey, making it impossible to measure melatonin secretion or variations.

Multiple logistic regression analysis showed that the MDQ subscale during menstruation related to sleep quality was “pain,” suggesting a relationship between sleep and dysmenorrhea. In dysmenorrhea without organic disease, the cause of pain could be excessive uterine contractions caused by prostaglandins released from the menstrual blood and uterine mucosa during menstruation. It is possible that the low-sleep quality group had more pain during menstruation because the prostaglandin system is activated when adequate sleep is not achieved [34].

The MDQ subscale in the premenstrual and postmenstrual periods related to sleep quality was “concentration.” Female hormone levels are associated with cognitive function. For example, the change in estradiol levels with the menstrual cycle causes changes in cognitive function such as memory [35]. Additionally, rapid changes in hormone levels during pregnancy alter cognitive abilities [36]. These findings indicate that changes in female hormone levels are involved in memory and other cognitive functions. As discussed in the previous paragraph, decrease in sleep quality decreases the secretion of melatonin, which plays a role in regulating female hormones, suggesting that sleep quality may be linked to concentration, a perimenstrual symptom.

Decreased sleep duration and long-term sleep deprivation are common in Japanese modern society. In a previous study involving Japanese college students, the mean sleep duration on weekdays was 5.9 hours; approximately 16% of the participants were categorized as evening-type individuals, and 56.1% felt sleepy during the day [27]. This seemingly represents the unhealthy sleeping habits of Japanese students. Perimenstrual symptoms are commonly experienced by

female college students [31]. Based on the results of our study, which demonstrates a relationship between sleep quality and perimenstrual symptoms, the need to improve sleep quality among Japanese female students is high. Sleep problems are caused by the blue light emitted from mobile phones and personal computers [37], humidity in the bedroom, bedding, background noise, human voices, lighting, etc. [38]. Particularly, the age group targeted in this study is one where smartphone usage is prevalent, making the issue of blue light exposure an important concern. About two hours before bedtime, the secretion of melatonin, a hormone that promotes sleep, begins. Exposure to light or the use of smartphones during this period, which emits blue light, has been reported to suppress the secretion of melatonin. This suppression disrupts the sleep-wake cycle, causing a delay in sleep onset and hindering the ability to fall asleep [39]. Consequently, minimizing blue light exposure from smartphone use at night could be a beneficial intervention. However, considering contemporary trends, it would be challenging to propose restrictions on smartphone use for students. Previous studies have demonstrated that regular aerobic exercise, such as walking or cycling, can enhance sleep quality by regulating circadian rhythms and decreasing sleep onset latency. Based on the results of a study by Lu in 2023, aerobic exercise significantly improved sleep quality in a sample of 719 college students, with a regression coefficient of −0.37 ($p < 0.001$), as determined by regression analysis [40]. Additionally, optimizing the sleep environment, such as using comfortable bedding and controlling room temperature, has been linked to better sleep quality and efficiency. In a study by Bert et al, it was found that switching to a new bedding system significantly improved sleep quality and comfort with improvements becoming more prominent over time [41]. These findings suggest that the use of appropriate bedding could be an important factor in enhancing sleep quality. Along with reducing blue light exposure, such interventions may offer effective strategies for improving sleep among young adults.

The present study had some limitations. First, the causal relationship between sleep quality and perimenstrual symptoms was not clarified. Second, the menstrual cycle at the time the participants completed the questionnaire was not considered, rendering this survey a cross-sectional one. However, the indicators used in this survey were established and confirmed to have no problems as retrospective formulas [22]. Third, since this was a retrospective study, recall bias might have occurred during the recall of perimenstrual symptoms and sleep conditions in each menstrual period. To minimize recall bias, respondents were asked to respond to items related to sleep conditions and perimenstrual symptoms within the last month. Fourth, the survey utilized a snowball sampling method, raising questions about the potential lack of randomness and the representativeness of the sample in terms of individual status. Although the survey was broadly disseminated to mitigate regional or demographic biases, the snowball sampling approach may have introduced selective bias, as participants likely shared the questionnaire with individuals possessing similar characteristics. A fifth limitation of this study is the relatively low response rate of 43.1% for the online survey. Although the questionnaires were

distributed without geographical limitations, these fourth and fifth limitations may indicate particular characteristics of the respondents. As such, the results should be interpreted cautiously, and future studies with higher response rates and more representative samples are necessary to confirm these findings. Finally, the secretion of melatonin and other body hormones was not measured. Measuring these variables could yield objective data to enhance the understanding of the physiological mechanisms underlying the relationship between sleep quality and perimenstrual symptoms. Given these limitations, future research should focus on conducting longitudinal or experimental studies to explore the causal relationships between sleep quality and perimenstrual symptoms. Expanding the sample size to incorporate a more diverse population is essential, accounting for factors such as lifestyle, education level, and other characteristics that could influence the results. Additionally, incorporating objective measurements of sleep and hormonal levels, such as melatonin secretion, would provide clearer insights into the physiological mechanisms involved. These steps would bolster the validity and generalizability of future findings.

We examined the association between sleep quality and perimenstrual symptoms among Japanese female students who were divided into normal- and low-sleep quality groups based on the cutoff values of the PSQI-J. The low-sleep quality group had higher total MDQ scores and several subscale scores compared with those of the normal-sleep quality group during the premenstrual, menstrual, and postmenstrual periods. In addition, multiple logistic regression analysis revealed that among the various menstrual symptoms, “concentration” during the premenstrual and postmenstrual periods and “pain” during menstruation were most strongly related to sleep quality. These results show that low sleep quality may be associated with worsening perimenstrual symptoms and suggest the importance of considering and addressing these relationships in the management of women's health issues.

Acknowledgments

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Data availability statement

All data used and analyzed in this study are available from the corresponding author upon reasonable request.

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Competing interests

None declared

Author contributions

The study was designed by SO, NM, TT, RM, MK, SA, TN, and KN. Original drafting, reviewing, and editing of the manuscript were performed by SO, TT, and MR. The methodology was designed by SO, TT, and MR. Formal analysis was performed by SO. The research was supervised by YU. All authors read and approved the final manuscript. Sakura Oda / SO is the guarantor

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Figure legend

Figure. 1 Flowchart of this study

Figure. 2 Comparison of MDQ total scores

Figure. 3 Comparison of MDQ subscale scores: premenstrual

Figure. 4 Comparison of MDQ subscale scores: during menstruation

Figure. 5 Comparison of MDQ subscale scores: postmenstrual

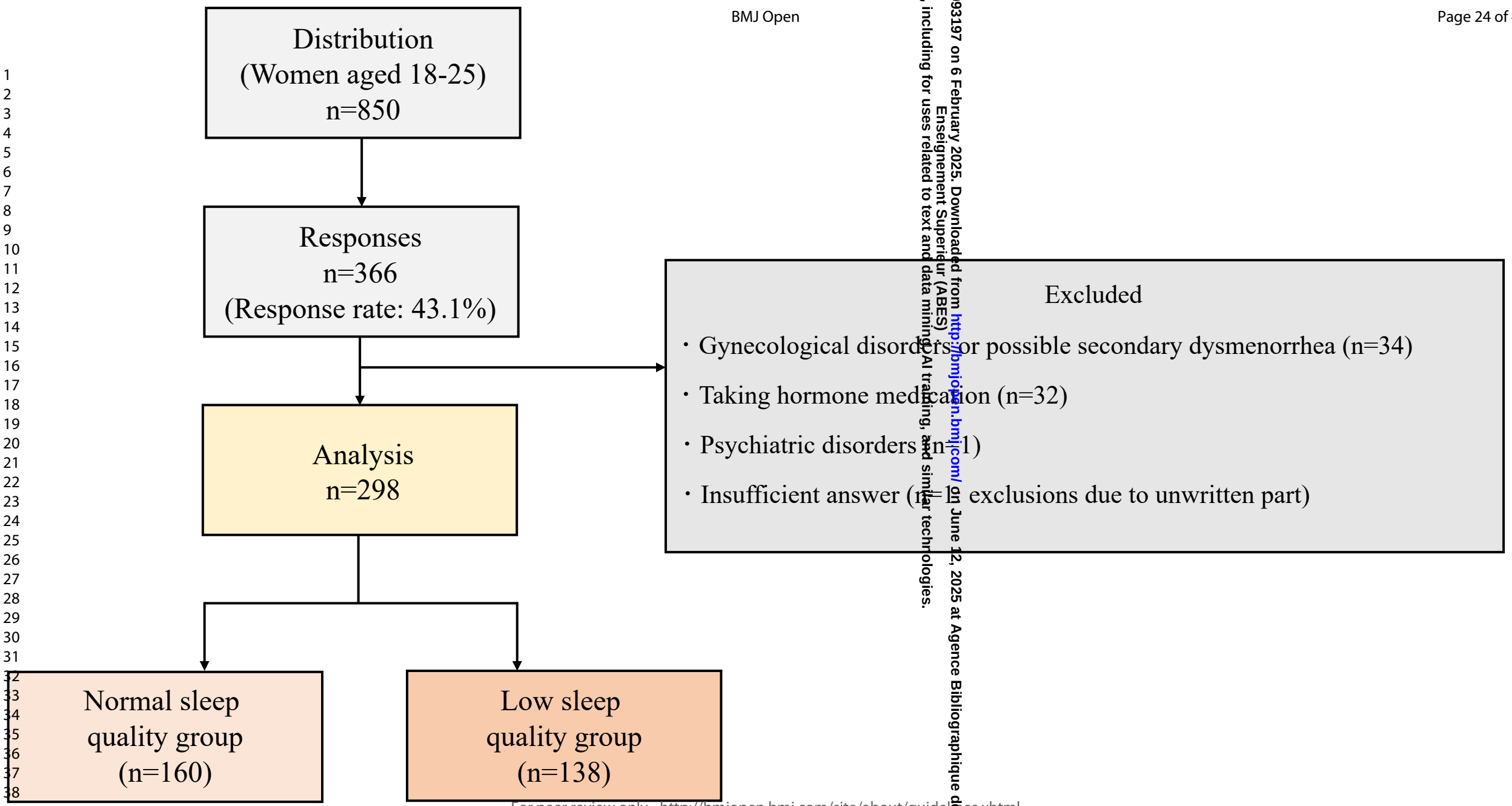

Figure. 1 Flowchart of this study

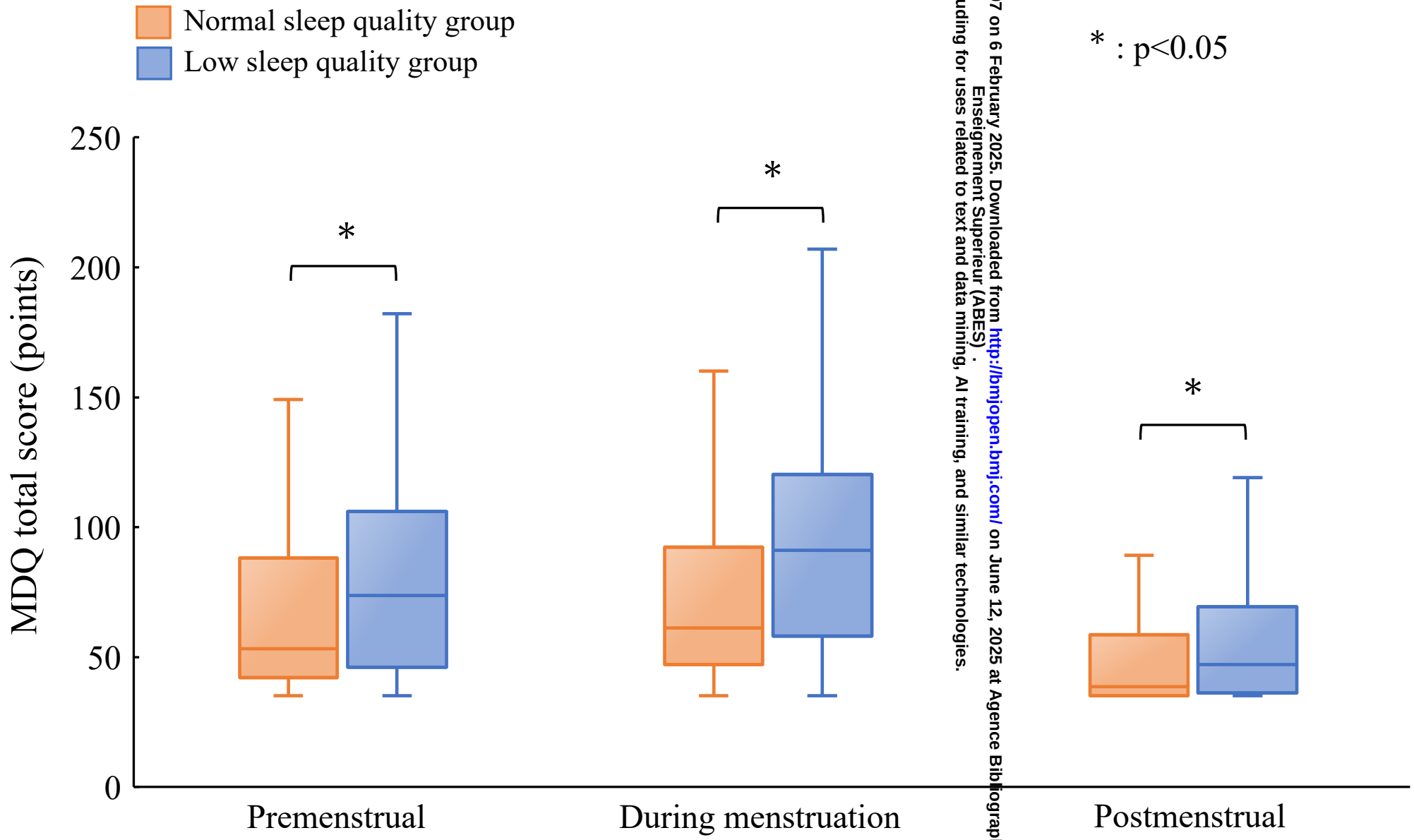

Figure. 2 Comparison of MDQ total scores

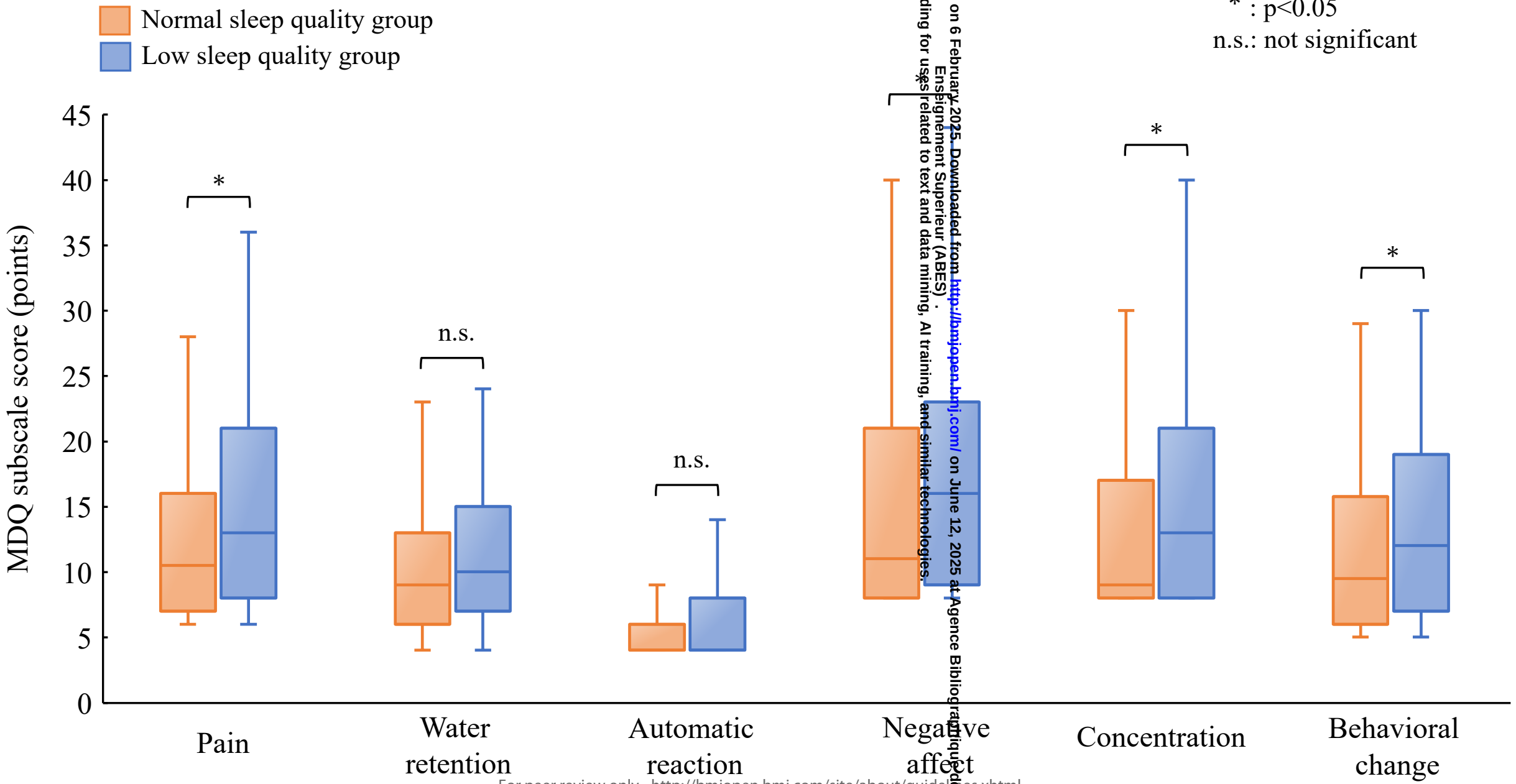

Figure. 3 Comparison of MDQ subscale scores: premenstrual

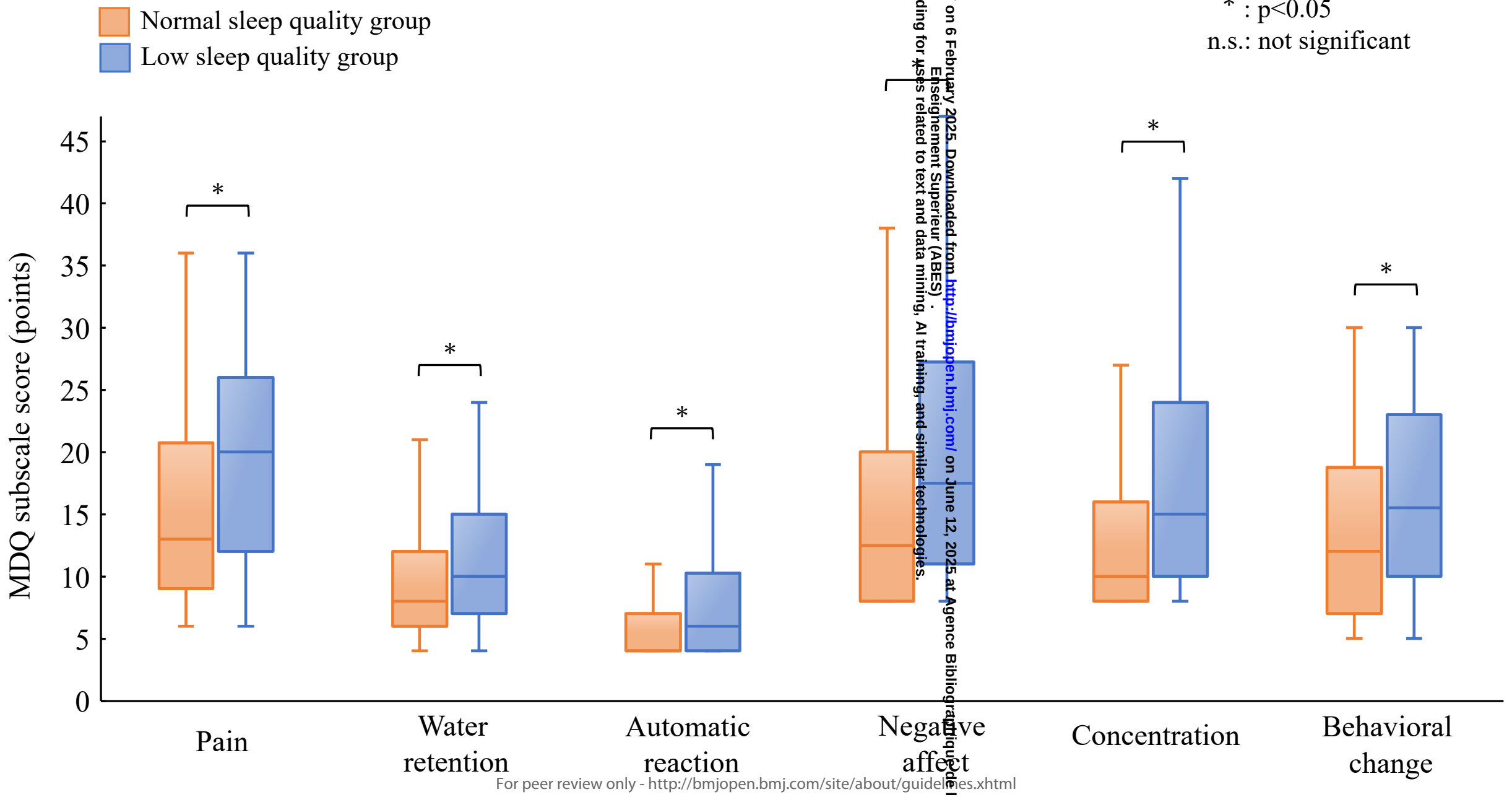

Figure. 4 Comparison of MDQ subscale scores: during menstruation

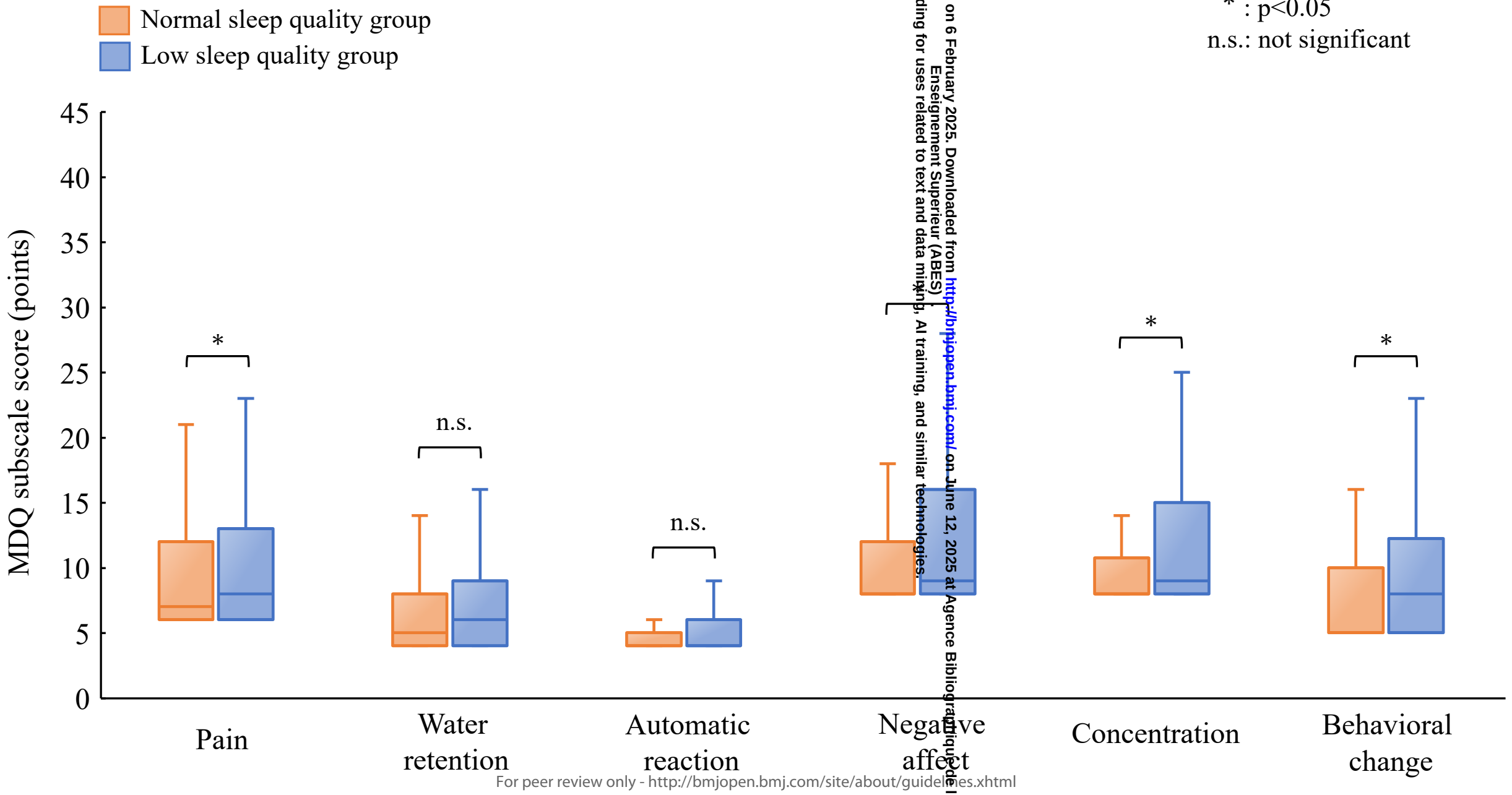

Figure. 5 Comparison of MDQ subscale scores: postmenstrual

Survey on perimenstrual symptoms and sleep in young women

Introduction

Many women experience various menstrual symptoms, such as dysmenorrhea and premenstrual syndrome (PMS), with an estimated prevalence of up to 80% among women. In addition, the impact of these symptoms on academic performance, quality of life, and socioeconomic losses has become a significant issue. Therefore, menstrual-related symptoms can be considered a critical problem that needs to be addressed.

Sleep, as an important lifestyle factor, accounts for approximately one-third of a person's life and is known to have various effects on both physical and mental health. Previous studies have highlighted issues such as short sleep duration and poor sleep quality among young women. These findings indicate the need to raise awareness about the importance of ensuring adequate sleep time and improving sleep quality in future health education programs for young women.

However, the relationship between menstrual symptoms and sleep has not been fully explored. Therefore, the purpose of this study is to investigate the relationship between menstrual symptoms and sleep among young women by surveying the current situation of these issues.

Survey Information

The survey takes approximately 20 minutes to complete. The target participants for this survey are women aged 18 to 25 years.

Please review the purpose and content of the survey below, and if you are willing to participate, proceed with the questions after providing your consent. You may stop the survey at any time; however, once the survey is submitted, it cannot be retracted. We appreciate your cooperation.

If you have any questions or comments regarding the content of this survey, please contact us at the information provided below.

[Inquiry]
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Please read the following items and the consent information carefully. If you agree to the contents, please check the "Consent to Participate" box and proceed with the questions.

---

1. Purpose and Significance of the Study

Many women experience various menstrual symptoms, such as dysmenorrhea and premenstrual syndrome (PMS), with an estimated prevalence of up to 80%. In addition, the impact of these symptoms on academic performance, quality of life, and socioeconomic losses has become a significant issue. Therefore, menstrual-related symptoms can be considered a critical problem that needs to be addressed. Sleep, which is an important lifestyle factor, accounts for approximately one-third of a person's life and is known to have various effects on both physical and mental health. Previous studies have highlighted issues such as short sleep duration and poor sleep quality among young women. These findings indicate the need to raise awareness about the importance of ensuring adequate sleep time and improving sleep quality in future health education programs for young women. However, the relationship between menstrual symptoms and sleep has not been fully explored. Therefore, the purpose of this study is to investigate the relationship between menstrual symptoms and sleep among young women by surveying the current situation of these issues.

2. Methods and Content

This survey will be conducted using Google Forms. The questionnaire includes basic information (age, height, weight, medication status, part-time job status, etc.), information about menstrual symptoms, and questions related to daily life (sleep, mental health, subjective well-being, anxiety, and lifestyle habits).

3. Possibility of Research Publication

We will handle personal information with the utmost care, and all responses will be kept confidential. This survey is anonymous, so responses will not be shared or disclosed in a way that could identify individuals. The responses will not affect your academic performance or workplace evaluations, and no one, including instructors, workplace representatives, or researchers, will know who has participated. Please feel free to answer honestly about your symptoms. The results of the survey may be presented at conferences or published in academic papers, but all personal identifiers will be excluded. We will ensure privacy and will not use the data for any purposes other than research. As this is an anonymous survey, the aggregated results will be reported on the homepage of the Hiroshima University Sports Rehabilitation

Consent to participate

☐ I agree to participate in the research

■ Basic information

・Age (○○ years)：_____

※Fill in the figures only

・Height (○○ cm) ：_____

※Fill in figures only (to one decimal place)

・Weight (○○ kg) ：_____

※Fill in figures only (to one decimal place)

・Current affiliation

□High school student
□Vocational student
□University student

・Current housemates

□Not living together (living alone)
□Family (living at home)
□Spouse, partner
□Friends, roommates
□Other

・Are you currently taking any ongoing medication?

□Yes
□No

・If you answered that you are taking any medication on an ongoing basis, please indicate the type of medication.

・Please indicate if you are currently being treated for any diseases.

・Do you currently have a part-time job?

□Yes
□No

▪Over the past week, how many minutes on average per day did you spend looking at a screen for leisure activities (such as videos, chatting, games, etc.)? (◯ minutes)Please enter the numerical value only.
For iPhone users: Please refer to the average screen time for the past 7 days.
For Android users: Please install the free app "Digitox" from Google Play (https://play.google.com/store/apps/details?id=phosphorus.app.usage.screen.time) and refer to the weekly average usage time.

▪Over the past week, how many minutes on average per day did you spend looking at a screen for studying or work? (◯ minutes)

Please enter the numerical value only.
For iPhone users: Please refer to the average screen time for the past 7 days.
For Android users: Please install the free app "Digitox" from Google Play (https://play.google.com/store/apps/details?id=phosphorus.app.usage.screen.time) and refer to the weekly average usage time.

・This refers to the time spent sitting or lying down every day (during work, study, leisure, etc.). This includes all time spent at a desk, chatting with friends, reading, sitting, lying down while watching TV, and so on. Please do not include sleep time. On weekdays, how many minutes in total do you usually spend sitting or lying down? (e.g., 180)
Please enter the numerical value only.

_____

・On weekends, how many minutes in total do you usually spend sitting or lying down in a day?
Please enter the numerical value only.

_____

・Please indicate how often you study or read until just before going to bed.

□None at all
□1~2 days a week
□At least three times a week

・Please indicate how often you watch TV until just before going to bed

□None at all
□1~2 days a week
□At least three times a week

・Please indicate how often you drink drinks containing caffeine (e.g. coffee, black tea, green tea, energy drinks).
□None at all
□1~2 days a week
□At least three times a week

■ About menstruation

・At what stage of your menstrual cycle are you currently (at the time of completing the questionnaire)?

□During menstruation
□Immediately after the end of menstruation - a few days later
□Ovulatory phase (from a few days after the end of menstruation to 1 week before the expected week of menstruation)
□Pre-menstrual (1 week before expected menstruation)
□No menstruation for the last three months or more

・At what age did you have your first menstruation? (○ years old) ：

_____

※Fill in the figures only

・Do you have dysmenorrhea?

□No I don't
□A little, but it does not interfere with daily life
□Pain is so severe that it interferes with daily life, but no medication is being taken
□Pain so severe that it interferes with daily life and requires medication

・If you answered that you have dysmenorrhea, how long does the pain last?

□Half day
□One day
□Two days
□Three days
□More than four days

・If you answered that you need to take medication in the two previous questions, please indicate the type of medication

※Multiple answers allowed
□Painkillers prescribed in hospital
□Over-the-counter painkillers
□Low-dose oral contraceptive pill
□Traditional Chinese medicine
□Other

■ Perimenstrual symptoms ※Created with reference to previous studies

Please answer the following questions about your **postmenstrual state** (Similar questions continue to be asked about premenstrual and during menstruation).

	1 Not applicable at all	2	3	4	5	6 Quite applicable
Weight gain	□	□	□	□	□	□
Insomnia	□	□	□	□	□	□
Crying	□	□	□	□	□	□
Lowered school or work performance	□	□	□	□	□	□
Muscle stiffness	□	□	□	□	□	□
Forgetfulness	□	□	□	□	□	□
Confusion	□	□	□	□	□	□
Take naps; stay in bed	□	□	□	□	□	□
Headache	□	□	□	□	□	□
Skin disorders	□	□	□	□	□	□
Loneliness	□	□	□	□	□	□
Feeling of suffocation	□	□	□	□	□	□
Affectionate	□	□	□	□	□	□
Orderliness	□	□	□	□	□	□
Stay at home	□	□	□	□	□	□
Cramps	□	□	□	□	□	□
Dizziness, faintness	□	□	□	□	□	□

Excitement	☐	☐	☐	☐	☐	☐
Chest pains	☐	☐	☐	☐	☐	☐
Avoid social activities	☐	☐	☐	☐	☐	☐
Anxiety	☐	☐	☐	☐	☐	☐
Backache	☐	☐	☐	☐	☐	☐
Cold sweats	☐	☐	☐	☐	☐	☐
Lowered judgment	☐	☐	☐	☐	☐	☐
Fatigue	☐	☐	☐	☐	☐	☐
Nausea, vomiting	☐	☐	☐	☐	☐	☐
Restlessness	☐	☐	☐	☐	☐	☐
Hot flashes	☐	☐	☐	☐	☐	☐
Difficulty concentrating	☐	☐	☐	☐	☐	☐
Painful breasts	☐	☐	☐	☐	☐	☐
Feelings of well-being	☐	☐	☐	☐	☐	☐
Ringing in the ears	☐	☐	☐	☐	☐	☐
Distractible	☐	☐	☐	☐	☐	☐
Swelling	☐	☐	☐	☐	☐	☐
Accidents	☐	☐	☐	☐	☐	☐
Irritability	☐	☐	☐	☐	☐	☐
General aches and pains	☐	☐	☐	☐	☐	☐
Mood swings	☐	☐	☐	☐	☐	☐
Heart pounding	☐	☐	☐	☐	☐	☐
Depression	☐	☐	☐	☐	☐	☐
Decreased efficiency	☐	☐	☐	☐	☐	☐
Lowered motor coordination	☐	☐	☐	☐	☐	☐
Numbness, tingling	☐	☐	☐	☐	☐	☐
Tension	☐	☐	☐	☐	☐	☐
Blind spots, fuzzy vision	☐	☐	☐	☐	☐	☐
Bursts of energy, activity	☐	☐	☐	☐	☐	☐

Please answer the following questions about your **premenstrual state**

	1 Not applicable at all	2	3	4	5	6 Quite applicable
Weight gain	☐	☐	☐	☐	☐	☐
Insomnia	☐	☐	☐	☐	☐	☐
Crying	☐	☐	☐	☐	☐	☐
Lowered school or work performance	☐	☐	☐	☐	☐	☐
Muscle stiffness	☐	☐	☐	☐	☐	☐
Forgetfulness	☐	☐	☐	☐	☐	☐
Confusion	☐	☐	☐	☐	☐	☐
Take naps; stay in bed	☐	☐	☐	☐	☐	☐
Headache	☐	☐	☐	☐	☐	☐
Skin disorders	☐	☐	☐	☐	☐	☐
Loneliness	☐	☐	☐	☐	☐	☐
Feeling of suffocation	☐	☐	☐	☐	☐	☐
Affectionate	☐	☐	☐	☐	☐	☐
Orderliness	☐	☐	☐	☐	☐	☐
Stay at home	☐	☐	☐	☐	☐	☐
Cramps	☐	☐	☐	☐	☐	☐
Dizziness, faintness	☐	☐	☐	☐	☐	☐
Excitement	☐	☐	☐	☐	☐	☐
Chest pains	☐	☐	☐	☐	☐	☐
Avoid social activities	☐	☐	☐	☐	☐	☐
Anxiety	☐	☐	☐	☐	☐	☐
Backache	☐	☐	☐	☐	☐	☐
Cold sweats	☐	☐	☐	☐	☐	☐
Lowered judgment	☐	☐	☐	☐	☐	☐
Fatigue	☐	☐	☐	☐	☐	☐
Nausea, vomiting	☐	☐	☐	☐	☐	☐
Restlessness	☐	☐	☐	☐	☐	☐
Hot flashes	☐	☐	☐	☐	☐	☐
Difficulty concentrating	☐	☐	☐	☐	☐	☐

Painful breasts	☐	☐	☐	☐	☐	☐
Feelings of well-being	☐	☐	☐	☐	☐	☐
Ringing in the ears	☐	☐	☐	☐	☐	☐
Distractible	☐	☐	☐	☐	☐	☐
Swelling	☐	☐	☐	☐	☐	☐
Accidents	☐	☐	☐	☐	☐	☐
Irritability	☐	☐	☐	☐	☐	☐
General aches and pains	☐	☐	☐	☐	☐	☐
Mood swings	☐	☐	☐	☐	☐	☐
Heart pounding	☐	☐	☐	☐	☐	☐
Depression	☐	☐	☐	☐	☐	☐
Decreased efficiency	☐	☐	☐	☐	☐	☐
Lowered motor coordination	☐	☐	☐	☐	☐	☐
Numbness, tingling	☐	☐	☐	☐	☐	☐
Tension	☐	☐	☐	☐	☐	☐
Blind spots, fuzzy vision	☐	☐	☐	☐	☐	☐
Bursts of energy, activity	☐	☐	☐	☐	☐	☐

Please answer the following questions about your **during menstruation state**

	1 Not applicable at all	2	3	4	5	6 Quite applicable
Weight gain	☐	☐	☐	☐	☐	☐
Insomnia	☐	☐	☐	☐	☐	☐
Crying	☐	☐	☐	☐	☐	☐
Lowered school or work performance	☐	☐	☐	☐	☐	☐
Muscle stiffness	☐	☐	☐	☐	☐	☐
Forgetfulness	☐	☐	☐	☐	☐	☐
Confusion	☐	☐	☐	☐	☐	☐
Take naps; stay in bed	☐	☐	☐	☐	☐	☐

Headache	☐	☐	☐	☐	☐	☐
Skin disorders	☐	☐	☐	☐	☐	☐
Loneliness	☐	☐	☐	☐	☐	☐
Feeling of suffocation	☐	☐	☐	☐	☐	☐
Affectionate	☐	☐	☐	☐	☐	☐
Orderliness	☐	☐	☐	☐	☐	☐
Stay at home	☐	☐	☐	☐	☐	☐
Cramps	☐	☐	☐	☐	☐	☐
Dizziness, faintness	☐	☐	☐	☐	☐	☐
Excitement	☐	☐	☐	☐	☐	☐
Chest pains	☐	☐	☐	☐	☐	☐
Avoid social activities	☐	☐	☐	☐	☐	☐
Anxiety	☐	☐	☐	☐	☐	☐
Backache	☐	☐	☐	☐	☐	☐
Cold sweats	☐	☐	☐	☐	☐	☐
Lowered judgment	☐	☐	☐	☐	☐	☐
Fatigue	☐	☐	☐	☐	☐	☐
Nausea, vomiting	☐	☐	☐	☐	☐	☐
Restlessness	☐	☐	☐	☐	☐	☐
Hot flashes	☐	☐	☐	☐	☐	☐
Difficulty concentrating	☐	☐	☐	☐	☐	☐
Painful breasts	☐	☐	☐	☐	☐	☐
Feelings of well-being	☐	☐	☐	☐	☐	☐
Ringing in the ears	☐	☐	☐	☐	☐	☐
Distractible	☐	☐	☐	☐	☐	☐
Swelling	☐	☐	☐	☐	☐	☐
Accidents	☐	☐	☐	☐	☐	☐
Irritability	☐	☐	☐	☐	☐	☐
General aches and pains	☐	☐	☐	☐	☐	☐
Mood swings	☐	☐	☐	☐	☐	☐
Heart pounding	☐	☐	☐	☐	☐	☐
Depression	☐	☐	☐	☐	☐	☐
Decreased efficiency	☐	☐	☐	☐	☐	☐
Lowered motor coordination	☐	☐	☐	☐	☐	☐
Numbness, tingling	☐	☐	☐	☐	☐	☐

Tension	□	□	□	□	□	□
Blind spots, fuzzy vision	□	□	□	□	□	□
Bursts of energy, activity	□	□	□	□	□	□

■ Sleep quality ※Created with reference to previous studies

Instructions: The following questions relate to your usual sleep habits during the past month only. Your answers should indicate the most accurate reply for the majority of days and nights in the past month. Please answer all questions.

・During the past month, what time have you usually gone to bed at night? *Please indicate after 24:00 as in the example (e.g. 24:00 → 0:00, 25:00 → 1:00).

_____

・During the past month, how long (in minutes) has it usually taken you to fall asleep each night? (○minutes) Fill in the figures only.

_____

・During the past month, what time have you usually gotten up in the morning?

_____

・During the past month, how many hours of actual sleep did you get at night? *This does not include the time spent in bed awake. (○ minutes)

_____

② During the past month, how often have you had trouble sleeping because you... Please select the most applicable one.

・Cannot get to sleep within 30 minutes

□Not during the past month
□Less than once a week
□Once or twice a week
□Three or more times a week

・Wake up in the middle of the night or early morning

□Not during the past month
□Less than once a week
□Once or twice a week
□Three or more times a week

・Have to get up to use the bathroom

□Not during the past month
□Less than once a week
□Once or twice a week
□Three or more times a week

・Cannot breathe comfortably

□Not during the past month
□Less than once a week
□Once or twice a week
□Three or more times a week

・Cough or snore loudly

□Not during the past month
□Less than once a week
□Once or twice a week
□Three or more times a week

・Feel too cold

□Not during the past month

□Less than once a week
□Once or twice a week
□Three or more times a week

・Feel too hot

□Not during the past month
□Less than once a week
□Once or twice a week
□Three or more times a week

・Have bad dreams

□Not during the past month
□Less than once a week
□Once or twice a week
□Three or more times a week

・Have pain

□Not during the past month
□Less than once a week
□Once or twice a week
□Three or more times a week

・Other reason(s), please describe: _____

□Not during the past month
□Less than once a week
□Once or twice a week
□Three or more times a week

・During the past month, how often have you taken medicine to help you sleep (prescribed or "over the counter")?

□Not during the past month

□Less than once a week
□Once or twice a week
□Three or more times a week

・During the past month, how often have you had trouble staying awake while driving, eating meals, or engaging in social activity?
□Not during the past month
□Less than once a week
□Once or twice a week
□Three or more times a week

・During the past month, how much of a problem has it been for you to keep up enough enthusiasm to get things done?
□No problem at all
□Only a very slight problem
□Somewhat of a problem
□A very big problem

・During the past month, how would you rate your sleep quality overall?
□Very good
□Fairly good
□Fairly bad
□Very bad

■ Experience of visiting a gynecologist

・Have you ever visited a gynecologist?
□yes, I have
□No, I haven't

・If you have been diagnosed by a gynecologist, please state the name of the diagnosis:

■ Lifestyle: Please answer yes or no to the following ※Created with reference to previous studies

・Have an exercise routine at least twice a week and for at least 30 minutes a day

□Yes
□No

・Eat breakfast at least 5 days a week

□Yes
□No

・No snacking and night eating habits

□Yes (not in the habit of eating snacks or evening meals)
□No (habit of snacking or eating evening meals)

・Sleeping for more than 7 hours

□Yes
□No

・Never smoked or quit the habit.

□Yes
□No

・Little or moderate alcohol consumption (2~4 days off per week)

□Yes (do not drink alcohol or drink the right amount)
□No (amount and frequency of alcohol consumption)