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Comparison of factors associated with the occurrence of menstruation-related symptoms in Japanese women without exercise habits and female soccer players: a cross-sectional study

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Abstract

Purpose The aims of this study were to identify factors associated with menstruation-related symptoms and compare them between female soccer players and women without exercise habits.

Methods This cross-sectional study was conducted between June and August 2022. Participants were healthy Japanese women aged 18–29 years, divided into two groups for comparison by exercise habits: women without exercise habits and female college soccer players. Participants responded to a self-administered questionnaire pertaining to their physical and menstrual characteristics, menstruation-related symptoms, and lifestyle habits. For menstruation-related symptoms, the Andersch and Milsom Scale was used to assess the severity of each of the 16 symptoms before and during menstruation. Lifestyle habits included stress, sleep, diet, and physical activity, which were assessed using Perceived Stress Scale, Japanese version of the Pittsburgh Sleep Quality Index, Food Frequency Questionnaire, and International Physical Activity Questionnaire, respectively. Data were analyzed using the t-test and multiple logistic regression analysis. All analyses were performed with a statistical significance of 5%.

Results A total of 428 women (192 without exercise habits; 236 soccer players) participated in the study, and 244 women (99 without exercise habits; 125 soccer players) were analyzed. For women without exercise habits, long menstrual days (OR = 5.627; 95% CI, 1.046–30.259) and high levels of stress (1.082; 1.011–1.157) were factors before menstruation, and stress (1.131; 1.045–1.225) was a factor during menstruation were significantly associated with severe menstruation-related symptoms. Contrastingly, for soccer players, high body mass index (BMI) (1.460; 1.080–1.973), late bedtime (0.288; 0.110–0.753) before menstruation, older age (1.662; 1.073–2.575), high BMI (1.468; 1.089–1.980), family history of menstruation-related symptoms (3.090; 1.179–8.098), late bedtime (0.358; 0.133–0.958), caffeine consumption (0.359; 0.139–0.930), and less frequent breakfast intake (0.807; 0.653–0.997) were significant factors. Additionally, the factors associated with the occurrence of menstruation-related symptoms differed according

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to the symptom type. The most frequently associated factor in women without exercise habits was stress (13 symptoms). In female soccer players, the most frequently associated factor was BMI (8 symptoms).

Conclusion Women presented different factors for menstruation-related symptoms depending on the presence or absence of exercise habits in their routine.

Keywords Female athletes, Japanese women, Lifestyle habits, Menstruation-related symptoms, Soccer players, Physical exercise

Introduction

Menstruation-related symptoms refer to physical and mental discomfort experienced or alterations perceived during the menstrual cycle, and include dysmenorrhea and premenstrual syndrome. Symptoms include physical symptoms such as lower abdominal pain, back pain, general discomfort, and fatigue, or psychological symptoms such as depression and agitation [1]. Menstruation-related symptoms are experienced by many women and are among the most common gynecological conditions in women [2, 3]. Approximately 70%–90% of menstruating women experience menstruation-related symptoms [4–6] leading to absence from school. Approximately 80% of women are absent from school because of menstruation [7]. The total labor loss due to these symptoms is approximately 683 billion yen [8]. This suggests that menstruation-related symptoms occur in a high proportion of women and affect their daily lives.

Specific strategies are needed to address menstruation-related symptoms in most women who have symptoms and perceive influences on their daily lives. Recent studies have focused on the factors associated with the presence and severity of menstruation-related symptoms [9–11]. One strategy to address menstruation-related symptoms is through exercise. Exercise may reduce menstruation-related symptoms, suggesting an association between daily exercise habits and menstruation-related symptoms [12, 13]. However, menstruation-related symptoms were also observed in female athletes who exercised daily. Menstruation-related symptoms in female athletes tend to be more frequently reported in team sports, such as soccer and volleyball; skill-dependent sports, such as gymnastics; and weight-making sports, such as taekwondo. Previous studies in female soccer players have shown that menstruation-related symptoms may affect athletic performance [14]. Therefore, strategies to reduce menstruation-related symptoms are needed for female athletes. A previous study that investigated risk factors for dysmenorrhea in female athletes reported that athletic-related items, such as training hours, may be associated with symptoms [15]. This suggests that the risk factors for menstruation-related symptoms may differ between female athletes who exercise daily and those who do not have an exercise habit.

In addition, menstruation-related symptoms are a generic term for multiple symptoms that occur before and during menstruation, and each woman symptoms differently. Therefore, to construct specific strategies, it is necessary to clarify whether different symptoms have different factors associated with the occurrence of menstruation-related symptoms. However, we found no studies that examined the risk factors for each menstruation-related symptom with a focus on the presence or absence of an exercise habit. If risk factors could be identified based on individual characteristics, such as exercise habits and symptoms experienced by women, it would be possible to establish more effective strategies that consider more individual conditions.

Therefore, the aims of this study were to identify factors associated with menstruation-related symptoms and compare them between female soccer players and women without exercise habits. We hypothesized that factors associated with menstruation-related symptoms would differ depending on exercise habits.

Materials and methods

Study design

This cross-sectional study was conducted between June and August 2022 using a web-based questionnaire on Google Forms. The questionnaire included questions on physical characteristics, menstrual characteristics, menstruation-related symptoms, and lifestyle habits. The study participants were healthy Japanese women who were distributed into two groups: women without exercise habits and female college-going soccer players. In this study, only female soccer players were included as female athletes with a reported prevalence of menstruation-related symptoms and their impact on performance to compare the effects of exercise habits. We calculated the sample size before participant recruitment, using the G*Power software (v3.1.9.6, Heinrich-Heine-Universität Düsseldorf, Düsseldorf, Germany) [16, 17]. We used 2-sided testing, odds ratio = 2, Pr (Y = 1| X = 1) H0 = 0.5, α err prob = 0.05, power (1-β err prob) = 0.85, R2 other X = 0.6, and the minimum sample size was set to 203. This study was conducted in accordance with the Declaration of Helsinki and was approved by the Ethics Review Board of the Institute of Health and Sport Sciences at

the University of Tsukuba (approval number: Tai 021–242). At the top of the questionnaire, the content of the study, the voluntary nature of cooperation in this study, anonymity, and confidentiality of the responses were explained, and informed consent was obtained, with the submission of the questionnaire considered as consent to participate in the study. The Internet E-Survey Checklist for Reporting Results (CHERRIES) [18] and Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) [19] were followed.

Participants

Women without exercise habits were recruited using snowball sampling methods. First, we asked acquaintances and others to participate in the study. Those acquaintances then asked their acquaintances and others to participate in this study, thus obtaining respondents in a chain reaction. In addition, posters describing the research and the URL to access the survey were displayed on university campuses and other locations, and cooperation in the research was widely requested. Female soccer players were recruited with the cooperation of the Kanto University Women's Soccer Federation. First, we asked the Kanto University Women's Soccer Federation to cooperate with this study. After receiving their approval, the Kanto University Women's Soccer Federation asked each university to participate in this study and received their responses.

Previous studies investigating risk factors for dysmenorrhea or premenstrual syndrome [20, 21], due to the fact that menstruation-related symptoms are most frequently reported in the late teens to 20 s, used age as an inclusion criterion [22]. Thus, our inclusion criteria were 1) between 18 and 29 years; 2) no history of pregnancy or childbirth; 3) no history of disease of gynecological origin; 4) no current illness; 5) no history or current use of oral contraceptives and low dose estrogen-progestin; and 6) no irregular menstrual cycle (normal menstrual cycle was 25–38 days [23]) for both women without exercise habits and female soccer players. Additionally, women without exercise habits had no regular exercise (defined as exercise > 30 min per session, at least twice a week, for at least 1 year) [24], and female soccer players were active participants of the university women's soccer club. Participants were asked to check all inclusion criteria items in the web-based questionnaire to determine their eligibility.

Measurements

Menstruation-related symptoms

Menstruation-related symptoms include primary dysmenorrhea and premenstrual syndrome, which encompasses multiple symptoms. Previously, we conducted a systematic review of the prevalence and risk factors for primary dysmenorrhea and premenstrual syndrome [11]. In this study, we investigated 16 symptoms that were reported most frequently in the studies included in a systematic review [11]. The 16 symptoms included in this study were: abdominal pain, headache, lower back pain, breast pain, fatigue, swelling, nausea, skin irritation, changes in appetite, changes in sleep, poor concentration, tearfulness, irritability, depression, anxiety, and tension. Participants were asked to indicate the frequency and severity of each symptom before and during their last two menstrual cycles. The severity of each symptom was quantified using the Andersch and Milsom Scale, with the participants selecting 0 (no symptoms: menstruation is painless and does not interfere with daily life), 1 (mild: menstruation is painful but does not interfere with daily life, and analgesics are rarely needed and the pain is mild), 2 (moderate: menstruation is moderately painful, interferes with daily life and requires painkillers, but is so analgesic that it is rare to miss work or school), or 3 (severe: menstruation is severely painful, poorly analgesic and clearly interferes with activity). The Andersch and Milsom Scale has been used in several studies and has high validity and reliability [21, 25].

Physical characteristics

Physical characteristics included age, height, and weight, based on several studies investigating risk factors for menstruation-related symptoms [25–30]. Responses to all items were self-reported. Body mass index(BMI) was calculated as weight (kg) divided by the square of height (m^2). In addition, female soccer players were asked about their position, playing history, competition level, training duration, and conditions during the year.

Menstrual characteristics

Menstrual characteristics included age at menarche, menstrual cycle, duration of menstruation, analgesic use, and family history of menstruation-related symptoms based on several studies investigating risk factors for menstruation-related symptoms [25–30], and responses to all items were self-reported.

Lifestyle habits

Lifestyle habits included stress, sleep, eating habits, and physical activity (PA), assessed by participants' responses to previously validated questionnaires.

Stress over the past month was assessed using the Perceived Stress Scale (PSS) [31, 32]. This scale consists of 14 questions, and participants selected 0 (none at all) to 4 (very stressful) for each question. The sum of the answers is the PSS score, and the PSS score ranges from 0 to 40, with higher scores indicating a higher level of stress.

Sleep quality in the past month was evaluated using the Japanese version of the Pittsburgh Sleep Quality Index (PSQI) [33–35], which consists of questions about bedtime, time taken from bedtime to sleep, waking time, and sleep quality. The actual sleep time was calculated from the bedtime, time taken from bedtime to sleep, and waking time, and was defined as hours of sleep.

Eating habits in the past month were investigated using a qualitative Food Frequency Questionnaire (FFQ) [36, 37]. The questionnaire assessed smoking habits, alcohol consumption, caffeine consumption, and number of breakfasts per week. For smoking habits, participants selected their answers from current smoking, past smoking, and never smoking, with current or past smoking defined as 'yes' and never smoking as 'no.' For alcohol consumption, participants were asked about their alcohol consumption and selected their answers from no, little, average, and plenty. A little, average, and plenty were defined as 'yes, and no was defined as 'no.' For caffeine consumption, participants were asked about their caffeine frequency and selected their answers from almost every day, four to five days a week, two to three days a week, and less than one day a week. Almost every day or four to five days a week were defined as 'yes, and two to three days a week or less than one day a week were defined as 'no.'

PA was assessed using the Japanese version of the International Physical Activity Questionnaire (IPAQ; usual seven days, short, self-administered version) [29]. IPAQ calculates the amount of walking, moderate, and high PA, and the total amount of PA from the sum of the total time per day spent walking and moderate and high PA for ≥ 10 min continuously over an average week and the number of days per week. Walking was defined as 3.3 metabolic equivalents (METs), moderate PA as 4.0 METs, and high PA as 8.0 METs. Missing data for hours or days were excluded from the analyses. METs is a unit of measurement for physical activity intensity. It shows how many times more energy is expended when the resting state is set to 1. All questionnaires have been used in several studies and have been administered with high validity and reliability [38–41].

Statistical analysis

Participant characteristics and the number of symptoms were compared between groups using an unpaired t-test. A logistic regression model was used to explore the risk factors associated with the presence and severity of menstruation-related symptoms. The dependent variable was the severity of all menstruation-related symptoms (16 symptoms) before or during menstruation. The independent variables were age (year), BMI (kg/m^2), age at menarche (year), duration of menstruation (short [menstrual days = 1–3 days], regular [menstrual days = 4–6 days], or long [menstrual days ≥ 7 days]), family history of menstruation-related symptoms (yes or no), alcohol consumption (yes or no), caffeine consumption (yes or no), number of breakfast intakes (times/week), smoking (yes or no), stress (score), hours of sleep (hour), bedtime (before 23:00 or after 23:01), number of days of high PA, moderate PA, or walking, total minutes of high PA, moderate PA, or walking per week, position (Forward; FW, Midfielder; MF, defender; DF, or goalkeeper; GK), competition level (international, national, regional, prefecture competitions and below), and duration of competition. The level of significance was set at 5%. All statistical analyses were performed using IBM SPSS (version 28.0; SPSS Inc., Armonk, NY, USA).

Results

Participant characteristics

In total, 428 healthy women (192 women without exercise habits and 236 female soccer players) participated in the study. Of these, 198 (93 women without exercise habits and 111 female soccer players) were excluded because of a history of pregnancy or childbirth (1 woman without exercise habits and 1 female soccer player), a current illness (8 women without exercise habits and 14 female soccer players), irregular menstruation (43 women without exercise habits and 67 female soccer players), current oral contraceptive use (20 women without exercise habits and 11 female soccer players), and incomplete data (21 women without exercise habits and 18 female soccer players). The final dataset comprised data from 99 women without exercise habits and 125 female soccer players (Fig. 1).

Table 1 presents the characteristics of participants. Significant differences in age, height, weight, and age at menarche were observed between women without exercise habits and female soccer players.

Prevalence of menstruation-related symptoms

The proportion of participants with at least one severe symptom before menstruation was 41.4% ($n = 41$) in women without exercise habits and 39.2% ($n = 49$) in female soccer players. The proportion of women with at least one severe symptom during menstruation was 44.4% ($n = 44$) in women without exercise habits and 35.2% ($n = 44$) in female soccer players.

Details of severe menstruation-related symptoms

Before menstruation, women without exercise habits most frequently reported changes in appetite (21.2%), fatigue (17.2%), changes in sleep (17.2%), skin irritation (16.2%), and irritability (16.2%). Female soccer players most frequently reported changes in appetite (24.0%),

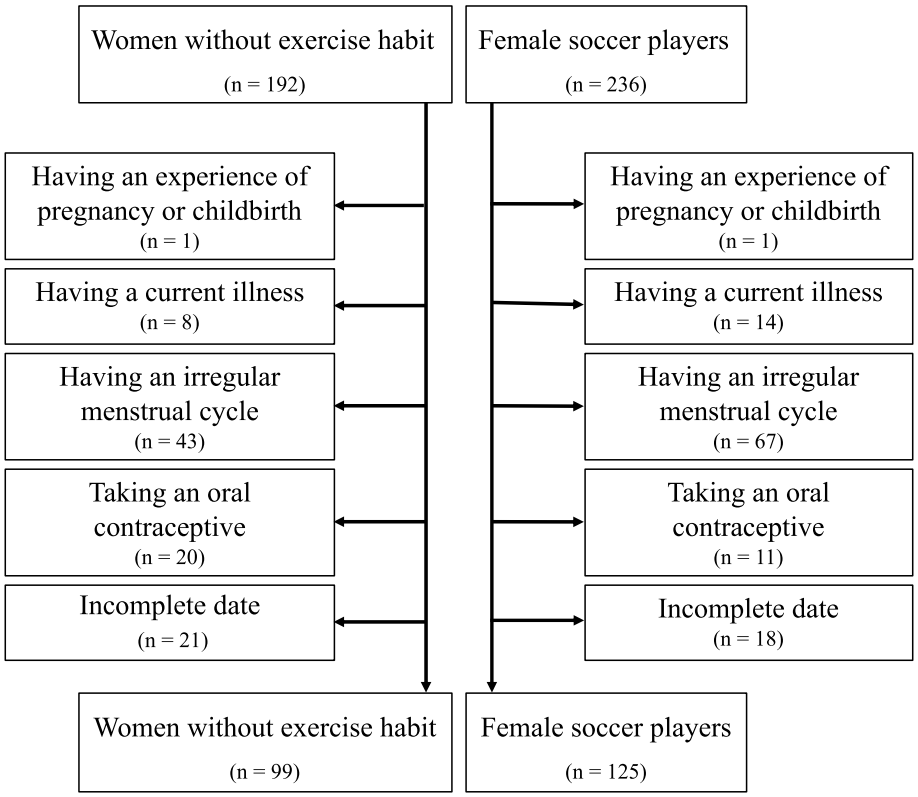

Fig. 1 Participant flow diagram

Table 1 The characteristics of the study participants

	All			Women without exercise habits			Female soccer players			*p*	
	(*n* = 224)			(*n* = 99)			(*n* = 125)				
Age (year)	20.4	±	2.63	21.2	±	2.96	19.7	±	2.15	0.018	*
Height (cm)	159.4	±	5.72	158.1	±	5.46	160.4	±	5.73	0.002	*
Weight (kg)	53.4	±	7.37	52.0	±	8.79	54.5	±	5.83	< 0.001	*
BMI (kg/m^2)	21.0	±	2.33	20.8	±	3.03	21.1	±	1.57	0.006	*
Age at menarche (year)	12.9	±	1.45	12.3	±	1.44	13.4	±	1.26	< 0.001	*

Data are presented as mean ± standard deviation (SD)

SD standard deviation, *BMI* body mass index

* $p < 0.05$

irritability (13.6%), skin irritation (10.4%), depression (8.8%), and fatigue (8.0%).

During menstruation, women without exercise habits most frequently reported abdominal pain (21.2%), fatigue (17.2%), changes in appetite (16.2%), changes in sleep (14.1%), and depression (14.1%). Female soccer players most frequently reported abdominal pain (16.0%), changes in appetite (14.4%), fatigue (11.2%), changes in sleep (9.6%), and lower back pain (8.0%).

Factors associated with all severe symptoms

Table 2 shows the logistic regression models with factors related to all severe symptoms before and during menstruation in women without exercise habits as the dependent variable. Before menstruation, menstrual days (long) and stress were associated with having at least one severe symptom among the 16 symptoms. During menstruation, Stress was associated with having at least one severe symptom among the 16 symptoms.

Table 2 Factors related to all severe symptoms before and after and during menstruation in women without exercise habit

before menstruation				during menstruation			
variables	OR	95%CI	p	variables	OR	95%CI	p
Age (year)	0.902	0.725 - 1.123	0.357	Age (year)	0.972	0.787 - 1.201	0.792
BMI (kg/m^2)	1.013	0.868 - 1.183	0.870	BMI (kg/m^2)	0.983	0.831 - 1.162	0.839
Age at menarche (year)	0.713	0.474 - 1.073	0.105	Age at menarche (year)	0.947	0.656 - 1.367	0.772
Menstrual days (long)	5.627	1.046 - 30.259	0.044 *	Menstrual days (long)	3.744	0.808 - 17.355	0.092
Family history of menstruation-related symptoms (yes)	1.455	0.521 - 4.060	0.474	Family history of menstruation-related symptoms (yes)	1.162	0.417 - 3.235	0.774
Stress (score)	1.082	1.011 - 1.157	0.023 *	Stress (score)	1.131	1.045 - 1.225	0.002 *
Hours of sleep (hour)	1.044	0.689 - 1.582	0.839	Hours of sleep (hour)	0.811	0.527 - 1.248	0.341
Bedtime (after 23:01)	2.237	0.641 - 7.799	0.206	Bedtime (after 23:01)	0.970	0.284 - 3.317	0.961
Smoking (yes)	0.000	0.000 - 0.000	0.999	Smoking (yes)	0.000	0.000 - 0.000	0.999
Alcohol consumption (yes)	0.447	0.132 - 1.507	0.194	Alcohol consumption (yes)	0.593	0.178 - 1.972	0.394
Caffeine consumption (yes)	0.876	0.297 - 2.586	0.810	Caffeine consumption (yes)	1.043	0.353 - 3.080	0.939
Number of breakfast intakes (times/week)	0.951	0.768 - 1.177	0.646	Number of breakfast intakes (times/week)	0.967	0.780 - 1.198	0.759
Total physical activity (METs)	1.000	1.000 - 1.000	0.406	Total physical activity (METs)	1.000	1.000 - 1.001	0.263

BMI body mass index, *METs* metabolic equivalents, *OR* odds ratio, *CI* confidence interval

*$p < 0.05$

Table 3 shows the logistic regression models with factors related to all severe symptoms before and during menstruation in female soccer players as the dependent variable. Before menstruation, Body mass index (BMI) and bedtime (after 23:01) were associated with having at least one severe symptom among the 16 symptoms. During menstruation, age, BMI, family history of menstruation-related symptoms, bedtime (after 23:01), caffeine consumption (yes), and number of breakfast intakes were associated with having at least one severe symptom among the 16 symptoms.

Factors associated with each severe symptom

Table 4 shows the logistic regression models with factors related to each severe symptom before and during menstruation in women without exercise habits as the dependent variable. Before menstruation, stress and total physical activity (PA) were associated with severe abdominal pain and headache. Family history of menstruation-related symptoms, stress, and alcohol consumption (yes) were significantly associated with fatigue. Stress was significantly associated with swelling, skin irritation, and depression. Early menarche was significantly associated with changes in sleep and decreased concentration. BMI, stress, and total PA were significantly associated with irritability. Menstrual days (long) and total PA were significantly associated with anxiety. BMI and menstrual days (short) were significantly associated with tension. Menstrual days (short), stress, and total PA were significantly associated with tearfulness. During menstruation, Menstrual days (long) and the number of breakfast intakes were significantly associated with abdominal pain. Stress was significantly associated with headache, swelling, skin irritation, changes in appetite, and depression. Stress and alcohol consumption (yes) were significantly associated with fatigue. Menstrual days (short), family history of menstruation-related symptoms, and total PA were significantly associated with irritation. Family history of menstruation-related symptoms, stress, and total PA were significantly associated with anxiety. Early menarche, family history of menstruation-related symptoms, caffeine consumption (yes), and total PA were significantly associated with tearfulness.

Table 3 Factors related to the all severe symptoms before and during menstruation in female soccer player

before menstruation				during menstruation			
variables	OR	95%CI	p	variables	OR	95%CI	p
Age (year)	1.254	0.846 - 1.860	0.259	Age (year)	1.662	1.073 - 2.575	0.023 *
BMI (kg/m^2)	1.460	1.080 - 1.973	0.014 *	BMI (kg/m^2)	1.468	1.089 - 1.980	0.012 *
Age at menarche (year)	1.146	0.819 - 1.605	0.427	Age at menarche (year)	0.942	0.667 - 1.332	0.737
Menstrual days (long)	1.070	0.184 - 6.240	0.940	Menstrual days (long)	0.377	0.052 - 2.730	0.334
Family history of menstruation-related symptoms (yes)	2.217	0.880 - 5.583	0.091	Family history of menstruation-related symptoms (yes)	3.090	1.179 - 8.098	0.022 *
Stress (score)	1.019	0.966 - 1.073	0.493	Stress (score)	1.033	0.978 - 1.090	0.242
Hours of sleep (hour)	0.738	0.483 - 1.128	0.160	Hours of sleep (hour)	1.052	0.694 - 1.595	0.812
Bedtime (after 23:01)	0.288	0.110 - 0.753	0.011 *	Bedtime (after 23:01)	0.358	0.133 - 0.958	0.041 *
Smoking (yes)	1.490	0.085 - 25.994	0.784	Smoking (yes)	16.112	0.704 - 368.764	0.082
Alcohol consumption (yes)	0.634	0.229 - 1.758	0.381	Alcohol consumption (yes)	0.413	0.140 - 1.222	0.110
Caffeine consumption (yes)	0.637	0.255 - 1.590	0.334	Caffeine consumption (yes)	0.359	0.139 - 0.930	0.035 *
Number of breakfast intakes (times/week)	0.847	0.690 - 1.041	0.114	Number of breakfast intakes (times/week)	0.807	0.653 - 0.997	0.047 *
Total physical activity (METs)	1.000	1.000 - 1.000	0.445	Total physical activity (METs)	1.000	1.000 - 1.000	0.113

BMI body mass index, *METs* metabolic equivalents, *OR* odds ratio, *CI* confidence interval

*$p < 0.05$

Table 4 Factors related to severe each symptoms before and during menstruation in women without exercise habit

before menstruation					during menstruation				
Symptoms	variables	OR	95%CI	p	Symptoms	variables	OR	95%CI	p
Abdominal pain	Stress (score)	1.119	1.044 – 1.199	0.001 **	Abdominal pain	Menstrual days (long)	26.412	2.732 – 255.312	0.005 **
	Total physical activity (METs)	1.000	1.000 – 1.000	0.041 *		Number of breakfast intakes (times/week)	0.638	0.418 – 0.975	0.038 *
Headache	Total physical activity (METs)	1.000	1.000 – 1.001	0.028 *	Headache	Stress (score)	1.254	1.063 – 1.479	0.007 **
Fatigue	Family history of menstruation-related symptoms (yes)	3.485	1.037 – 11.705	0.043 *	Fatigue	Stress (score)	1.118	1.028 – 1.216	0.009 **
	Stress (score)	1.085	1.004 – 1.173	0.039 *		Alcohol consumption (yes)	0.308	0.098 – 0.968	0.044 *
	Alcohol consumption (yes)	0.183	0.053 – 0.638	0.008 **	Swelling	Stress (score)	1.148	1.017 – 1.295	0.026 *
Swelling	Stress (score)	1.131	1.015 – 1.261	0.026 *	Skin irritation	Stress (score)	1.129	1.032 – 1.236	0.008 **
Skin irritation	Stress (score)	1.178	1.048 – 1.323	0.006 **	Changes in appetite	Stress (score)	1.072	1.001 – 1.149	0.048 *
Changes in sleep	Stress (score)	0.581	0.354 – 0.954	0.032 *	Irritation	Menstrual days(short)	10.586	1.283 – 87.337	0.028 *
Decreased concentratio	Age at menarche (year)	0.525	0.294 – 0.937	0.029 *		Family history of menstruation-related symptoms (yes)	10.119	2.151 – 47.605	0.003 **
Irritation	BMI (kg/m^2)	1.373	1.107 – 1.702	0.004 **		Total physical activity (METs)	1.000	1.000 – 1.001	0.023 *
	Stress (score)	1.124	1.010 – 1.250	0.032 *	Depression	Stress (score)	1.122	1.028 – 1.226	0.010 *
	Total physical activity (METs)	1.000	1.000 – 1.001	0.035 *	Anxiety	Family history of menstruation-related symptoms (yes)	6.039	1.031 – 35.367	0.046 *
Depression	Stress (score)	1.097	1.008 – 1.194	0.032 *		Stress (score)	1.167	1.023 – 1.331	0.022 *
Anxiety	Menstrual days (long)	8.412	1.525 – 46.403	0.015 *		Total physical activity (METs)	1.001	1.000 – 1.001	0.006 **
	Total physical activity (METs)	1.000	1.000 – 1.001	0.006 **	Sensitive to tears	Age at menarche (year)	0.511	0.271 – 0.963	0.038 *
Tension	BMI (kg/m^2)	1.462	1.058 – 2.021	0.021 *		Family history of menstruation-related symptoms (yes)	14.97	2.037 – 110.009	0.008 **
	Menstrual days(short)	50.756	3.117 – 826.465	0.006 **		Caffeine consumption (yes)	0.171	0.034 – 0.877	0.034 *
Sensitive to tears	Menstrual days(short)	11.944	1.170 – 121.917	0.036 *		Total physical activity (METs)	1.001	1.000 – 1.001	0.007 **
	Stress (score)	1.233	1.042 – 1.460	0.015 *					
	Total physical activity (METs)	1.000	1.000 – 1.001	0.041 *					

BMI body mass index, *METs* metabolic equivalents, *OR* odds ratio, *CI* confidence interval

*$p < 0.05$

**$p < 0.01$

Table 4 shows the logistic regression models with factors related to each severe symptom before and during menstruation in female soccer players as the dependent variable. Before menstruation, menstrual days (long) and stress were significantly associated with abdominal pain. BMI was significantly associated with swelling and changes in sleep. BMI, early menarche, and bedtime (after 23:01) were significantly associated with irritation. Stress was significantly associated with anxiety. BMI, family history of menstruation-related symptoms, stress, and hours of sleep were significantly associated with tearfulness. During menstruation, total PA was significantly associated with headache and lower back pain. Stress was significantly associated with breast pain and tearfulness. BMI was significantly associated with fatigue, changes in sleep, and irritation. Menstrual days (short) and total PA were significantly associated with skin irritation. BMI and early menarche were significantly associated with poor concentration.

Additionally, to determine whether age difference would affect the factors associated with menstrual-related symptoms, we excluded 17 women over 23 years of age without exercise habits and analyzed 82 women (age 19.9 ± 0.95, BMI 20.8 ± 3.17, age at menarche 12.1 ± 1.34). The results showed that factors before menstruation [stress (OR = 1.127; 95% CI, 1.037–1.225)] and during menstruation [more menstrual days (12.643; 1.195–133.786) and stress (1.080; 1.007–1.158)] were associated with menstruation-related symptoms. The results were similar to our results including women over 23 years of age, with differences in the associated items only corresponding with activity levels.

Discussion

This study investigated factors associated with the presence and severity of menstruation-related symptoms in women without exercise habits and female soccer players. The results showed that having severe symptoms

before and during menstruation in women without exercise habits and female soccer players was associated with physical and menstrual characteristics and lifestyle habits.

Teper and Rimpela reported that the prevalence of menstruation-related symptoms by age group was 48% in the 12-year-old group and 79% in the 18-year-old group [42]. Kamat et al. reported that the prevalence of menstruation-related symptoms increased with age [43]. These studies did not consider exercise habits as a factor, and the results showed that in women without an exercise habit, the peak prevalence of menstruation-related symptoms was between the age of 18 years and early 20 s, which is consistent with the results of the present study, which included participants aged 18–29 years and found that younger age increased the prevalence of menstruation-related symptoms. Furthermore, the results of the present study suggest that the prevalence of menstruation-related symptoms may increase with age in women with an exercise habit, unlike in women without an exercise habit.

Many previous studies have reported associations between body mass index (BMI) and menstruation-related symptoms [10, 20, 44–46]. A meta-analysis examining factors associated with chronic pelvic pain demonstrated that a BMI < 20 kg/m^2 and > 24 kg/m^2 increased the risk of dysmenorrhea [47]. Ju et al. reported a U-shaped relationship between body fat percentage and the prevalence of menstruation-related symptoms [45]. These results suggest that both low and high BMI are risk factors for menstruation-related symptoms. Therefore, maintaining an appropriate BMI may reduce the prevalence and severity of menstruation-related symptoms in adolescents.

The relationship between early menarche and menstruation-related symptoms has been reported in several studies [5, 10, 48, 49]. Early menarche is associated with a longer exposure period to prostaglandins, which promote uterine contractions. Prostaglandins are also pain-causing agents, and prolonged exposure to prostaglandins may lead to more severe symptoms during menstruation [48, 50].

The relationship between a family history of menstruation-related symptoms and menstruation-related symptoms may be due to the mother being the primary source of information on menstruation or genetic factors [51, 52].

Stress was associated with tearfulness before menstruation in women without exercise habits and with irritability before menstruation in female soccer players. Female reproductive organs are highly sensitive to stress, and intense stress can have detrimental effects on health [53]. Stress-related hormones, such as adrenaline and cortisol, can also increase prostaglandin synthesis and cause menstruation-related symptoms [53]. Shorter sleep duration has been associated with dysmenorrhea, consistent with the results of the present study. Furthermore, the presence of menstruation-related symptoms affects sleep duration; hence, the causal relationship remains unclear [54]. Further studies are needed to determine the associations between sleep duration, bedtime, and primary dysmenorrhea. The relationship between caffeine consumption and menstruation-related symptoms and pain during menstruation can be attributed to excessive uterine contractions [55]. Caffeine consumption reduces uterine arterial blood flow [56], which may cause menstrual pain. Skipping breakfast reduces the intake of certain nutrients and can affect reproductive functions [57, 58].

Previous studies reported that rapid changes in female hormones induce psychological symptoms. Psychological symptoms, such as anxiety and depression, suppress the secretion of the neurotransmitter serotonin and lower the pain threshold [59], and that depressed patients reportedly have a higher frequency and severity of daily headaches than healthy controls [60].

Additionally, female hormones lower the pain threshold [61]. This suggests that women who are more likely to experience psychological symptoms related to menstruation may have a lower pain threshold, which may increase the severity of their physical symptoms. Strategies to address this include exercise and physical therapy [62, 63]. Moderate exercise stimulates the release of serotonin, which is involved in pain thresholds, and endorphins, which have pain-reducing effects; thus, it may reduce pain [64]. Furthermore, exercise during menstruation can promote the removal of pain-causing prostaglandins, shorten the duration of pain, and reduce stress [65]. Notably, among athletes who exercise regularly and nonathletes without exercise habits, the prevalence of dysmenorrhea was higher in nonathletes [15], which is in line with our findings. Therefore, it is possible that in athletes, exercise may promote serotonin and endorphins and remove prostaglandins, thereby reducing pain and psychological symptoms. Thus, it is conceivable that moderate exercise may improve menstruation-related symptoms, and excessive exercise may promote them, indicating that caution should be used in setting exercise intensity because excessive exercise may induce menstruation-related symptoms. Since we were unable to measure exercise intensity in female athletes in this study, more detailed studies are needed to determine the appropriate level of exercise intensity to develop more specific strategies. In addition, a previous study on manual therapy in women with dysmenorrhea, physical therapy and other treatments for menstruation-related

symptoms, showed a significant increase in blood serotonin levels and a reduction in subjective pain after the intervention. Additionally, combining physical therapy and exercise has been shown to effectively reduce menstruation-related symptoms.

Factors associated with menstruation-related factors may also be influenced by age. A teenagers-only study found that symptoms were associated with BMI, age at first menstruation, and missing breakfast [35]. Another study included participants in their late teens to early 20 s, and reported that symptoms were associated with BMI, family history, and missing breakfast [66–68]. Two more studies including women in their late teens to 20 s found that symptoms were associated with BMI and family history [20, 29]. This is in line with our results.

These results suggest that factors associated with menstruation-related symptoms may differ according to symptoms and between women without exercise habits and female college soccer players. Hence, individualized strategies are necessary to address menstruation-related issues.

Limitations and strengths

This study investigated the factors associated with the occurrence and severity of menstruation-related symptoms in Japanese women without exercise habits and female soccer players, separately for at least one symptom before and during menstruation and for each symptom. Previous studies have reported factors associated with a single menstrual symptom [69, 70], and the strength of the present study lies in the simultaneous examination of multiple symptoms. However, this study had several limitations. First, this was a cross-sectional study, and causal relationships could not be assessed. Second, it was based on self-reports of menstruation-related symptoms, which may have been inaccurate due to recall bias. Third, the sample size was too small reach the statistical power necessary for population generalization. Fourth, there was a difference in age between the two groups. However, upon further analysis, we found no age-related differences. Finally, this study focused on female soccer players as female athletes, which may diminish the differences among sports while limiting the generalizability of this study. Therefore, further studies are required to address these limitations of the present study.

Conclusion

We investigated the factors associated with the presence and severity of menstruation-related symptoms in Japanese women without exercise habits and female soccer players. The results showed that the factors related to the occurrence of menstruation-related symptoms differed depending on the symptoms a woman has and whether or not the woman has an exercise habit. Hence, different individualized strategies are necessary for managing menstruation-related symptoms.

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s12905-025-03655-w.

Supplementary Material 1.

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Authors' contributions

RisaM and YN conceptualized this study. RisaM, RyokoM, and HN contributed to data collection. YN conducted/supervised data collection. RisaM undertook the analysis and wrote the manuscript. SM contributed to the interpretation of the data. All authors reviewed and provided input into the final version of the manuscript.

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Data availability

The datasets used and analyzed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate

This study was conducted under the Declaration of Helsinki and was approved by the ethics review board of the Institute of Health and Sport Sciences at the University of Tsukuba (approval number: Tai 021–242). At the top of the questionnaire, the content of the study, the voluntary nature of cooperation in this study, anonymity, and confidentiality of the responses were explained. We considered submitting the questionnaire as consent to participate in the study.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

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