

The Relationship Between Physical Activity and Premenstrual Syndrome in Female College Students

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Research Article

Keywords: Premenstrual syndrome, International Physical Activity Questionnaire, physical activity, woman's health

Posted Date: January 18th, 2022

DOI: <https://doi.org/10.21203/rs.3.rs-1248368/v1>

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Abstract

Background

In recent years, moderate physical activity has attracted the attention of experts and women as a way to cope with premenstrual syndrome (PMS). Studies investigated the effects of exercise on PMS, but only a few reports focused on the relationship between physical activity, which included daily movement and exercise, and PMS. Therefore, the present study investigated the relationship between the amount of daily physical activity and PMS symptoms in sexually mature women.

Methods

A total of 381 female university students in Japan were surveyed using a paper or web-based questionnaire with the same content. The questionnaire consisted of basic information, PMS symptoms, and physical activity based on the International Physical Activity Questionnaire (IPAQ). Participants were divided into two groups (≥ 3000 The Metabolic Equivalent of Task(MET)s/week and < 3000 METs/week) based on their total physical activity as calculated using the IPAQ guidelines. The two groups were then compared in terms of the severity of their PMS physical and psychological symptoms as calculated based on the American College of Obstetricians and Gynecologists' PMS diagnostic criteria. The Wilcoxon's rank-sum test was used for statistical analyses. We then divided the participants based on the presence or absence of each symptom using the Chi-square test. The significance level was set at $< 5\%$.

Results

Those with total physical activity of 3000 METs or more had lower total PMS symptom scores ($p < 0.01$), physical symptom scores ($p = 0.01$), and psychological symptom scores ($p = 0.01$) compared with those with total physical activity of < 3000 METs/week.

Conclusion

These results suggest that people with moderate physical activity (≥ 3000 METs/week) in daily life have milder symptoms of PMS.

Background

Premenstrual syndrome (PMS) is characterised by emotional, behavioural, and physical symptoms that occur during the late luteal phase of the menstrual cycle. It terminates after the onset of menstruation. Premenstrual dysphoric disorder (PMDD) is a more severe condition that includes functional impairment and disruption of personal relationships, such as depression [1][2]. There is abundant clinical research on perimenstrual symptoms, which include PMS and menstrual symptoms. The results of a study revealed that the frequency of PMS was relatively high (80 – 90%) [3]. Other studies reported that 5-8% of reproductive-aged women exhibited moderate to severe PMS symptoms that interfered with their daily activities [4]. PMS may be caused by a variety of factors, mainly including sex hormones, autonomic nervous system, psychological factors, and lifestyle (sleep, diet, exercise, stress, and personal preferences) [5]. Many women prefer non-medical treatment options for PMS. This is mainly because they want to avoid the side effects, contraindications to drug treatments, and the high cost of treatment [4][6]. Current recommendations for coping with PMS include exercise [7] and dietary management [8]. These lifestyle changes are often cited as a way of dealing with PMS and are considered important non-pharmacological treatments that can be adjusted accordingly. However, there is a lack of comprehensive research on the relationship between lifestyle and PMS symptoms.

Several studies showed that exercise could improve PMS symptoms. These included aerobic exercises, such as swimming exercises [9]. Dahnavi et al. created an eight-week aerobic exercise plan [10]. The intensity was determined using the heart rate,

which should be within 120-150 beats per minute (bpm) after exercise. Kamalifard et al. created a six-week yoga exercise regimen [11]. These two studies focused on exercises of different kinds and intensities.

Recently, physical activity (PA) and its ability to prevent menstruation-related symptoms have attracted the attention of experts and women [12]. PA is an activity that involves bodily movements resulting in energy expenditure. Only a few reports focused on the relationship between PMS and the amount of PA, including exercise and movement in daily life. One study examined PA's self-report measures using questionnaires, diaries, and brief logs [13]. However, only a few reports measured the regular PA in the daily lives of women in their childbearing age [14]. This vital information can provide a more detailed interpretation of the results.

The International Physical Activity Questionnaire (IPAQ) is the most representative questionnaire for assessing PA. Several studies reported the use of the IPAQ to measure PA [15, 16]. IPAQ can be applied to participants with a widely varied age. In the IPAQ guidelines, a separate category labelled 'high' can be computed to describe higher levels of PA participation [17]. The criteria for classification as 'high' are seven or more days of any combination of walking, moderate-intensity, or vigorous-intensity activities achieving a minimum total PA of at least 3000 MET-minutes/week.

Most of the studies [18] encouraged the employment of regular, moderate-intensity aerobic exercise [19] as a potential intervention for preventing PMS. Moderate-intensity aerobic exercises correspond to a high PA in daily life. Thus, we hypothesised that PMS symptoms were milder in people with a high PA. To test this hypothesis, we used the IPAQ to calculate the daily PA of participants. We then examined the relationship between PMS and daily PA in women of childbearing age. The purpose of this study was to investigate the relationship between PMS symptoms and PA levels.

Methods

This cross-sectional study (prospective questionnaire survey) designed to determine the relationship between PA and PMS symptoms was conducted following the Helsinki Declaration of 1975, as revised in 1983. The participants received information regarding our research and provided written or verbal consent after understanding the study protocol.

The present study was conducted in accordance with the guidelines of the Declaration of Helsinki and its amendments. This study was approved by the Kyoto University Graduate School and Faculty of Medicine and Kyoto University Hospital Ethics Committee (approval number: R1442). All information regarding participant data remains confidential. The participants' responses were anonymous.

Participants

In this study, 427 women consented to participate. This study was conducted in Japan between August and September 2016. The participants included in this study were a convenience sample consisting of undergraduate and graduate female students. The inclusion criteria were as follows: affiliated with a university in Japan, literate in Japanese so as to read and understand the proposed survey, potentially reproductive, and consented to participate. Those who were excluded from the study were menopausal women, those with current depression, anxiety, or any other psychiatric disorder previously diagnosed, those who received hormonal therapy, those who experienced a traumatic life event (widowhood, death of a close friend or relative, and imprisonment) before or during the study period, and those who were not due to drug therapy, hormonal internal use, or drugs.

Questionnaire

Our survey was administered via a paper or a web-based questionnaire with the same content. The questionnaire included basic information such as age, height, weight, menstrual conditions, levels of PMS symptoms, and PA.

PMS

PMS symptoms were referred to as premenstrual dysphoric disorder (PMDD) (An additional movie file shows this in more detail [see Additional file 1]) in accordance to the American Psychiatric Association, 5th edition of the Diagnostic and Statistical

Manual of Mental Disorders [20] and as PMS symptoms in the American College of Obstetrics and Gynecology guidelines (Additional file 2). We identified the symptoms among our participants by adding them in the questionnaire. We based our questionnaire on a previous study [21]. The symptoms we added were 'Lower abdominal pain', 'Increased appetite', 'Easily fatigued and feeling listless', 'Low back pain', 'Sleepiness', 'Decreasing concentration', and 'Fatigue or lack of energy Overeating'. The total number of PMS items in the questionnaire was 18. (Additional file 3).

To establish a diagnosis of PMS based on previous guidelines [22], we included a question regarding the presence of the symptoms in the past three menstrual cycles and whether at least one of the physical or psychological symptoms were observed 5 days prior to menstruation. The participants answered a questionnaire based on self-review. In this study, among all the items regarding symptoms, participants who checked as 'No problem but symptomatic' or 'Problematic' for one or more items were diagnosed with PMS.

All symptoms were separated into three levels. The 'problematic symptoms' corresponded to symptoms interfering with activities of daily living. 'No problem but symptomatic' corresponded to symptoms not interfering with activities of daily living. The final category, the 'no symptom', corresponded to the lack of symptoms.

The total score was calculated according to the following: no symptoms, 0 points; no problem but symptomatic, 1 point; and problematic symptoms, 2 points (Additional file 2).

For each symptom, we divided the patients into two groups: participants with and without symptoms.

PA

We used the short version of the IPAQ to determine the participants' daily PA. The IPAQ was developed as an instrument for cross-national monitoring of PA and inactivity. The IPAQ instruments have acceptable measurement properties, which are at least as good as other established self-reports. Moreover, they have reasonable measurement properties for monitoring the levels of PA among a population consisting of 18-65 years old adults with diverse backgrounds [23].

We asked about participants' moderate intensity active time, vigorous-intensity active time, and walking time. The participants' METs were then calculated according to the IPAQ guidelines. These were calculated as follows:

$$WalkingMET - \frac{minutes}{week} = 3.3 * walkingminutes * walkingdays$$

$$ModerateMET - \frac{minutes}{week} = 4.0 * moderate - intensityactivityminutes * moderatedays$$

$$VigorousMET - \frac{min}{week} = 8.0 * vigorous - intensityactivityminutes * vigorous - intensityday$$

$$TotalphysicalactivityMET - minutes / week = sumofwalking + moderate + vigorousMET - minutes / weekscores$$

Statistical analysis

The PA data were divided into two groups according to the total metabolic equivalent of task (MET) in a week, which was defined by IPAQ as > 3000 MET-minutes/week and < 3000 MET-minutes/week). The two groups' severity scores for each of the PMS physical and psychological symptoms calculated based on the questionnaire were compared. Associations with characteristics were assessed using the Wilcoxon rank-sum test. We then divided the participants based on the presence or absence of each symptom using the chi-square test for comparison in terms of the IPAQ. The significance level was set at <5%. All analyses were conducted using the JMP Pro 14.0 (SAS Institute, Cary, NC, USA).

Results

The questionnaire was completed by a total of 381 female university students (89.22%). The participants' characteristics are described in Table 1 and Table 2 (mean \pm SD, age: 20.4 \pm 1.2 years; height: 159.5 \pm 5.6 cm; weight: 51.7 \pm 5.8 kg; Body Mass Index (BMI): 20.27 \pm 1.78). Of these, 76.3% had regular menstrual cycles (25-38 days), while 70.87% students had a PMS.

Table 1
Basic information of participants

Total n=381	
Age (y)	20.44 \pm 1.23
Height (cm)	159.57 \pm 5.58
Weight (kg)	51.67 \pm 5.75
BMI (kg/m ²)	20.27 \pm 1.78
Total PMS score	8.84 \pm 6.89
Total physical activity (MET-minutes/week)	4829.09 \pm 4537.48
* <i>p</i> < .05	

Table 2
Menstrual information of participants

Regular menstrual cycles	
Yes	291 (76.3)
No	90 (23.6)
PMS	
Yes	344 (90.2)
No	37 (9.7)

The results are shown in Table 3, the participants were divided into two groups based on their total PA. Those with total PA of 3000 METs/week or more had lower total PMS symptom scores (*p* < 0.01), physical symptom scores (*p* = 0.01), and psychological symptom scores (*p* = 0.01).

Table 3
The Wilcoxon's rank-sum test of group divided based on those who met at least 3000 METs and score of PMS symptoms

	Total physical activity (MET-minutes/week)		z	<i>p</i> value
	\geq 3000 (n=200)	< 3000 (n=181)		
Physical symptoms	4.94	5.79	2.66	0.01*
Psychological symptoms	3.21	3.99	2.47	0.01*
PMS symptoms	8.16	9.78	2.88	0.00*
* <i>p</i> < .05				

We observed the effects of 3000 METs/week, depending on the presence or absence of each PMS symptom. As Table 4, the ratio of participants who with more than 3000 METs/week have no these symptoms is high: 'sleepiness', 'acne', 'feeling depressed', 'decreasing concentration', 'easily fatigued and feeling listless'.

Table 4
The ratio of those with symptoms in the group divided based on the total METs

	Total physical activity (MET-minutes/week)		
	≥3000 (n=200)	< 3000 (n=181)	p value
With symptoms			
Sleepiness	103 (51.5)	124 (68.51)	<0.01
Acne	61 (30.5)	80 (44.20)	<0.01
Feeling depressed	84 (42.00)	95 (52.49)	0.04
Decreasing concentration	66 (33.00)	87 (48.07)	<0.01
Easily fatigued and feeling listless	84 (42.00)	96 (53.04)	0.03
n (row%)			

Chi-square test

Discussion

In this study, we found a relationship between regular PA and PMS symptoms. This study clarified two results. First, people with a PA of 3000 METs/week or more had lower scores for psychological and physical symptoms. Second, the ratio of participants who had more than 3000 METs/week had no symptoms.

PMS is one of the most common problems among women. Moreover, PMS can interfere with activities of daily living. Thus, finding a way to prevent or treat PMS is an important health and research priority. In our study, we found that over 90% of women reported at least one symptom of PMS. This findings was similar to a study that found that 95% of participating women aged 18-24 years experienced at least one PMS symptom.[24]

Our first conclusion was that people whose PA is more than 3000 METs/week had lower scores in psychological and physical symptoms. This conclusion complemented Koushkies et al.'s finding, which showed an association between an increased PA and a significant reduction in PMS symptoms [25]. However, Kroll-Desrosiers et al.'s study showed no evidence of an association between PA and either the presence of PMS or premenstrual symptom severity [14]. The difference must have been due to the difference in method. Kroll-Desrosiers et al.'s examined PA by continuous METs per week and analysed the data by dividing the group by tertiles of PA. Higher levels of participation were characterised using the IPAQ, which defined vigorous-intensity activity 3000 MET-minutes/week or more. Furthermore, we used 3000 MET-minutes/week because this number approximated the recommended levels (150 minutes of moderate-intensity physical activity per week) of PA after calculation [26][27].

Regarding the second conclusion, the ratio of participants who had more than 3000 METs/week had no symptoms. The symptoms we found in this study were 'sleepiness', 'acne', 'feeling depressed', 'decreasing concentration', and 'easily fatigued and feeling listless'. Some studies explained this phenomenon. Wilmore et al. showed that regular PA had many benefits, including reduction of stress and PMS [28]. Additionally, PA might still affect sex hormone function by modulating target tissue sensitivity to these hormones [29]. A previous study showed a significant decrease in prolactin, oestradiol, and progesterone levels, resulting in fatigue, impaired concentration, confusion, and most PMS symptoms. In addition, a study showed that increased prolactin level in the late luteal phase was one of the causes of breast pain and swelling. PA in non-athletes possibly reduces the status of this hormone; thus, the ratio of breast pain and swelling may be reduced. However, our results did not corroborate with this finding [30]. PA, including resistive exercise, induces neuroimmunomodulation effects, increases neurotrophies [31]and β -endorphins[32], decreases the sympathetic response, affects the hypothalamic-pituitary-adrenal axis reactions, and improves the serotonin system. All of these responses may decrease anxiety and depression [33].

Acne is a symptom associated with polycystic ovarian syndrome and is a common metabolic disturbance, particularly in women [34][35]. A study suggested that regular exercise decreased plasma insulin levels and reduced metabolic disease [36].

Sleep and activity during awake time interact to influence many aspects of health [37]. Moreover, a study showed that age and sex were associated with PA and sleep. They found that aspects of PA were significantly lower in younger adults (20-39 years old) who reported more frequent daytime sleepiness [38].

Priya et al. studied the effect of aerobic exercise at different intensities on PMS and concluded that moderate-intensity aerobic exercise should be encouraged as a potential prophylaxis for PMS [39]. This study gave us a range of PAs that they investigated. In this study, we converted different intensities of exercise into numbers that were calculated from the participants' daily PA. We were not simply considering exercise alone, but also the overall PA. In addition to high-intensity exercise in participants engaged in sports, we also examined the presence of daily moderate-intensity exercise and walking time.

In addition, we considered that PMS symptoms affected daily PA. A systematic review and meta-analysis indicated that exercise performance might be trivially reduced during the early follicular phase of the menstrual cycle compared with all other stages [18]. We considered the possibility that PMS symptoms affected exercise. Although some of the participants' PA included high-intensity exercise in our study, it could not be denied that PMS affected PA.

Thus, according to our results, women with 3000 METS/week or more of PA had milder symptoms of PMS.

Study limitations

Researchers frequently rely on questionnaires to assess PA because of their low cost and ease of administration. However, inherent limitations, such as participant recall bias and an inability to accurately retrospectively recall relevant PA details, may lead to overestimation or underestimation of PA. The target is limited, and causality is not known. The IPAQ-short version typically overestimates PA as measured by an objective criterion by an average of 84% [40].

Conclusion

This study is one of the few studies that analysed the relative factors of PMS based on regular PA using a questionnaire. The findings of this research showed that people with high PA had milder physical symptoms of PMS. This implies that recommending more regular PA as a non-pharmacological therapy is likely to be an effective treatment for PMS because it is a low-risk, low-cost, and simple method of symptom management for PMS.

Abbreviations

Premenstrual syndrome (PMS)

Premenstrual dysphoric disorder (PMDD)

Beats per minute (bpm)

Physical activity (PA)

International Physical Activity Questionnaire (IPAQ)

The Metabolic Equivalent of Task (MET)

Body Mass Index (BMI)

Declarations

Data availability

Data cannot be shared publicly because of the policy of the Kyoto University for data safety and protection. Data are available on request from the faculty of human health sciences for researchers who meet the criteria for access to confidential data or enrolled in the faculty. Data requests may be directed to the Kyoto University Graduate School and Faculty of Medicine, Ethics Committee, Department of Ethics Support (email: ethcom@kuhp.kyoto-u.ac.jp; telephone/fax: 0081-75-753-4680). Data requests may also be directed to Assistant Professor Momoko Tanima, who is in the department and unaffiliated with the current study (email: tanima.momoko.8s@kyoto-u.ac.jp; telephone: 0081-75-751-3964).

Ethics approval and consent to participate

Ethical approval was obtained from the Ethics Committee of Kyoto University Graduate School and Faculty of Medicine (No. R1442).

Informed consent was obtained from all individuals who participated in this study via an online questionnaire. Sending the questionnaire constituted consent to participate in this study, and all necessary explanations were provided in the online document. Participants under 20 years of age were asked to obtain consent from their parents.

Consent for publication

Not applicable.

Competing interests

The authors have no relevant financial or non-financial interests to disclose.

Funding

The authors declare that no funds, grants, or other support were received during the preparation of this manuscript.

Authors' contributions

SM designed the study, CYC collected data, analysed and interpreted the data, and wrote the manuscript. MT, RK interpreted the data and reviewed the manuscript. KM, MK, KS, HS, YS reviewed the manuscript. TA reviewed the manuscript and supervised the entire research process. All authors read and approved the final manuscript.

Acknowledgement

We would like to express our gratitude to all the participants who were very cooperative throughout the research period.

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Figures

In the past three menstrual cycles, at least one of the following physical symptoms or psychological symptoms were observed during the 5 days before menstruation.

Psychological symptoms	Physical symptoms
Depression	Breast tenderness
Anger	Abdominal distension
Irritability	Headache
Anxiety	Limbs swelling
Confusion	
Absent from society	

These symptoms were relieved within 4 days after the start of menstruation. They did not recur in the next 13 days after the onset of menstruation.

These symptoms were not due to drug therapy, hormonal internal use, drugs, or alcohol use.

The symptoms must occur reproducibly during the two cycles of prospective recording.

A clear obstacle of social or economic competence was recognised.

Figure 1

Premenstrual syndrome (PMS) diagnostic criteria of the American College of Obstetrics and Gynecology (2000).

	Symptoms	No symptoms	No problem but symptomatic	Problematic
Physical symptoms	Breast tension and pain	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	Headache	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	Lower abdominal tightness	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	Lower abdominal pain	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	Swelling of hands and feet	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	Increased appetite	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	Easily fatigued and feeling listless	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	Low back pain	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	Sleepiness	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	Acne	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Mental symptoms	Feeling depressed	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	Feeling irritable	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	Feeling confused	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	Having feelings of sudden anger	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	Feeling anxious	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	A desire to be alone	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	Fatigue or lack of energy Overeating	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	Decreasing concentration	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
☐symptoms not applicable to the above. (for example :)				

Figure 2

PMS symptoms questionnaire

A. In the majority of menstrual cycles, at least five symptoms must be present in the final week before the onset of menses. These symptoms should have started to improve within a few days after the onset of menses and should have improved or absent in the week after menses.	
B. One (or more) of the following symptoms must be present:	
	1. Marked affective lability (e.g., mood swings; feeling suddenly sad or tearful, or increased sensitivity to rejection).
	2. Marked irritability or anger or increased interpersonal conflicts.
	3. Marked depressed mood, feelings of hopelessness, or self-deprecating thoughts.
	4. Marked anxiety, tension, and/or feelings of being keyed up or on edge.
C. One (or more) of the following symptoms must additionally be present, to reach a total of five symptoms when combined with symptoms from Criteria B, which can be seen above.	
	1. Decreased interest in usual activities (e.g., work, school, friends, hobbies).
	2. Subjective difficulty in concentration.
	3. Lethargy, easy fatigability, or marked lack of energy.
	4. Marked change in appetite; overeating; or specific food cravings.
	5. Hypersomnia or insomnia.
	6. A sense of being overwhelmed or out of control.
	7. Physical symptoms such as breast tenderness or swelling, joint or muscle pain, a sensation of "bloating," or weight gain.
note: The symptoms in Criteria A–C must have been met for most of the menstrual cycles that occurred in the preceding year.	
D. The symptoms are associated with clinically significant distress or interference with work, school, usual social activities, or relationships with others (e.g., avoidance of social activities; decreased productivity and efficiency at work, school, or home).	
E. The disturbance is not merely an exacerbation of the symptoms of another disorder, such as major depressive disorder, panic disorder, persistent depressive disorder (dysthymia), or a personality disorder (although it may co-occur with any of these disorders).	
F. Criterion A should be confirmed by prospective daily ratings during at least two symptomatic cycles. (note: The diagnosis may be made provisionally before this confirmation.)	
G. The symptoms are not attributable to the physiologic effects of a substance (e.g., a drug of abuse, a medication, other treatment) or another medical condition (e.g., hyperthyroidism).	

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Figure 3

Diagnostic Criteria for Premenstrual Dysphoric Disorder

Supplementary Files

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