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Anthropometric indices and physical activity in relation to premenstrual syndrome among female adolescents

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ABSTRACT

Background: Premenstrual syndrome (PMS) is a collection of symptoms that are usually experienced by female adolescent before the start of each menstrual cycle which can impact their social activities and concentration on studies. There are several factors that can influence the occurrence of PMS, such as nutritional status, body composition, and physical level.

Objectives: To explore the incidence of PMS among female adolescents and its correlation with anthropometric indices and physical activity in Malang City, Indonesia

Materials and Methods: A cross-sectional study was conducted in August to November 2023. A total of 143 female second year students from three public high schools in Malang City was participated in this study. Weight, height, waist circumference, hip circumference, and body fat percentage (BF%) were measured. Anthropometric indices including body mass index-for-age (BMI-for-age), waist-to-hip ratio (WHR), and waist-to-height ratio (WHtR) were calculated. PMS was measured using 10-item shortened Premenstrual Assessment Form(sPAF) and physical activity using Physical Activity Questionnaire for Adolescent (PAQ-A). Spearman test was used to evaluate the correlation between variables.

Results: There were significant positive correlations among anthropometric indices. There was a positive correlation between PMS with BF%, WHR, and WHtR, however no correlation was found with BMI-for-age. PMS was inversely correlated with physical activity level.

Conclusion: Anthropometric indices as predictor of obesity such as BF%, WHR, and WHtR was positively correlated with PMS while physical activity was negatively correlated with PMS. These findings suggest that changes toward healthy lifestyle, such as having regular physical activity and maintain a normal range of body composition and nutritional status are important to alleviate PMS symptoms in female adolescents.

Keywords: Adolescent; anthropometric indices; body fat; physical activity; premenstrual syndrome

BACKGROUND

Premenstrual syndrome (PMS) is a collection of physical and psychological symptoms which consistently happen during the luteal phase of the menstrual cycle. Generally, PMS occurs seven to ten days before menstruation and disappears at the start of menstruation.(1) In a meta-analysis study, the prevalence of PMS is estimated around 47.8% worldwide.(2) Female adolescents will experience menstruation as a sign of the maturity of the reproductive system. PMS can affect women's productivity and mental health. Around 75% of women complain of PMS symptoms and 30% of them need treatment.(3) In 2018, the incidence of severe PMS among high school students was reported to be 97%.(4) At a young age, a severe PMS could be an indicator of a serious health problem.

Adolescence is a unique period of significant psychological and physiological changes, particularly for high school students who face intense academic pressure from long hours of studying and preparation for university. This stress is compounded by the lifestyle differences between adolescents and adults, as well as increased screen time from personal computers and smartphones, leads to sedentary behavior.(5) Prior studies in Malang City indicated that high school students experiencing stress also reported severe PMS.(6,7) Severe PMS could cause significant disruptions in their daily lives which negatively affected their interpersonal relationships.(8)

The cause of PMS is not fully understood. Wahyuni (2018) showed that the cause of PMS symptoms is a complex interaction between hormones and neurotransmitters combined with psychological stress.(9) An imbalance between estrogen and progesterone, changes in the production of other ovarian hormones, changes in the effects of steroid ovaries are one of the main causes of PMS. The role of lifestyle factors such as food intake and physical activity could not be ignored. Thus, PMS is due to combination of internal factors (genetic, hormonal, psychological) and external factors (dietary and behavioral).(10)

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Nutritional status is one of the lifestyle factors that are widely studied.[11] The higher the percentage of fat tissue, the more estrogen that is formed which can then disrupt the balance of hormones in the body which causes a woman to be at risk of undergoing PMS.[12] Prediction of the percentage of fat can be measured using a body mass index or body composition, mainly fat mass, that describes a person's nutritional status. Both overall and central obesity were strongly associated with PMS, frequently measured using waist-to-height or waist-to-hip ratio.[10,11] Even though being overweight are likely to play a role in the etiology of PMS, there is uncertain relationship between PMS and anthropometric indices, as it is direct or indirect related to the hormonal balance mechanisms.[13,14]

Most adolescents have sedentary lifestyles, which has a negative impact on their health.[5] Technological advances have made lifestyle changes leading to a sedentary lifestyle and lack of physical activity. Lack of physical activity cause endorphin deficiency in the body which can result in PMS.[10] The severity of PMS symptoms in women is much higher than in those who exercise regularly. However, there are inconsistencies between the relationship of physical activity and PMS. While some studies indicates that regular physical activity was adversely associated with PMS, other study report no link between exercise and PMS.[10,15–17] Further study is needed to explore this relationship to gain a better understanding on how to alleviate the severity of PMS.

Symptoms that appear before menstruation will interfere with daily activities in female adolescent until menstruation occurs. PMS could have an impact on decreased appetite, fatigue, and sudden mood changes. For female student, PMS can disrupt their quality of health, concentration, achievement and active learning activities at school.[15–17] Based on this background, the aim of this study is to investigate the correlation of anthropometric indices measurement, physical activity, and PMS in female adolescents at Malang City, Indonesia.

MATERIALS AND METHODS

This study was an observational study with cross-sectional design conducted in Malang City, East Java, Indonesia between August and November 2023. The study location was at three public high schools that were chosen using a cluster random sampling method based on three school zonations in Malang City. The participants are second year female students from each school that were chosen by purposive random sampling. The inclusion criteria were aged 16 – 18 years old, have menstruated, and apparently healthy. Students who were on medications to relieve pain before menstruation, had a history of any disorder related to systems and glands, and had a special diet were excluded. A total of 143 students were eligible to enroll in this study and written informed consent was signed by all the eligible participants. All of the study protocols were reviewed and approved by the Ethical Committee of the Faculty of Health Sciences, Universitas Brawijaya, Indonesia (No. 5805/UN10.FN17.10.4/TU/2023).

Anthropometric indices measured in this study were: Body Mass Index (BMI), body fat percentage (%BF), waist-to-hip ratio (WHR), and waist-to-height ratio (WHtR). Body weight and %BF were measured using a body composition monitor bio impedance analyzer (BIA) digital scale (Omron Karada Scan). The height was measured with a stature meter (GEA). Waist circumference was measured around abdominal midpoint level. Hip circumference was measured around the widest part of the hips. Waist and hip circumference were measured using a non-elastic tape measure (OneMed). BMI was calculated from body weight (kg) divided by the square of height (m). WHR is determined by dividing the waist circumference by the hip circumference. WHtR is determined by dividing waist circumference by body height. BMI was calculated from body weight (kg) divided by the square of height (m), then converted into z-score using the WHO Anthroplus application. All measurements were performed in replicate using standardized procedures. Classification of nutritional status based on the BMI-for-age for girl adolescent[18], body fat percentage for adolescent[19], WHR[20], and WHtR[21].

Premenstrual syndrome data were assessed using the 10-item Shortened Premenstrual Assessment Form (sPAF) instrument. The sPAF is a self-administered questionnaire that determine the severity of premenstrual symptoms assessed from physical, emotional, and behavioral domains. The total score of the symptoms then categorized as "mild symptoms" if <27 and "severe symptoms" if ≥ 27.[22] Physical activity was measured using the Physical Activity Questionnaire for Adolescent (PAQ-A). This questionnaire consists of 7-day recall questionnaire to provide a general estimate of physical activity levels in healthy 8–20 years olds, cover the sport participation, activity during and after school, in the evenings and at the weekends. Physical

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activity score between 1.00 – 2.33 were classified as "inactive", 2.34 – 3.66 as “moderate”, and 3.67 – 5.00 as "active".[23] All instruments were translated in Indonesia and demonstrated as valid and reliable questionnaires.

The data were analyzed using SPSS version 25 for Windows. Descriptive statistics were presented by frequencies and percentages (n, %) for categorical variables, means and standard deviations (mean±SD) or median and interquartile range (median (IQR)) for continuous variables. Correlations between nutritional status, body fat, physical activity, and premenstrual syndrome were analyzed by Pearson’s Correlation or Spearman’s Correlation Rank tests. All p-values are two-tailed and statistically significant at $p<0.05$.

RESULTS

The characteristics of the study population is shown in Table 1. A total of 143 participants with mean age of 16.03±0.71 years old were included. The mean of BMI-for-age Z-score was 0.26, classified as normal BMI range of adolescent, also showed by the biggest proportion of the normal nutritional status of the participants (70.6%). Other anthropometric indices also showed similar findings, most of the participants had a normal WHR, WHtR, and body fat percentage. As for the physical activity score, two-third of participants (61.5%) was within the inactive range, with the mean score of 2.28. Moreover, according to the sPAF score, 101 (70.6%) had mild PMS and the rest (29.4%) had severe PMS.

Table 1. Characteristics of the Study Participants

Variable	n(%)	Mean ± SD
Age, years		16.03 ± 0.71
Weight, kg		52.63 ± 11.24
Height, cm		155.58 ± 5.08
BMI-for-age Z-Score		0.26 ± 1.17
Underweight	2 (1.4)	
Normal	101 (70.6)	
Overweight	31 (21.7)	
Obese	9 (6.3)	
Waist circumference, cm		71.88 ± 8.40
Hip circumference, cm		94.10 ± 31.30
WHR		0.76 ± 0.01
Normal	143 (100.0)	
WHtR		0.46 ± 0.46
Normal	83 (58.0)	
At risk	60 (42.0)	
Body fat, %		27.79 ± 4.05
Low	6 (4.2)	
Normal	85 (59.4)	
High	52 (36.4)	
Physical activity score		2.28 ± 0.66
Inactive	88 (61.5)	
Moderate	49 (34.3)	
Active	6 (4.2)	
PMS score		23.51 ± 7.37
Mild	101 (70.6)	
Severe	42 (29.4)	

Abbreviation: SD = standard deviation; BMI = Body Mass Index; WHR = waist-to-hip ratio; WHtR = waist-to-height ratio; PMS = premenstrual syndrome

This study also explores the correlations among anthropometric indices to give an overview of the relationship between different body composition assessment in the study participants (Table 2).

Table 2 shows that all anthropometric indices had positive correlations with each other. BMI-for-age was correlated with WHR ($p=0.010$), WHtR ($p<0.001$), and %BF ($p<0.001$). WHR had a moderate correlation with WHtR ($p<0.001$). WHR and WHtR similarly had a weak correlation with %BF ($p<0.001$). Furthermore, to demonstrate the potential anthropometric indices with PMS, correlations analyses were also performed. The analysis result is shown in Table 3.

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Table 2. Correlation coefficient matrix analysis among the anthropometric indices

Variable	BMI-for-age Z-Score	WHR	WHtR	%BF
BMI-for-age Z-Score	1.000	-	-	-
WHR	0.215[1]	1.000	-	-
WHtR	0.301[2]	0.517[2]	1.000	-
%BF	0.797[2]	0.290[2]	0.395[2]	1.000

[1]significant correlation at the p<0.10 level; [2]significant correlation at the p<0.001 level

Table 3. Correlation analysis of anthropometric indices measurements and premenstrual syndrome score

Variable	PMS score	
	r value	p-value
BMI-for-age Z-Score[1]	0.056	0.505
WHR[2]	0.178	0.034[3]
WHtR[2]	0.221	0.008[4]
% body fat[2]	0.284	0.001[4]
Physical activity[2]	-0.166	0.047[3]

[1]Analyzed using Pearson's correlation test; [2] Analyzed using Spearman's Correlation Rank; [3]significant correlation at the p<0.05 level; [4]significant correlation at the p<0.01 level

There was no correlation found between BMI-for-age Z-score and PMS. However, other anthropometric indices showed a very weak to a weak, positive correlations with PMS, namely WHR, WHtR, and % body fat, with p=0.034, p=0.008, and p=0.001, respectively. The higher the anthropometric indices, the more severe the PMS symptoms experienced by the participants. Apart from it, physical activity negatively correlated with PMS (r=-0.166; p=0.047). It can be concluded that the higher the level of physical activity or the more active the subject, the milder the PMS symptoms.

DISCUSSION

The objective of this study is to investigate the possible correlations between anthropometric indices measures and physical activity level with premenstrual syndrome in adolescent girls. The subjects were public high school students, considered represents the female adolescent population in Malang City, Indonesia. Physical activity and anthropometric indices, except BMI-for-age, were significantly correlated with the premenstrual syndrome.

All the study participants experienced PMS symptoms before their menstrual cycle where most of them (70.6%) had mild symptoms. This result is supported by study in Surakarta and Malang that the most of high school students experience mild PMS symptoms.[4,24] The study participants in this study often experienced PMS symptoms such as hip and joint pain, irritability, and difficulty in concentrating that normally reduced over time. Adolescents who experience premenstrual symptoms can interfere their daily and emotional activities.[12]

There was no correlation found between BMI-for-age and PMS. This result is different from previous study in Bengkulu and Surabaya which showed that there was a significant correlation between nutritional status and PMS or dysmenorrhea degree in female adolescents.[12,25] Previous study that had significant correlation demonstrated that almost half of their participants had malnutrition, either undernutrition or overnutrition. Subjects with undernutrition were 2.562 times had a higher risk to experience PMS compared to those with good nutritional status. Meanwhile, overweight and obese subjects had a 2.275 times greater chance of experiencing PMS compared to normal subjects.[12] The different results in this study could be due to majority of the participants in this study had normal BMI range and mild PMS symptoms, thus the correlation could not be detected. A positive relationship between PMS and BMI is commonly observed due to studies including a higher proportion of malnutrition subjects, where factors like hormonal imbalances, inflammation, and psychological stress may worsen PMS symptoms.[12,25,26] In this study, the majority of respondents have a normal BMI-for-age, which could explain the lack of correlation, as these individuals might experience fewer hormonal fluctuations or possess lifestyle factors that mitigate PMS severity.

Other potential reason for the lack of correlation between BMI-for-age and PMS could be due to the body composition of the subject. Subject with normal BMI-for-age range do not necessarily have a normal body fat percentage and this was in line with prior study that showed that women with normal nutritional status

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could had a high body fat percentage.[10,27] In this study, participants who had high body fat percentage (36.4%) was greater than overweight and obese participants (30%). It means that high body fat was also found in participants with normal nutritional status. BMI has been widely used as an anthropometric measurement of obesity because of its ease to use, convenience to subject, and relatively affordable.[28] It was proven in our study that BMI-for-age has a positive correlation with other obesity indices: WHR, WHtR, and body fat percentage. BMI alone does not reflect the body fat percentage. Individual with sedentary activity might have a normal BMI but eventually have a high level of body fat, low level of muscle and bone mass. Better predictor of obesity is by measuring central adiposity such as waist circumference, WHR, WHtR, and body fat percentage.[28] In this study, body fat percentage, WHR and WHtR was significantly correlated with the PMS.

High central adiposity could lead to low-grade chronic inflammation in the body, indirectly result in PMS[11,29]; and subsequently lead to increased risk of cardiovascular events and death.[30] Individual with high adiposity also have a high level of leptin, a hormone that synthesized by the adipose tissues and plays a role in energy regulation. A higher intake of calorie and carbohydrate was indicated in luteal phase in women with PMS.[31] During this phase, leptin level increased which can lead to decreased sensitivity to leptin, resulting in increased appetite and cravings for high-calorie foods, which may worsen PMS symptoms, as hormonal fluctuations lead to mood swings and physical discomfort.[31,32] Prior study also showed that women had a higher risk of PMS with an increase in basal metabolic rate due to the change of the hormonal regulation.[33] Furthermore, leptin level also determined by the fat distribution in the body. Leptin is primarily produced by isolated subcutaneous adipocytes, resulting in higher secretion levels in subcutaneous adipose tissue compared to visceral adipose tissue. Since women tend to store fat in gluteofemoral area, this part has a stronger association with leptin regulation than upper body fat.[34]

Physical activity was also inversely correlated with PMS score. More than 60% participants in this study categorized of had a low physical activity level or being inactive. Previous studies have observed that PMS frequency is higher among women with low physical activity level or having a sedentary lifestyle.[10,15,25] Low physical activity can increase the severity of PMS symptoms, such as feelings of high tension, emotion and depression. This could be occurring due to disruption of the neurotransmitter's regulation, all of which play crucial roles in mood and pain perception. Reduced serotonin levels are often linked to increased mood swings and depression during PMS, which can result from the depletion of the essential amino acid tryptophan that serves as the precursor of serotonin or by the administration of a serotonin receptor antagonist.[35] Low endorphin levels can lead to heightened pain sensitivity, while decreased dopamine regulation may affect motivation and reward processing, contributing to fatigue and irritability. These imbalances can intensify the severity of PMS symptoms, creating a cycle of physical and emotional discomfort.

Physical activity or exercise increases endorphin and dopamine levels. Endorphins act as a natural sedative produced by the brain, causing a feeling of comfort, relieve stress, and improve overall mood, while dopamine enhance motivation and counteract fatigue, ultimately leading to a reduction in irritability and discomfort.[35,36] Therefore, having a daily exercise is considered as one of the nonpharmacological therapies for PMS.[36] The correlation between physical activity and PMS could be explained by several biological mechanisms. Muscle contractions during exercise can reduce back pain and pelvic discomfort by increasing oxygen delivery to the muscles. Improvement of psychological symptoms due to PMS by increased endorphins secretion, lower estrogen and other steroid hormones, lower cortisol levels, which could lead to lower inflammation. Lifestyle changes by having regular physical activity and healthy diet have been shown to reduce the severity of the PMS and enhance the quality of life.[10,12,36]

The cause of PMS is not certainly known, the symptoms could occur due to an imbalance in reproductive hormones. Possible factors that may influence the severity of PMS symptoms, including genetic, hormonal, psychological, nutritional intake, stress, smoking, medication, and others that may influence the formation and regulation of reproductive hormones.[29,37] These findings highlight the importance of awareness and education to adolescent girl in regard of balanced diet and healthy lifestyle to reduce the severity of PMS. This study is limited by the participants that sampled within public high schools only and did not examine the food intake and leptin hormone. Further investigation is needed by assessing the energy, macro and micronutrient intake as well as measuring leptin level to determine the energy regulation during luteal phase that leads to the severity of PMS.

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CONCLUSIONS

In conclusion, the present study showed that anthropometric measurements that serve as obesity indices, including body fat percentage, waist-to-hip ratio, and waist-to-height ratio, had positive correlation with PMS in female adolescents in Malang City, Indonesia. However, no correlation was found between BMI-for-age and PMS. Physical activity was negatively correlated with PMS. These findings suggest that changes toward healthy lifestyle, such as regular exercise and maintain a normal range nutritional status could serve as treatment of PMS in female adolescents.

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