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Eating behavior, phytoestrogen intake and chronotype in relation with premenstrual syndrome among female college students

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ABSTRACT

Background: Premenstrual syndrome (PMS) is a group of physical, behavioral, and emotional problems that occur before menstruation. Although the exact cause of this illness is unknown, various studies have suggested that it may be brought on by dietary, behavioral, or hormonal changes.

Objectives: This study examined how eating behavior, phytoestrogen intake, and chronotype related to PMS in female college students at Universitas Jenderal Soedirman, Indonesia.

Materials and Methods: Data were collected using a cross-sectional design with a cluster sampling method. This study was conducted with 104 participants, with the criteria: aged 18-22 years, class of 2020-2022, physically healthy, and willing to participate in the entire series of studies. The exclusion criteria in this study were taking sleeping pills, using hormonal therapy, and being diagnosed with a gynecological disorder. Statistical data analysis using the Spearman Correlation test. The Dutch Eating Behavior Questionnaire (DEBQ) was used to assess eating behavior, Semiquantitative Food Frequency Questionnaire (SFFQ) to assess phytoestrogen intake, Morningness-Eveningness Questionnaire Self Assessment Version (MEQ-SA) to assess chronotype, and Shortened Premenstrual Assessment Form (SPAF) to assess PMS.

Results: Of the 104 participants, 99% reported having experienced symptoms of PMS. 90.4% of participants reported consuming phytoestrogens at a lower level than the sufficiency level. Emotional eating dominated the eating behavior characteristics with a 69.2% prevalence, while half of the respondents (59.6%) had a morning chronotype. Eating behavior, especially restrained eating and external eating was significantly correlated with PMS severity ($p<0.023$; $r=0.222$); ($p=0.002$; $r=0.304$). Phytoestrogen intake was significantly associated with PMS ($p=0.007$; $r=-0.264$). However, emotional eating and chronotype did not correlate with PMS.

Conclusion: Eating behaviors: restrained, external eating, and phytoestrogen intake were associated with PMS while emotional eating and chronotype showed no correlation with PMS severity.

Keywords: *chronotype; eating behavior; phytoestrogen intake; premenstrual syndrome*

BACKGROUND

Female students are a group of late adolescents to early adults aged 18-25 years [1]. This group is classified women of reproductive age between 15-49 years from the first menstruation (menarche) to menopause [2]. Often women have physical, behavioral, and emotional disturbances that last several days before menstruation. This condition is called premenstrual syndrome (PMS) [3]. Emilia (2008) reported that 95% of Indonesian women have PMS with a symptom severity rate of 5% [4]. Symptoms of premenstrual syndrome can have various effects, such as decreased work productivity, digestive disorders, changes in appetite, and easy hunger [5,6].

Several studies showed that PMS is related to psychological and lifestyle factors. One factor that may influence PMS severity is eating behavior [7,8]. Eating behavior consists of three aspects: emotional eating, external eating, and restrained eating. Someone with restrained eating will try not to eat for a long time, causing depression, mood swings, and sleep disturbances. Conversely, someone with emotional eating and external eating tends to consume sweet foods and fast food excessively, resulting in swelling, bloating, and body aches. These conditions are associated with increased hormone estrogen in the body [9,10].

Another dietary factor may play a role in PMS is phytoestrogen intake. Increased estrogen hormone levels before menstruation can be controlled by consuming phytoestrogen-rich foods such as soybeans and their derivatives, including tofu, tempeh, soy milk, soy yogurt and also sesame seeds[11–14]. Phytoestrogens act as receptors for the hormone estrogen, which works by suppressing estrogen levels that are too high to relieve PMS symptoms [15]. Some studies have focused more on the effects of isoflavones on PMS [16,17], where

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isoflavones are part of phytoestrogens [18], rather than examining the overall intake of phytoestrogens in relation with PMS. Phytoestrogen consumption has some physiological effects on hormone regulation in humans, yet, like hormones, the advantages vary depending on the stage of life, including young women [19]. PMS symptoms can also be influenced by chronotype, the individual's biological tendency to choose when to sleep and do activities [20]. Takeuchi et al. (2015) revealed that severe PMS symptoms are at greater risk of occurring in women with eveningness type [21]. Someone with eveningness type tends to remain awake at night and perform at their peak in terms of mental, physical, and concentration abilities in the evening and at night [22]. Cortisol levels in eveningness women will peak at night [23]. This condition suppresses progesterone hormone secretion, resulting in an imbalance in reproductive hormone levels, which correlates with PMS [24]. To the best of the author's knowledge, not much study has been conducted to associate chronotype factors with PMS in female college students. There are several chronotypes among college students, and these chronotypes can have an impact on reproductive hormone regulation as well as general health [25].

Previous research showed that as many as 53.3% of female students at the Faculty of Medicine, Universitas Jenderal Soedirman, had premenstrual syndrome [26]. In addition, the results of a preliminary study of 32 female student classes in 2019 at Universitas Jenderal Soedirman also showed that 100% of female students had PMS with a mild symptom level of 25%, moderate 46.88%, and severe 28.13%. This study need to be conducted because PMS can affect college female students' academic performance by causing them to miss classes and exams more frequently, as well as alter their appetite and become more easily hungry[6,27,28]. This study aimed to explore how eating behavior, phytoestrogen intake, and chronotype are related to premenstrual syndrome (PMS) in female college students at Universitas Jenderal Soedirman.

MATERIALS AND METHODS

This study was an observational study with a cross-sectional design conducted Universitas Jenderal Soedirman from January to May 2023 involving 104 female college students. The population in the study were undergraduate students at Universitas Jenderal Soedirman, which consists of 12 faculties. The sample was selected using the cluster sampling method by fulfilling the inclusion criteria: being 18–25 years old, class of 2020–2022, physically healthy, and willing to participate in the entire research series. This research also excluded participants based on this following criteria: sleep medication usage, hormone treatment administration and medically diagnosed gynecological conditions. Respondents completed the questionnaire themselves in order to collect data for eating behavior, chronotype, and PMS variables, while phytoestrogen intake data was acquired through enumerators interviewing respondents.

Eating behavior data were collected using the Dutch Eating Behavior Questionnaire (DEBQ) instrument, consisting of 33 questions to assess three aspects of eating behavior: 10 for restrained eating, 13 for emotional eating, and 10 for external eating. The DEBQ has been translated in Indonesian language and tested. The validity and reliability tests of this questionnaire were conducted on college students and obtained a validity coefficient value of 0.45-0.81 and a Cronbach's Apha coefficient of 0.846 (very high) [29]. This questionnaire uses a Likert scale consisting of five scores: 1) Never; 2) Rarely; 3) Sometimes; 4) Often; and 5) Very often or always. The most dominant aspect of eating behavior in individuals can be seen based on the comparison between the scores divided by the total number of question items for each aspect of eating behavior[30].

Chronotype is a biological tendency individual in determining sleep time and time to start activities. Chronotype is not static, which can change over time. Chronotype measurement was conducted using the Morningness-Eveningness Questionnaire Self-Assessment Version (MEQ-SA). This questionnaire consists of 19 questions with different scores for each question point. The Indonesian versions of the Morningness-Eveningness Questionnaire Self Assessment Version (MEQ-SA) has been tested after being translated in Indonesia language with a Cronbach's Alpha coefficient of 0.86 (very high) [31]. The total MEQ-SA score was categorized into three types: Eveningness type (score ≤41), Intermediate type (score 42-58), and Morningness type (score ≥59). The assessment to determine the level of symptoms of PMS using the Shortened Premenstrual Assessment Form (SPAF) instrument, which consists of 10 questions with a Likert scale as follows: 1) Not experiencing; 2) Very mild; 3) Mild; 4) Moderate; 5) Severe; and 6) Extreme. The scores from each question were then summed and classified into no PMS (score 1-10), mild PMS (score 11-19), moderate PMS (score 20-29), and severe PMS (score ≥30)[32]. The Shortened Premenstrual Assessment Form (SPAF) has been translated into Indonesian and tested on college students for validity and reliability. Based on the results of the

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validity test, the calculated r was 0.496 - 0.782, so that all question items were declared valid. In addition, this questionnaire was also declared reliable with a Cronbach Alpha value of 0.848 (very high) [33].

Phytoestrogen intake data were obtained using the Semi-Quantitative - Food Frequency Questionnaire (SFFQ) form by directly interviewing respondents about their food history during the last month. Microsoft Excel was used to input the SFFQ data, which includes a phytoestrogen intake calculation formula for the past month. Daily food consumption of phytoesterogen intake was calculated by multiplying individual serving portions by their respective consumption frequencies. These dietary intake measurements were then cross-referenced against standardized phytoestrogen content values (expressed per 100 grams of food item) derived [11–14]. The results of the calculation of phytoestrogen intake were classified into three categories: less (<30 mg/day), sufficient (30–50 mg/day), and excess (>50 mg/day)[34]. The data were then statistically analyzed using the Spearman Correlation test to determine the relationship between the independent variables (eating behavior, phytoestrogen intake, and chronotype) and the dependent variable (PMS). The data collection process involved four enumerators who conducted SFFQ interviews. This research has received permission from the Health Research Ethics Commission, Faculty of Health Sciences, Universitas Jenderal Soedirman with Number: 1036/EC/KEPK/III/2023.

RESULTS

Table 1 showed the characteristics of 104 female students from the study. Based on the table, it was found that the age of respondents was between 18 and 22 years old, with the majority aged 20 years (47.1%) and starting menstruating at the age of 12 years (28%). Generally, menarche occurs at the age of 10–16 or when entering early adolescence [35]. Most respondents had a menstrual cycle between 21 and 35 days (54.8%) and a sleep duration of less than 7 hours per day (62.5%). This condition showed that the respondents have a shorter than usual sleep time, which can impact the secretion of female reproductive hormones and put them at risk of experiencing menstrual problems [36]. The recommended sleep duration for women is 7-9 hours a day [37]. BMI is one of the variables that can be related to PMS. However, the results of several previous studies showed inconsistent results, where a study had significant results, but there was also one that had insignificant results [38,39]. In addition, it is recommended to examine the relationship between body composition variables related to fat such as fat mass and fat free mass with PMS [40].

Table 1. Distribution of Respondent Characteristics

Variable	n (%)
Age of Respondents	
18 years	15 (14.4)
19 years	22 (21.2)
20 years	49 (47.1)
21 years	14 (13.5)
22 years	4 (3.8)
Age of *Menarche*	
10 years	5 (4.8)
11 years	20 (19.2)
12 years	28 (26.9)
13 years	26 (25)
14 years	15 (14.4)
15 years	9 (8.7)
16 years	1 (1)
Menstrual Cycle	
<21 days	40 (38.5)
21-35 days	57 (54.8)
>35 days	7 (6.7)
Nutritional Status (BMI)	
Underweight	22 (21.2)
Normal	63 (60.6)
Overweight	7 (6.7)
Obesity	12 (11.5)

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Variable	n (%)
Sleep Duration	
<7 hours/day	65 (62.5)
7-9 hours/day	39 (37.5)
>9 hours/day	0 (0)

Based on Table 2, as much as 69.2% of respondents had external eating behavior; while restrained eating and emotional eating occurred at rates of 16.3% and 14.4%, respectively. External eating represents eating behavior primarily induced by food-related stimuli, such as visual, olfactory, and taste cues, regardless of hunger or satiety states [41]. Emotional eating reflected response to stress or insufficient and ineffective coping, typically caused someone to have excessive intake more than nutritional requirement [42]. While restrained eating represents an eating behavior where individuals attempt to counteract their food cravings [43]. Eating behavior is a complex habit related to psychological, biological, and environmental factors that determine the response to food [44]. According to past research about eating behavior in college students, they tend to have external eating behaviors [45]. Female college students have a low level of phytoestrogen intake (90.4%). The results of the S-FFQ in the study revealed that respondents rarely consume phytoestrogen sources such as soy and processed products due to their dislike of them and finding it difficult to get or prepare them. Lack of phytoestrogen intake can occur due to low intake of food and beverage sources of phytoestrogen [46,47].

Table 2. Distribution of Eating Behavior, Phyoesterogen Intake, Chronotype and PMS

Variable	n (%)
Eating Behavior	
Restrained eating	17 (16.3)
Emotional eating	15 (14.4)
External eating	72 (69.2)
Phytoesterogen Intake	
Less (<30 mg/day)	94 (90.4)
Sufficient (30–50 mg/day)	8 (7.7)
Excess (>50 mg/day)	2 (1.9)
Chronotype	
Eveningness	1 (1.0)
Intermediate	41 (39.4)
Morningness	62 (59.6)
Premenstrual Syndrome	
No PMS	1 (1.0)
PMS	103 (99.0)
Mild PMS	29 (27.9)
Moderate PMS	50 (48.1)
Severe PMS	24 (23.1)

The majority of respondents had morningness type (59.6%) and intermediate type (39.4%). Study of preclinical medical student found that students in their 20s tend to have morningness and intermediate chronotypes due to their morning academic schedules. It makes students accustomed to getting up and doing activities in the morning with a high level of concentration[48]. As much as 99% of respondents had PMS, with the majority of symptoms being moderate PMS (48.1%). Psychological disorders such as feeling sad or angry (temperamental), as well as joint and abdominal pain, were commonly reported symptoms.

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Table 3. Bivariat Analysis of Eating Behavior, Phytoesterogen Intake and Chronotype with PMS

Variable	Premenstrual Syndrome (PMS) n=104				Total	*Spearman Test*	
	No	Mild	Moderate	Severe			
	n (%)	n (%)	n (%)	n (%)	n (%)	*p*	r
Eating Behaviors							
Restrained eating	0 (0)	7 (6.7)	9 (8.6)	1 (0.95)	17 (16.3)	0.023	0.222
Emotional eating	1 (0.96)	6 (5.7)	5 (4.8)	3 (2.8)	15 (14.4)	0.180	-
External eating	0 (0)	16 (22.2)	36 (34.6)	20 (19.2)	72 (69.2)	0.002	0.304
Phytoestrogens Intake							
Less (<30 mg/day)	0 (0)	24 (23)	46 (44.1)	24 (23)	94 (90.3)	0.007	-0.264
Sufficient (30–50 mg/day)	1 (0.96)	3 (2.9)	4 (3.85)	0 (0)	8 (7.7)		
Excess (>50 mg/day)	0 (0)	2 (1.9)	0 (0)	0 (0)	2 (1.9)		
Chronotype							
Eveningness	0 (0)	0 (0)	0 (0)	1 (0.96)	1 (0.96)	0.111	-
Intermediate	0 (0)	11 (10.6)	17 (16.3)	13 (12.5)	41(39.4)		
Morningness	1 (0.9)	18 (17.3)	33 (31.7)	10 (9.6)	62 (59.6)		

The results of the analysis showed that there was a significant relationship between restrained eating (p=0.023) and external eating (p=0.002) with PMS (p<0.05). The table also showed the correlation coefficient r = 0.222 (very weak) for restrained eating and r = 0.304 (weak) for external eating. This value illustrated the strength of the relationship between eating behaviors and PMS as a unidirectional relationship. It means the higher the score on the restrained eating, the more PMS symptoms will also be worse. In contrast to the two previous eating behaviors, emotional eating behavior had no relationship with PMS (p=0.180; p>0.05).

The results of the correlation analysis also showed a significance value of 0.007 (p<0.05) with correlation coefficient of -0.264. It has been discovered that there was a significant relationship between the intake of phytoestrogen and (PMS). The level of negativity in this relationship was relatively high, indicating that the severity of PMS symptoms experienced increases as phytoestrogen intake decreases. The results of the correlation analysis also showed a significance value of 0.111 (p>0.05). It has been discovered that there was no relationship between chronotype and (PMS).

DISCUSSION

The results of the analysis showed that there was a significant relationship between restrained eating and PMS (p=0.023, r=0.222). A high score on restrained eating could indicate that a person is very determine to limit their food intake in order to fight hunger [49]. The levels of serotonin decrease when hunger lasts for a long time [9]. It happens because hunger places stresses on the body as a result of tryptophan deficiency, which is an important factor in the synthesis of serotonin produced by food [50]. If the body is continuously stressed, it activates the Hypothalamus Pituitary Adrenal (HPA) axis to release cortisol, which can suppress serotonin synthesis [51]. When serotonin levels are low, psychological disorders are more likely to occur, and these symptoms are often experienced during the luteal period [52].

The findings of the research analysis indicate that there is no correlation between emotional eating and PMS (p=0.180). This contrasts with other studies, which have found a connection between PMS and emotional eating [53,54]. This condition occurs because an imbalance in the estrogen and progesterone hormones in the luteal phase interferes with serotonin synthesis and causes changes in mood and appetite (emotional eating) [55]. In this study, the most common PMS symptom in female students with emotional eating was not a psychological disorder but abdominal pain, which resulted in an unwillingness to eat. The absence of emotional symptoms and increased appetite in respondents resulted in no correlation between PMS and a person's eating behavior [24].

Research showed a significant relationship between external eating and PMS (p=0.002, r=0.304). Regardless of hunger, a person with external eating experiences food cravings brought on by outside stimuli like the sight, smell, or taste of food [56]. According to the correlation analysis, r = 0.304 was obtained, indicating a fairly strong positive correlation, meaning that PMS symptoms become more severe when the external eating score increases. For those students who had external eating behavior experience PMS, with the majority experiencing moderate PMS. Symptoms that are getting worse occur because external eating often consumes

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foods high in sugar, sodium, fat, and processed food [57]. If these foods are consumed continuously, they will result in fluid and sodium retention, which causes breast pain, abdominal pain, and swelling [10].

The analysis indicates a significant correlation between phytoestrogen intake and PMS (p=0.007, r=-0.264). These findings are consistent with other research which also identified a link between soy isoflavone consumption and PMS (p=0.001, r=). Isoflavones, a type of phytoestrogen, function similarly to the body's estrogen hormone (17β-estradiol).[58].

The results from the SFFQ interviews on this study indicated that several foods and beverages high in phytoestrogens were consumed by respondents over the past month, including tempe at a frequency of 2-4 times per week (one piece per serving), tofu 2-4 times per week (one medium-sized piece per serving), and soy milk 1-3 times per month (one small glass per serving). These foods and beverages are easily accessible sources of phytoestrogens; however, they were found rarely consumed by the 90,4% female students. This could lead to low phytoestrogen intake among the majority of respondents. According to Table 3, phytoestrogen intake is predominantly low among female students, which may contribute to the occurrence of PMS. High levels of phytoestrogen intake will help relieve the symptoms of PMS. This condition occurs because phytoestrogens are compounds that work as antagonists against excess estrogen in the body, so the imbalance of the hormones estrogen and progesterone at the luteal stage (before menstruation) can suppressed [59]. Therefore, phytoestrogens can be said to be able to maintain the stability of female reproductive hormones so that menstrual problems can minimized [46].

Unlike previous study, this research revealed no significant relationship between chronotypes and PMS (p=0.111). This finding contrasts with the study by Takeuchi in 2015, which identified a connection between chronotype and PMS (p=0.002). The discrepancy in results may be due to the fact that, in this study, only one respondent with an eveningness chronotype exhibited severe PMS symptoms. A person with the eveningness type tends to have a high level of stress, resulting in a decrease in progesterone levels during the luteal phase due to soaring cortisol levels at night. It will have an impact on the imbalance of the hormones estrogen and progesterone, which correlate with PMS [60].

The majority of respondents in this study have morningness and intermediate chronotypes; however, respondents tend to have an insufficient sleep duration of less than 7 hours per day. Women reproductive age age (19–25 years old) need 7–9 hours of sleep each day [61]. Lack of sleep duration affects the secretion of hormones during sleep, one of which is melatonin. A decrease in melatonin levels causes an increase in the production of the hormone estrogen, which then has an impact on the imbalance of the hormones estrogen and progesterone in the body [62]. Therefore, female students with poor sleep duration have the opportunity to have a more severe degree of PMS.

The limitation of this research were that the measurement of emotional eating and external eating behavior was only based on psychological aspects rather than objective dietary intake measurements, BMI should be considered as potential confounder in the analysis. Other factors that cause emotional and external eating were not analysed, such as the intake of foods high in energy, sugar, salt, fat, and fast food. Apart from that, the proportion of chronotype types in this study was uneven which means the small number of participants with an evening chronotype (only 1%). Furthermore, there was no descriptive information regarding stress levels and social jetlag (a condition when there is a balance between the body's internal clock and social time) from respondents, which could limit the ability to detect of a significant relationship between chronotype on PMS symptoms.

CONCLUSIONS

Eating behaviors such as restrained and external eating, and phytoestrogen intake were associated with PMS, while emotional eating and chronotype showed no correlation with PMS severity. Further research for observational study could consider to incorporate other variables related to emotional and external eating such as high consumption of energy, sugar, sodium and fat as well as body composition such as fat mass and fat free mass. In addition, experimental studies can also be conducted by providing phytoestrogen food ingredients or processed products in relation to the levels of estrogen hormone in the body during the luteal phase of menstruation.

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