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Association of nutrient adequacy, diet diversity, and sleep quality with premenstrual syndrome (PMS) in young adult women aged 18-25 years in Mumbai

Alfiya Naik, Dr. Rajeshree Shinde and Dr. Madhuri Nigudkar

Abstract
Premenstrual Syndrome (PMS) is a prevalent condition characterized by a range of emotional and physical symptoms that significantly impact women's daily lives. Symptoms such as irritability, depression, abdominal bloating, cramps, breast tenderness, fatigue, mood swings, headaches, and sleep disturbances typically occur in the week leading up to menstruation and can persist for a few days into the menstrual cycle. The severity of PMS varies among women due to hormonal, psychosocial, and physiological factors. While lifestyle factors such as diet diversity and sleep quality have been linked to the severity of PMS symptoms, there is limited data on their association among young adult women. This study aimed to assess the association between nutrient adequacy, diet diversity, sleep quality, and PMS among young women aged 18-25 years in Mumbai. A cross-sectional study was conducted from December 2023 to March 2024, involving 150 participants selected through convenience sampling from colleges and workplaces. Data collection involved structured questionnaires to gather information on sociodemographic characteristics, anthropometric measurements, PMS, diet diversity, daily food intake, and sleep quality. Data analysis was performed using SPSS software version 25, employing the chi-square test, ANOVA, t-test, and Pearson correlation coefficient, with a significance level set at $p < 0.005$. The results showed no significant differences in weight, height, or BMI among participants with varying PMS severity ($p > 0.05$). Additionally, there were no significant differences in energy and macronutrient intake among participants with different PMS severities ($p > 0.05$). Although 47.3% of participants had adequate diet diversity, no significant association was found between diet diversity and PMS severity ($p > 0.05$). Notably, 57.3% of participants reported poor sleep quality, which was significantly associated with higher PMS severity ($p < 0.05$). Correlation analysis revealed a significant negative correlation between sleep quality and PMS severity ($p < 0.05$), indicating that poorer sleep quality was associated with higher PMS severity. In conclusion, the study found that poor sleep quality is significantly correlated with higher PMS severity, while diet diversity and anthropometric measurements do not exhibit a significant relationship with PMS symptoms. These findings suggest that improving sleep quality could potentially alleviate PMS-related discomfort, though further research is needed to understand the role of diet and anthropometric factors in PMS symptom severity.

Keywords: Premenstrual syndrome, diet diversity, lifestyle factors, sleep quality

1. Introduction

1.1 Premenstrual Syndrome (PMS)

Premenstrual Syndrome (PMS) is a condition occurring in the late luteal phase of the menstrual cycle, significantly impacting women's daily functioning due to a combination of emotional and physical symptoms. These symptoms, which typically emerge in the week leading up to menstruation and can persist into the menstrual cycle, include irritability, lack of concentration, depression, abdominal bloating, cramps, breast tenderness, anger, general aches, nausea, vomiting, fatigue, decreased concentration, mood swings, headaches, anxiety, sleep disturbances, and appetite changes (Hashim *et al*., 2019) [5]. The American College of Obstetrics and Gynecology (ACOG) criteria for PMS diagnosis requires the presence of at least one affective symptom and one somatic symptom for five days before menstruation, recurring for three consecutive cycles, and resolving within four days of menses onset (Upadhyay *et al*., 2023a) [12].

PMS severity varies due to hormonal, psychosocial, and physiological factors, posing

challenges to female adolescents and young adults by reducing productivity, quality of life, and causing reliance on healthcare and disruptions in daily activities (Hashim *et al*., 2019) [5]. Premenstrual Dysphoric Disorder (PMDD) represents a severe form of PMS. PMS is linked to an increased risk of hypertension, decreased work-related quality of life, and adverse effects on academic and athletic performance (Hashim *et al*., 2019) [5]. Although PMS symptoms usually subside with menstruation, their cyclical nature impacts many women's quality of life, posing significant productivity and mental well-being challenges (Seedhom *et al*., 2013) [9].

1.2 Biochemistry of PMS

PMS symptoms coincide with menstrual cycle hormonal fluctuations, particularly estrogen and progesterone imbalances, and serotonin, a key etiological factor. Estradiol, the most potent estrogen, fluctuates during the luteal phase, influencing mood changes. Decreased estrogen levels trigger norepinephrine release from the hypothalamus, leading to declines in acetylcholine, dopamine, and serotonin, causing insomnia, fatigue, and depression. The cyclic effects of estrogen and progesterone on serotonin, γ-aminobutyric acid, and dopamine systems can cause mood changes and alter the renin-angiotensin- aldosterone (RAS) system, explaining symptoms like bloating, cramps, swelling, and weight gain.

1.3 Prevalence of Premenstrual Syndrome

PMS affects millions of women, with 75% experiencing some symptoms and 3% to 8% reporting severe manifestations. Globally, nearly half of women (47.8%) report PMS symptoms (Abu Alwafa *et al*., 2021) [1]. In India, prevalence estimates range from 14.3% to 74.4%, influenced by cultural stigmas and societal norms that hinder women from seeking help for PMS-related discomfort (Upadhyay *et al*., 2023b) [12]. Factors such as nutrition, physical activity, age, and different measurement tools contribute to regional prevalence variations (Sharifan *et al*., 2023) [10]. PMS significantly impacts the well-being and academic performance of female university students, leading to substantial challenges in their quality of life and academic achievements (Hashim *et al*., 2019) [5].

1.4 Lifestyle Factors and Dietary Habits in PMS

Severe PMS symptoms are linked to age, smoking, and alcohol consumption, as well as low fruit and seafood intake, reduced plant protein consumption, high grain and fat intake, and elevated calorie intake (Sharifan *et al*., 2023) [10]. Promoting a healthy lifestyle, including hydration with water or juice, avoiding soft drinks, alcohol, and caffeinated beverages, and maintaining regular, balanced meals, can manage PMS symptoms. Dietary habits, as the most impactful and adjustable management factor, can disrupt neurotransmitter and hormonal balance if specific nutrients are imbalanced (Helmy *et al*., 2023) [6]. Higher consumption of riboflavin, saturated fatty acids (SFA), and vitamin D reduces severe PMS risk (Sharifan *et al*., 2023) [10]. Nutritional supplements like vitamin B6, calcium, and magnesium, along with regular aerobic exercise, are recommended for managing PMS symptoms (Seedhom *et al*., 2013) [9].

1.5 Association of Sleep Quality with PMS

Research consistently shows that women with PMS experience lower sleep quality. Studies highlight a significant correlation between PMS severity and the luteal phase, leading to increased daytime sleepiness (Winyuchakrit & Taneepanichskul, 2017) [17]. Poor sleep quality, insomnia, and shorter sleep duration are linked to PMS occurrence in adults, with inadequate sleep intensifying stress, a well-known PMS risk factor (Jeong *et al*., 2023) [16].

1.6 Diet Diversity Score

Diet diversity, an indicator of a nutritious diet, involves consuming all essential food groups: vegetables, fruits, grains, meat, and dairy. It ensures adequate nutrient intake and promotes optimal growth and development. Dietary diversity, quantified by the number of different foods or food groups consumed, assesses nutritional adequacy and overall well-being (Nachvak *et al*., 2017) [8]. The Food and Agriculture Organization (FAO) endorses Dietary Diversity as a proxy for nutritional adequacy, reflecting the range of food groups consumed and positively impacting nutritional status (Wiafe *et al*., 2023) [13]. The Dietary Diversity Score (DDS) is widely used in studies and surveys to evaluate dietary quality.

This cross-sectional study, conducted in Mumbai from December 2023 to March 2024, involved 150 adolescent girls aged 18-25 years, selected using convenience sampling from colleges and workplaces. Ethical approval was obtained from the Intersystem Biomedical Ethics Committee, Mumbai. Participants were informed about the study's objectives and protocols through a detailed information sheet and provided written informed consent. The study included women with regular menstrual cycles and excluded those on medications affecting menstrual cycles or with known histories of PCOS, diabetes, or hypertension. Data were collected through case record forms and face-to-face interviews, complemented by a Google form in English.

Sociodemographic data included age, occupation, marital status, educational attainment, primary earner's occupation, family income, and socioeconomic status, assessed using the Kuppuswamy scale. Anthropometric measurements, including height and weight, were recorded to calculate Body Mass Index (BMI), classified according to WHO Asian BMI cut-offs. PMS severity was assessed using the Premenstrual Syndrome Scale (PMSS), which evaluated physiological, psychological, and behavioral symptoms over the seven days preceding menstruation. Scores ranged from 1 (Never) to 5 (Always), with total scores from 40 to 200. A score of 80 or above indicated PMS, categorized into "No symptoms," "Mild," "Moderate," "Severe," and "Very Severe." Dietary diversity was measured using the Minimum Dietary Diversity for Women (MDD-W) tool from the Food and Agriculture Organization (FAO), categorizing food consumption into ten groups. Adequate diet diversity was defined as consuming at least five of these groups within a 24-hour recall period. Nutrient intake, including energy and macronutrients, was calculated. Sleep quality was evaluated using the Pittsburgh Sleep Quality Index (PSQI), a 19-item questionnaire assessing sleep over the past month. Scores ranged from 0 to 21, with higher scores indicating poorer sleep quality. Participants were classified as "good sleepers" (PSQI $\leq$ 5) or "poor sleepers" (PSQI > 5).

Statistical analysis was performed using SPSS, employing chi-square tests, ANOVA, t-tests, and Pearson correlation coefficients to explore associations between PMS, dietary diversity, sleep patterns, and nutrient adequacy, with significance set at $p < 0.005$.

Table 1: Sociodemographic characteristics of the study participants

Characteristics	Frequency
Type of family size	
1-2 person	4
3-4 person	50.7
5-6 person	32
> 7 person	13.3
Marital status	
Married	2
Unmarried	98
Education level	
Undergraduate	79.3
Graduate	9.3
Postgraduate	11.3
Occupation	
Student	92
Working	8
Socioeconomic class [Kuppuswamy scale]	
Upper class	24.7
Upper middle	51.3
Lower middle	15.3
Upper lower	8
Lower	7
Age of menarche	
Before 10 years	2
10-12 years	38.7
13-16 years	56
After 16 years	3.3
Duration of the menstrual cycle (in days)?	
＜21	10.7
21-27	44
28-35	37.3
> 35	8
Smoking status	
Yes	0.7
No	99.3

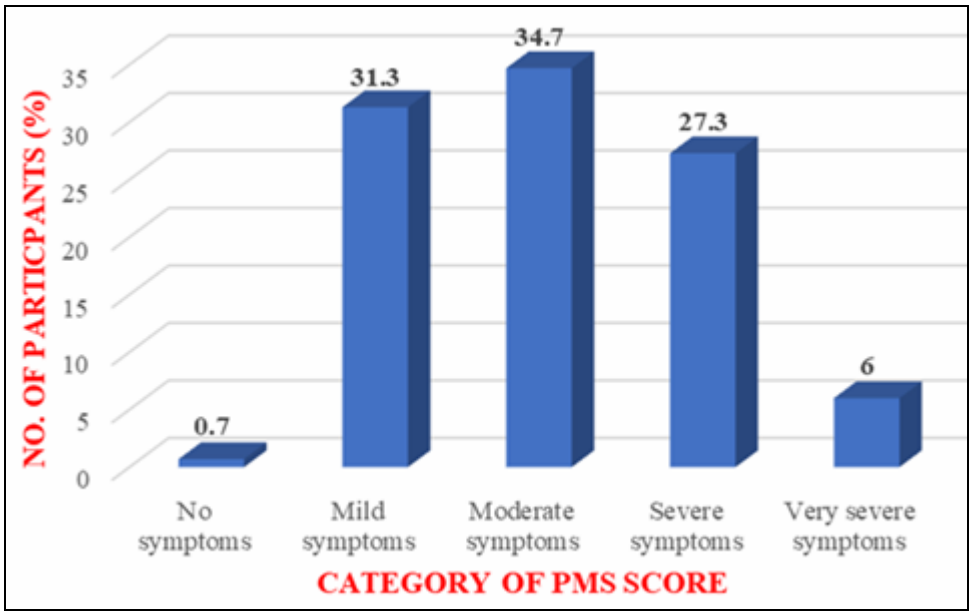

Fig 1: Category of PMS score

There were a total of 150 participants. The majority (n=76, 50.7%) of the participants had families consisting of 3-4 members (Fig 4.1a) and were unmarried (n=147, 98%) (Fig 4.1b). The majority were undergraduates (n=119, 79.3%), reflecting the prevalence of individuals in this age group still pursuing their studies and that's why all were students (n=138, 92%). Participants were asked about the occupation and education level of the head of the family, along with the monthly family income according to the Kuppuswamy scale. Subsequently, participants were categorized into different socioeconomic groups based on their responses. The upper-middle-class category comprised the largest proportion of participants (n=77, 51.3%). Regarding menarche, most participants experienced it between the ages of 13 and 16 years (n=84, 56%), with menstrual cycles lasting between 21 and 27 days (n=66, 44%). Smoking was reported by only one

participant (n=1, 0.7%). Participants were asked to rate 40 symptoms from the Premenstrual Syndrome Scale (PMSS) using a Likert scale. Based on their responses, they were categorized into five groups from 'Nos symptoms' to 'Very severe symptoms'. Most participants experienced moderate symptoms (n=52, 34.7%), while only one participant reported having no symptoms (n=1, 0.7%).

Table 2: Mean age and PMS score of the study participants

	Mean value + S.D.
Age (years)	19.9±2.1
PMS score No symptoms (N=1)	40
Mild symptoms (N=47)	65.5±11.0
Moderate symptoms (N=52)	96.0±13.1
Severe symptoms (41)	132.2±14.8
Very severe symptoms (N=9)	172.7±9.6

The mean age of the participants was 19.9±2.1 years. The mean score of the participant with no symptoms was 40 as there was only one participant. The mean score of the participants with mild symptoms, moderate symptoms, severe symptoms, and very severe symptoms was 65.5±11.0, 96.0±13.1, 132.2±14.8, and 172.7±9.6 respectively.

Table 3: Anthropometric measurements of the study participants when classified as per the categories of PMS score

Anthropometric measurements	**All (N =150)**	**No symptoms**	**Mild symptoms**	**Moderate symptoms**	**Severe symptoms**	**Very severe symptoms**	**p-value**
Weight (kg)	55.7±14.954	43	55.66± 20.664	55.08± 10.331	58.02± 13.250	50.33± 8.276	0.569
Height (cm)	157.73± 7.351	157	158.45± 6.649	156.77± 7.059	158.98± 8.460	153.89± 6.566	0.291
BMI (kg/m2)	22.17± 5.260	17	21.64 ±6.713	22.29± 2.987	22.95 ±5.128	21.22± 3.768	0.620

The mean weight of all participants was 55.7±15.0 kg. Participants with no symptoms had a lower mean weight of 43 kg, whereas those in the severe symptom's category had a higher mean weight of 58.02±13.3 kg. There is no significant difference in mean weight among participants with different levels of PMS symptoms (p=0.569).

The mean height of the participants was 157.7±7.4 cm, and there was no significant difference in mean height among participants with different levels of PMS symptoms (p = 0.291).

The mean BMI of all participants was 22.2±5.3 kg/m², which falls within the normal range as per Asian cutoffs. The lowest mean BMI was observed for the 'No symptom' category (17 kg/m²). There was no statistically significant difference in the mean BMI of the participants belonging to different categories of PMS score (p=0.620).

These findings are consistent with a study conducted in Sharjah among 300 female participants (Hashim *et al*., 2019) [5]. In that study, researchers found no significant difference in anthropometric measurements, such as weight, height, and BMI with three categories of PMS symptoms, and the participants belonged to the normal BMI category. Similarly, a study conducted in Jordan revealed consistent findings, with participants' average BMI falling within the normal range. However, BMI was significantly associated with an increased risk of physical and behavioral symptoms of PMS.

Table 4: Daily Energy and Macronutrient intake of the study participants

Nutrients	**All (N =150)**	**No symptom s**	**Mild symptoms**	**Moderate symptoms**	**Severe symptoms**	**Very severe symptoms**	**p-value**
Total Energy (kcal)	1142± 766.7	1029	1067± 356.4	1222± 1070.1	1157± 730.3	1023±399.4	0.871
Percent Energy RDA met	69.2± 46.5	62.4	64.7± 21.6	74.0±64.9	70.1±44.3	62.0±24.2	0.871
Total Protein (g)	36.4 ±24.4	37	34.8± 13.7	39.4±33.8	35.6±22.1	30.9±13.9	0.831
Percent Protein RDA met	79.7± 53.5	80.8	76.1± 30.1	86.3±74.1	78.1±48.4	67.8±30.3	0.833
Total Carbohydrate (g)	149.6± 110.0	162	143.0± 49.0	159.3± 155.5	148.3± 101.8	132.1±64.0	0.937
Total Fat (g)	44.4 + 27.7	26	39.9 +18.1	47.5 + 35.6	45.9 + 27.4	44.4 + 17.8	0.655

Participants with no symptoms of PMS have a mean energy intake of 1029 kcal, while those with mild, moderate, severe, and very severe symptoms have mean energy intakes of 1067±356.4 kcal, 1222±1070.1 kcal, 1157±730.3 kcal, and 1023±399.4 kcal, respectively. Also, the mean percent energy RDA met for all participants was 69.2±46.5%. There is no significant difference in energy intake as well as percent energy RDA met among participants with different levels of PMS symptoms (p= 0.871, p=0.871 respectively). Participants with no symptoms of PMS have a mean protein intake of 37 grams, while those with mild, moderate, severe, and very severe symptoms have mean protein intakes of 34.8±13.7

grams, 39.4±33.8 grams, 35.6±22.1 grams, and 30.9±13.9 grams, respectively. The mean percent energy RDA met for all participants was 79.7±53.5%. There is no significant difference in protein intake as well as percent protein RDA met among participants with different levels of PMS symptoms (p= 0.831, p=0.833 respectively). Participants with no symptoms of PMS have a mean carbohydrate intake of 162 grams, while those with mild, moderate, severe, and very severe symptoms have mean carbohydrate intakes of 143.0±49.0 grams, 159.3±155.5 grams, 148.3±101.8 grams, and 132.1±64.0 grams, respectively. Similarly, There is no significant difference in carbohydrate intake among participants with different levels of PMS symptoms (p= 0.937). Participants with no symptoms of PMS have a mean fat intake of 26 grams, while those with mild, moderate, severe, and very severe symptoms have mean fat intakes of 39.9±18.1 grams, 47.5±35.6 grams, 45.9±27.4 and 44.4±17.8 grams, respectively. There is no significant difference in fat intake among participants with different levels of PMS symptoms (p= 0.655).

These findings are similar to the findings of a study where they also found no significant differences in energy and macronutrient intake among women with different severities of PMS. Also, a study conducted in Iran showed no significant difference in nutrient intakes between PMS severity groups (Sharifan *et al*., 2023) [10]. This finding suggests that there may not be a direct relationship between overall nutrient intake and PMS severity.

In the present study, there was no statistically significant difference observed in the daily energy and macronutrient intake. This lack of difference may explain why there were no significant variations in anthropometric measurements among participants with different levels of PMS symptoms.

Table 5: Classification of study participants as per Diet diversity score and mean Diet diversity score

Diet diversity status	All (N=150)	Participants with no symptoms of PMS	Mild symptoms	Moderate symptoms	Severe symptoms	Very severe symptoms	p-value
Adequate diet diversity	71 (47.3%)	1 (100%)	25 (53.2%)	22 (42.3%)	17 (41.5%)	6 (66.7%)	0.379
Inadequate diet diversity	79 (52.7%)	0	22 (46.8%)	30 (57.7%)	24 (58.5%)	3 (33.3%)	
Mean diet diversity score*	4.4±1.2	5	4.5±1.1	4.3±1.1	4.2±1.1	5±1.2	0.297

***** Values in the table are in mean± S.D.

The Dietary Diversity Score (DDS) was determined using the Minimum Dietary Diversity for Women (MDD-W) based on their 24-hour dietary recall. MDD-W comprises 10 food groups, with adequate dietary diversity defined as consuming 5-10 food groups, and inadequate dietary diversity defined as consuming 0-4 food groups.

Among all participants, 71 (47.3%) had adequate diet diversity. 79 (52.7%) had inadequate diet diversity. However, the maximum percent of participants with severe symptoms and moderate symptoms of the PMS category (58.5%, and 57.7% respectively) showed inadequate dietary diversity, whereas participants in the mild PMS symptom category were almost equally divided into adequate diet diversity group (53.2%) and inadequate diet diversity group (46.8%). However, there is no significant difference among the participants with different levels of PMS symptoms when classified as per the categories of diet diversity score.

The mean DDS for all participants was 4.4±1.2 and there was also no significant difference with different levels of PMS (p=0.297).

Diet diversity has been investigated among women of reproductive age and other populations, but its comparison with PMS has not been explored. A study conducted in Bangladesh among 1169 households of reproductive age revealed a low mean Dietary Diversity Score (DDS), with diets consisting primarily of starchy staples and low amounts of vegetables and fruits. The educational level of participants significantly influenced dietary diversity (Islam *et al*., 2023) [20]. In contrast, a study in India involving 1235 lactating women found that the majority had adequate dietary diversity. However, younger participants exhibited lower dietary diversity due to difficulties in making optimal food group choices (Shumayla *et al*., 2022) [22].

Table 6: Classification of study participants as per sleep quality score and mean of sleep quality score

Sleep quality status	All (N=150)	No symptoms	Mild symptoms	Moderate symptoms	Severe symptoms	Very severe symptoms	p-value
Good	64 (42.7%)	0	30 (63.8%)	22 (42.3%)	11 (26.8)	1 (11.1%)	0.002*
Poor	86(57.3%)	1 (100%)	17 (36.2)	30 (57.7%)	30 (73.2%)	8 (88.9%)	
Mean sleep score*	6.2±2.9	7	4.7±2.5	5.9±2.3	7.5±2.6	9.3±3.9	0.000*

***** Values in the table are in mean± S.D.

The majority of participants 86 (57.3%) reported poor sleep quality. The majority of the participants with moderate and severe PMS symptoms fell into the category of poor sleep quality (n=30, 57.7% and n=30, 73.2% respectively), while the majority of the participants with mild symptoms fell into the category of good sleep quality (n=30, 63.8%). There is a significant difference in sleep quality among participants with different levels of PMS symptoms (p= 0.002).

The mean sleep quality score for all participants was 6.2±2.9 and there was a significant difference with different levels of PMS (p= 0.000).

The findings of this study align with previous research. For example, a study involving Korean high school girls demonstrated that sleep quality, sleep patterns, and shorter sleep duration were significantly associated with moderate to severe PMS symptoms (Jeong *et al*., 2023) [16].

Contrastingly, a study conducted on nurses in Thailand did not establish a conclusive relationship between PMS and

sleep quality. Despite experiencing poor sleep quality, the majority of nurses did not report PMS symptoms. It is possible that the physical symptoms such as muscle and joint pains, attributed to shift work, may have contributed to their poor sleep quality.

Table 7: Association of Nutrient Adequacy, Diet diversity, and Sleep quality with PMS

		Premen strual syndro me (PMS) Score	Minimum Dietary Diversity for Women (MDD-W) Food Group Score	Pittsburgh Sleep Quality Index (PSQI) Score	Total Energy (kcal	Total Protein (g)	Total carbohydrate (g)	Total fat (g)
Premenstru al syndrome (PMS) Score	Pearson Correlati on	1	- 0.029	0.504**	0.011	-0.018	-0.020	0.081
	P value		0.723	0.000	0.889	0.827	0.803	0.322

A significant negative correlation was observed between DDS and PMS scores. These findings suggest that the higher the DDS low is the PMS score. However, there is no significant correlation between DDS and PMS scores. However study conducted on lactating women in India did not show any negative correlation with another factor (Shumayla *et al*., 2022) [22].

Also, there was a significant negative correlation between total protein and carbohydrate intake with the PMS score suggesting higher protein and carbohydrate intake lower the PMS score. A study conducted in Iran showed no negative correlation between nutrient intake and PMS score.

There was a statistically significant correlation between sleep quality and PMS score suggesting poor sleep quality and higher PMS score. Thai finding is similar to the findings of the study involving Korean high school girls demonstrated that sleep quality, sleep patterns, and shorter sleep duration were significantly associated with moderate to severe PMS symptoms (Jeong *et al*., 2023) [16].

Strengths and Limitations

Detailed dietary history was obtained through the 24-hour recall method and the use of validated tools to assess PMS symptoms and sleep quality, enhancing reliability. However, factors such as academic or personal stress, which can influence sleep quality, were not considered due to time constraints. Other potential confounding factors affecting sleep quality were not explored, limiting a comprehensive understanding of its impact on PMS symptoms. Future research should include a broader range of variables to understand better the relationships between diet, sleep, and PMS.

Conclusion

Based on the findings of this study, a significant correlation was observed between sleep quality and premenstrual syndrome (PMS) symptoms. However, no significant relationships were found between diet diversity score (DDS) and anthropometric measurements with PMS symptoms. These results underscore the importance of sleep quality in the manifestation of PMS symptoms. Poor sleep quality appears to be a contributing factor to the severity of PMS symptoms, suggesting that interventions targeting sleep improvement could potentially alleviate PMS-related discomfort. However, there may be other confounding factors like academic stress, and personal stress that could result in poor sleep quality. Nevertheless, the lack of significant associations between DDS and anthropometric measurements with PMS symptoms warrants further investigation. Future research should delve deeper into the potential influences of diet diversity and anthropometric factors on the severity of PMS symptoms. Additionally, there is a notable gap in the literature regarding the correlation between DDS and PMS scores. Therefore, future studies should investigate this potential relationship to provide a more comprehensive understanding of factors influencing PMS symptoms.

Recommendations

For future studies, it's advisable to expand the participant pool for better representativeness. Incorporating a three-day dietary recall can enhance insight into eating patterns. Additionally, assessing micronutrient intake alongside other dietary factors may unveil correlations with PMS symptoms, offering a deeper understanding of dietary influences. These adjustments could refine research outcomes, aiding in targeted interventions and improving PMS management strategies.

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