



Correlation between calcium intake and severity of premenstrual syndrome in female students in boarding high schools

Korelasi antara jumlah asupan kalsium dan keparahan premenstrual syndrome pada siswi di SMA berasrama

Syaleisha Yasmine Razi¹, Yudi Feriandi², Yafma Femin Helta Heriady³, Eva Rianti Indrasari⁴, Mirasari Putri^{5*}

¹ Undergraduate Medical Study Program, Faculty of Medicine, Universitas Islam Bandung, Bandung, Indonesia.

E-mail: syasmine.razi@gmail.com

² Department of Humanities, Medical Education, Bioethics, and Islamic Insert, Faculty of Medicine, Universitas Islam Bandung, Indonesia.

E-mail: yudi.feriandi@unisba.ac.id

³ Departement of Biochemistry, Nutrition, dan Biomolecular, Faculty of Medicine, Universitas Islam Bandung, Bandung, Indonesia. E-mail: Yafma.helta@unisba.ac.id

⁴ Departement of Biochemistry, Nutrition, dan Biomolecular, Faculty of Medicine, Universitas Islam Bandung, Bandung, Indonesia. E-mail: evaindrasari@unisba.ac.id

⁵ Departement of Biochemistry, Nutrition, dan Biomolecular, Faculty of Medicine, Universitas Islam Bandung, Bandung, Indonesia.

E-mail: mirasari.putri@unisba.ac.id

*Corresponding Author:

Departement of Biochemistry, Nutrition, dan Biomolecular, Faculty of Medicine, Universitas Islam Bandung. Jalan Tamansari No. 22, Bandung, Jawa Barat, Indonesia.

E-mail: mirasari.putri@unisba.ac.id

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Abstract

Premenstrual Syndrome (PMS) is a multifactorial condition that occurs during the luteal phase and affects the daily activities of women of reproductive age. Calcium plays a role in PMS symptom severity, but its intake among adolescents, particularly boarding school students with limited dietary diversity, is often below the recommended RDA. This study aimed to identify the relationship between calcium intake and PMS symptom severity among female students at a boarding high school in Bogor during the 2025/2026 academic year. A quantitative observational study with a cross-sectional design was conducted among 85 respondents selected using the Proportionate Random Sampling method. Calcium intake data were collected using 3×24-Hour Estimated Food Records, and PMS symptom severity was measured using the Shortened Premenstrual Assessment Form (SPAF). The average calcium intake of respondents was 121±63 mg/day, and the average PMS score was 26±7.7. Spearman correlation analysis showed a significant relationship ($p=0.04$), negative correlation ($r=-0.21$), and weak correlation strength (CI: -0.413 to 0.005) between low calcium intake and increased PMS symptom severity. In conclusion, these findings support the association between low calcium intake and increased PMS symptom severity, highlighting the importance of adequate calcium intake among adolescents, especially those living in boarding school environments.

Keywords: Adolescent girls, calcium intake, premenstrual syndrome.

Abstrak

Premenstrual Syndrome (PMS) merupakan gejala-gejala fase luteal yang memengaruhi aktivitas sehari-hari pada wanita usia reproduktif. Interaksi berbagai faktor berkontribusi terhadap munculnya PMS. Kalsium merupakan salah satu faktor yang diperkirakan berkontribusi terhadap keparahan gejala PMS melalui perannya pada level seluler dan neurotransmitter. Namun, asupan kalsium pada remaja jauh dari rekomendasi AKG. Remaja yang tinggal asrama lebih rentan kekurangan asupan kalsium akibat makanan yang tidak beragam. Penelitian ini bertujuan untuk mengidentifikasi hubungan antara asupan kalsium dan keparahan gejala PMS di kalangan siswi di salah satu sekolah menengah atas berasrama di Bogor pada tahun ajaran 2025/2026. Penelitian menggunakan desain kuantitatif observasional analitik dan metode cross-sectional pada 85 responden, dipilih menggunakan metode *Proportionate Random Sampling*. Data asupan kalsium dikumpulkan melalui *3×24-Hours Estimated Food Record*, keparahan gejala PMS diukur menggunakan kuesioner *Shortened Premenstrual Assessment Form* (SPAF). Analisis deskriptif menunjukkan rata-rata asupan kalsium responden adalah 121±63 mg/hari dan rata-rata skor PMS sebesar

26±7.7. Analisis korelasi *Spearman* menunjukkan hubungan signifikan ($p=0.04$), korelasi negatif ($r=-0.21$), dengan kekuatan hubungan lemah (CI: -0.413 hingga 0.005) antara rendahnya asupan kalsium dan meningkatnya keparahan gejala PMS. Kesimpulan, temuan ini menunjukkan teori rendahnya asupan kalsium berkontribusi dalam keparahan gejala PMS dan menegaskan pentingnya pemenuhan asupan kalsium pada remaja, khususnya di lingkungan asrama.

Kata Kunci: Asupan kalsium, *premenstrual syndrome*, remaja putri

Introduction

Premenstrual syndrome (PMS) typically occurs in women of reproductive age (Thakur et al., 2022). The global prevalence of PMS is reported to be 47.8% (95% CI: 32.6-62.9) based on a meta-analysis of 17 studies covering 18,803 individuals (Direkvand-Moghadam et al., 2014). Meanwhile, a 2019 study in Indonesia found that 42.5% of adolescents in Yogyakarta experienced PMS (Dewi et al., 2019). PMS symptoms vary in severity and may include physical, psychological, and emotional symptoms such as weight gain, abdominal and back pain, headaches, breast tenderness, nausea, constipation, increased appetite, fatigue, anxiety, irritability, emotional changes, and a tendency to cry (Barus et al., 2024; Oboza et al., 2024).

PMS results from the interaction of various genetic, hormonal, neurotransmitter, vitamin, and mineral deficiencies and decreased serotonin levels (Masoumi et al., 2016; Thakur et al., 2022). One underlying mechanism of PMS symptoms is the central nervous system's response to changes in estrogen and progesterone during the luteal phase, which affects neurotransmitter regulation, particularly serotonin. Decreased serotonin availability plays a role in the onset of affective and somatic symptoms of PMS (Casanova et al., 2019; Chen et al., 2023).

Calcium intake is related to PMS severity because it plays a role in nerve and muscle function and in the regulation of neurotransmitters. Calcium deficiency can trigger cramps, pain, and mood disorders by disrupting the calcium-serotonin balance (Arab et al., 2020; Du et al., 2022; Fradista, 2023; Masoumi et al., 2016; Masruroh & Muniroh, 2021). Several studies have supported this association. A study conducted in 2023 found that female students experiencing PMS tended to consume fewer dairy products than those without PMS (Fradista, 2023). Interventional studies have

also shown that calcium supplementation is associated with reduced PMS symptoms (Ilçioğlu et al., 2025; Shobeiri et al., 2017).

However, calcium intake in adolescents remains far from the recommended levels. According to a 2017 systematic review, daily calcium intake in Asia, particularly Southeast Asia, remains very low, with an average of less than 400-500 milligrams per day, with Indonesia being one of the countries with the lowest intake levels (Balk et al., 2017). The recommended calcium intake for adolescent girls is 1,200 mg/day according to the Indonesian Recommended Dietary Allowance (Kementrian Kesehatan Republik Indonesia, 2019).

Premenstrual syndrome (PMS) affects lifestyle, daily activities, work, and various other activities (Barus et al., 2024). Research on high school students in Thailand found that PMS was significantly associated with various problems in educational activities. These problems include poor concentration, reduced motivation, decreased individual and collaborative performance, and low academic grades (Buddhabunyakan et al., 2017).

This study was conducted among female students attending a boarding school in Bogor, Indonesia. The nutritional adequacy of boarding school students is highly dependent on the food provided by schools (Asare et al., 2024). Previous studies have shown that students living in boarding schools have more limited food choices and lower dietary diversity than those living at home (Neda et al., 2023). Consistent with these findings, Majida et al. reported that students living at home consumed higher amounts of milk and dairy products than those living in dormitories (Majida et al., 2024). According to Minister of Health Regulation Number 41 of 2014, dietary diversity is one of the pillars of balanced nutrition, and adolescent girls are encouraged to consume a variety of foods to meet their macronutrient and

micronutrient needs that support growth (Menteri Kesehatan Republik Indonesia, 2014). Therefore, limited dietary diversity among boarding school students may increase the risk of inadequate calcium intake.

Although previous studies have reported an association between calcium intake and PMS symptoms, evidence on adolescents living in boarding school environments remains limited. Therefore, this study aimed to address this gap by focusing on a population with unique dietary conditions that may affect calcium intake and PMS symptom severity.

Based on this rationale, the hypothesis of this study is that there is a relationship between calcium intake and the severity of premenstrual syndrome (PMS) symptoms in high school students living in dormitories.

Methods

This quantitative study used a cross-sectional method and observational analytic design. This research was conducted at a boarding high school in Bogor.

The dependent variable was PMS symptom severity, assessed by completing the valid and reliable Shortened Premenstrual Assessment Form (SPAF) questionnaire. The Shortened Premenstrual Assessment Form (SPAF) is a shortened version of the Premenstrual Assessment Form (PAF). The SPAF consists of 10 items developed by Allen et al. It assesses the severity of premenstrual affective and somatic changes on a 6-point Likert scale: 1 = no change, 2 = very mild, 3 = mild, 4 = moderate, 5 = severe, and 6 = extreme. The total score can then be categorized as follows: a score of 10 indicates no PMS, 11–29 indicates mild PMS, 30–44 indicates moderate PMS, and 45–60 indicates severe/extreme PMS. Participants retrospectively completed the questionnaire by recalling the symptoms experienced during the premenstrual (luteal) phase of their most recent menstrual cycle (Allen & McBride, 1991; Joyce & Stewart, 2023; Masrurroh & Muniroh, 2021).

The independent variable was calcium intake, obtained by completing the 3×24-hour Estimated Food Record questionnaire. Prior to data collection, the research team observed the boarding school dining facilities to identify and document the serving utensils used by students, such as rice and vegetable ladles. Participants

were instructed to record food portions using these standardized serving utensils (e.g., number of ladles or tablespoons consumed) to facilitate portion size estimation. The recorded food intake data were analyzed to estimate the daily calcium intake.

The sample size formula for correlation tests was used to calculate the minimum sample size for this study (Dahlan, 2010). The formula is as follows.

$$n = \left(\frac{Z_{1-\alpha/2} + Z_{1-\beta}}{0.5 \times \ln \left(\frac{1+r}{1-r} \right)} \right)^2 + 3$$

Information:

- n = number of samples
- $Z_{(1-\alpha/2)}$ = Z value at a certain confidence level
- $Z_{1-\beta}$ = Z value at a certain test power
- r = expected correlation
- + 3 = used for conservative correction

There were no correlation data from similar studies on the same population; therefore, a correlation value of $r = 0.3$ was used based on Cohen's classification as a medium effect size (Cohen, 1992).

Based on this formula, a minimum sample size of 85 respondents was determined. The respondents were 11th and 12th grade female students at a boarding high school in the 2025/2026 academic year. Respondents were selected using Proportionate Random Sampling. The population was divided by grade level (11th and 12th), and the sample size for each class was determined proportionately. Eligible students were identified from the official class list provided by the school. Within each grade, the names of eligible students were randomized, and participants were selected from the randomized list by choosing students in odd-numbered positions until the required sample size was reached. This procedure ensured that all eligible students had an equal opportunity to be included in this study.

The respondents were female students who met the inclusion criteria: aged 15-18, currently attending a boarding school in Bogor, having experienced menstruation for at least two years, willing to participate and sign informed consent, and following the school-provided diet and types. Respondents were also not allowed to meet exclusion criteria, such as consuming calcium supplements, vitamin D, or

hormonal medications. The respondents also had no history of diagnosis or current reproductive system disorders. Respondents with a BMI >27.5, smoking habits, and those who did not complete the research questionnaire were also excluded.

The collected data were edited, coded, entered, and cleaned using Microsoft Excel. Subsequently, the analysis was conducted using GraphPad Prism 10. Univariate analysis was performed to describe each variable, and bivariate analysis was performed to analyze the relationship, direction, and strength of the association between calcium intake and PMS symptom severity. Spearman's correlation test was used. This study was conducted with ethical and moral values in mind and received ethical approval from the Health Research Ethics Committee of the Faculty of Medicine, Bandung Islamic University, No. 140/KEPK-Unisba/IX/2025.

Result and Discussion

Table 1. Characteristic of respondents (n=85)

Characteristics	Students
Age, n (%)	
15	5 (5.9)
16	47 (55.3)
17	32 (37.6)
18	1 (1.2)
Class, n (%)	
11	50 (58.8)
12	35 (41.2)
Age at menarche (years), mean $\pm$ SD	11.7 $\pm$ 1.1

Table 1 presents the respondents' characteristics. Most participants were 16 years old (55.3%), followed by 17 years (37.6%). More than half of the respondents were 11th grade students (58.8%), while 41.2% were 12th grade students. The mean age at menarche was 11.7 $\pm$ 1.1 years.

Univariate analysis was performed to obtain an overview of calcium intake and PMS severity. The analysis revealed that the calcium intake among the respondents was substantially below the recommended daily intake of 1,200 mg/day. Notably, even the highest recorded intake did not reach one-third of the recommended level, indicating a widespread

inadequacy of calcium intake among students. Normality testing showed that the calcium intake data were not normally distributed.

Table 2. Calcium intake and PMS severity characteristics (n=85)

Variable	Min	Max	Mean	SD
Calcium intake (mg/day)	30	331	121	63
SPAF Score (1-60)	11	45	26	7.7

This average calcium intake is far below the recommended dietary allowance (RDA). Even the maximum calcium intake was far from the recommended daily intake. Previous research has shown results consistent with those of this study. The average daily calcium intake in Asia is 400-500 mg/day (Balk et al., 2017). National research also indicates that the average calcium intake in Surabaya is 360 mg/day (Masruroh & Muniroh, 2021). This low calcium intake may be influenced by low calcium intake, as calcium can only be obtained from foods such as milk and dairy products, fish, green vegetables, and fortified foods (Fradista, 2023; Jelmila et al., 2023; Weaver & Peacock, 2019).

Calcium deficiency can disrupt muscle contraction, neurotransmitter synthesis and release, cell membrane permeability, and nerve transmission (Fradista, 2023; Masruroh & Muniroh, 2021). Calcium deficiency can also contribute to emotional and mood disturbances, as well as physical symptoms such as cramps, migraines, and swelling associated with PMS (Arab et al., 2020).

A descriptive analysis of the SPAF scores indicated that most respondents experienced mild PMS symptoms. Normality testing demonstrated that the SPAF scores were normally distributed ($p > 0.05$).

The average SPAF score in this study indicated that most respondents experienced mild PMS. This is consistent with research in high schools in Malang, where the average SPAF score was 23.51 $\pm$ 7.37, categorized as mild (Maulidiana et al., 2024). Another study of high schools in China also showed that the majority of respondents experiencing PMS experienced mild PMS (Shi et al., 2024). The tendency for PMS in adolescents is caused by fluctuations in ovarian hormones and the sensitivity of the central nervous system to these changes. PMS occurs

due to an exaggerated brain response to post-ovulatory ovarian hormone changes. During the luteal phase, increased progesterone levels are converted to allopregnanolone, which affects the sensitivity of GABA-A receptors. These changes in the GABA system disrupt the neurotransmitter balance, particularly that of serotonin. Progesterone metabolites increase monoamine oxidase activity, resulting in decreased serotonin levels, which triggers the emotional and behavioral symptoms of PMS (Imai et al., 2015).

Prolactin also plays a role in PMS, particularly during the luteal phase, where its increase can cause breast tenderness (Modzelewski et al., 2024). In addition to hormonal factors, PMS is influenced by the interaction of various factors, such as genetics, lifestyle, and diet, which are important factors. Certain nutritional deficiencies are known to exacerbate PMS symptoms through their effects on neurotransmitters and smooth-muscle contractions (Hashim et al., 2019).

Descriptive analysis results showed that the average calcium intake was very low, whereas the SPAF score indicated mild PMS symptom severity. The present study found a weak negative association between calcium intake and PMS severity. Lower calcium intake was associated with higher PMS severity scores, although the magnitude of this association was relatively small. However, the weak correlation coefficient suggests that PMS severity is not determined solely by calcium intake and may also be influenced by other factors, including nutritional status, psychological factors, and lifestyle factors.

Additionally, a bivariate analysis was conducted to determine the relationship between these two variables. Based on the

correlation analysis results in Table 3, a p-value of 0.04 was obtained. A p-value < 0.05 indicated a significant relationship between calcium intake and PMS symptom severity. Spearman's rank correlation analysis showed a weak negative correlation between calcium intake and PMS severity ($r=-0.21$). This indicates that a lower calcium intake is associated with a higher PMS score, and vice versa. This weak relationship indicates that other factors beyond calcium intake influence PMS symptom severity.

The weak correlation observed in this study suggests that calcium intake alone may not adequately explain variations in PMS severity in adolescents. PMS is a multifactorial condition influenced by biological, psychological, and lifestyle factors. Previous studies have reported that stress, physical activity, sleep quality, nutritional status, hormonal fluctuations, and the intake of other micronutrients, such as magnesium and vitamin D, may also contribute to the development and severity of PMS symptoms. These factors were not comprehensively assessed in the present study and may partly explain the relatively weak association observed between calcium intake and PMS severity (Alquaiz et al., 2022; Hashim et al., 2019; Mohebbi et al., 2017; Yonkers & Simoni, 2018).

The 95% Confidence Interval (CI: -0.413 to 0.005) indicates considerable uncertainty regarding the precision of the estimated correlation. Although the p-value suggests statistical significance, the confidence interval crossed zero, indicating that the true association may be weaker than estimated or may be absent. Therefore, the observed relationship should be interpreted with caution and requires confirmation in studies with larger sample sizes in the future.

Table 3. Relationship between calcium intake and severity of premenstrual syndrome symptoms

Variable	Mean	Spearman's (r)	95% CI	p-value*
Calcium intake (mg/day)	121±63	-0.21	-0.41 - 0.005	0.04
SPAF Score (1-60)	26±7.7			

*Significant at $p < 0.05$

This relationship can be explained by the biological role of calcium in PMS. PMS is associated with an abnormal neurotransmitter response to hormonal fluctuations in the luteal phase, including increased progesterone and decreased estrogen levels, which affect the serotonergic and GABAergic systems, resulting in decreased serotonin and GABA levels. These

changes contribute to the emotional and behavioral symptoms of PMS (Casanova et al., 2019; Imai et al., 2015). This condition can be exacerbated by a low calcium intake.

Calcium plays a vital role in the transmission of nerve impulses and muscle contraction and in relaxation. Calcium deficiency can disrupt these functions, triggering cramps

and pain (Fradista, 2023). Furthermore, the balance of intracellular and extracellular calcium influences the synthesis and release of neurotransmitters, particularly serotonin; therefore, disrupted calcium levels can impact mood and stress responses (Arab et al., 2020; Du et al., 2022).

Although the confidence interval indicates a low correlation strength and the influence of other factors, such as vitamin D, magnesium, stress, and physical activity, these findings still support the hypothesis that low calcium intake is associated with increased severity of PMS symptoms (Hashim et al., 2019; Mohebbi et al., 2017). Therefore, adequate calcium intake may be associated with lower PMS symptom severity among adolescent girls, although the relationship appears to be modest and may be influenced by other biological and lifestyle factors.

Several limitations should be considered when interpreting the findings of this study. Calcium intake was measured using a 3×24-hour Estimated Food Record, which relied on participants' self-reporting and may have contained reporting errors. PMS symptom severity was assessed retrospectively using the PMS Assessment Form (SPAF) questionnaire based on symptoms experienced during the last menstrual cycle, which may have been affected by recall bias. In addition, although some potential confounders were addressed through the exclusion criteria, several factors were not measured, including psychological stress, magnesium intake, vitamin D status, sleep quality, and physical activity. These factors are associated with hormonal regulation, mood stability, and pain perception, which may be related to PMS symptoms. Therefore, the potential influence of unmeasured confounding factors should be considered when interpreting the findings. Furthermore, the observed correlation was weak, and the 95% confidence interval crossed zero, indicating uncertainty regarding the precision of the estimated association. The cross-sectional design of this study limits our ability to determine the timing of the relationships and draw causal conclusions between calcium intake and PMS severity. Future longitudinal or interventional studies with larger sample sizes are needed to clarify these associations.

Conclusion

This study showed that calcium intake was significantly associated with the severity of PMS symptoms among adolescent girls living in dormitories. Meeting the daily calcium intake requirements is an important effort to reduce the severity of PMS symptoms.

Therefore, schools and dormitories should improve education on balanced nutrition for female students and prioritize providing calcium-rich menus, such as milk, dairy products, fish, and green vegetables, to meet daily calcium intake requirements, thus supporting reproductive health and preventing the risk of PMS in female students.

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