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RELATIONSHIP BETWEEN SERUM CALCIUM LEVELS, BODY MASS INDEX (BMI), AND PHYSICAL ACTIVITY WITH THE SEVERITY OF PREMENSTRUAL SYNDROME (PMS) AMONG UNDERGRADUATE MIDWIFERY STUDENTS

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ABSTRACT
PMS is a collection of physical, emotional, and behavioral symptoms that occur prior to menstruation in most women of reproductive age. The severity of PMS symptoms is suspected to be related to serum calcium levels, and may also be influenced by confounding factors such as BMI and physical activity. Analyze the relationship between serum calcium levels, BMI, and physical activity with the severity of PMS. Serum calcium levels through blood tests using the direct colorimetric test method (arsenazo III), assessed PMS severity using the Premenstrual Symptoms Screening Tool (PSST) questionnaire, calculated BMI based on body weight and height data, and measured physical activity using the Global Physical Activity Questionnaire (GPAQ). This study used a cross-sectional design. The study sample consisted of 45 female students, selected using a purposive sampling technique. The relationship between calcium levels and PMS severity was analyzed using the Mann–Whitney test, while the relationships between BMI and physical activity with PMS severity were analyzed using the Chi-square test. The median serum calcium level of respondents was 9.70 mg/dL. Most respondents (68.9%) fell into the no-PMS or mild-PMS category, while 31.1% experienced moderate to severe PMS. The results showed that serum calcium levels were significantly associated with PMS severity (p=0.019). BMI (p=0.746) and physical activity (p=0.717) were not significantly associated with PMS severity. The study is that serum calcium levels are associated with PMS severity. BMI and physical activity are not associated with PMS severity. Female students are encouraged to make efforts to prevent PMS severity by meeting their calcium needs.

Keywords: BMI; midwifery students; physical activity; premenstrual syndrome; serum calcium levels

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INTRODUCTION

Premenstrual syndrome (PMS) is a cluster of cyclic physical, emotional, and behavioral symptoms occurring during the luteal phase that automatically subside with the onset of menstruation. The American College of Obstetricians and Gynecologists (ACOG) defines PMS based on the occurrence of at least one emotional and one physical symptom during the luteal phase severe enough to impair daily activities (ACOG, 2023). Globally, the prevalence of PMS is estimated at 47.8% (Modzelewski et al., 2024), whereas in Indonesia it is reported to reach 85% among reproductive-aged women (Suparman, 2013). Among Indonesian female adolescents and university students, reported prevalence ranges from 51.8% to 85% (Wijayanti et al., 2022; Lumingkewas et al., 2021; Daiyah et al., 2021). The variation in symptom severity which disrupts academic, occupational, and social functioning underscores PMS as a significant reproductive health concern.

The pathophysiology of PMS involves neuroendocrine dysregulation driven by fluctuations in estrogen and progesterone, which disrupt serotonin signaling and GABA-A receptor function (Hantsoo & Epperson, 2020). Calcium plays a critical role in neuromuscular function, signal

transduction, and neurotransmitter release (Shaker & Deftos, 2023). Consequently, altered calcium homeostasis may heighten neuromuscular sensitivity and exacerbate emotional and physical PMS symptoms (Arab et al., 2020). Numerous observational studies have found lower serum calcium levels in women with PMS and supplementation trials consistently demonstrate symptom alleviation (Arab et al., 2020; Abdul-Razzak et al., 2024; Mohammed & Saikia, 2020; Shobeiri et al., 2017; Robinson et al., 2025).

However, observational evidence regarding circulating total serum calcium and PMS severity remains inconsistent. Large prospective cohorts, such as the Nurses' Health Study II, observed no direct association between total plasma calcium and PMS risk (Bertone-Johnson et al., 2014). This inconsistency stems from strict physiological regulation by the parathyroid hormone–vitamin D axis, calcium-to-magnesium ratios, and potential confounding variables—notably Body Mass Index (BMI) and physical activity (Goltzman et al., 2018; Moslehi et al., 2019). BMI reflects adipose tissue accumulation that regulates aromatase activity and estrogen synthesis (Thakur et al., 2022), whereas physical activity modulates systemic endorphin levels and bone calcium metabolism (Dózsa-Juhász et al., 2023; Johannes et al., 2024).

The discrepancy between the proven therapeutic efficacy of calcium supplementation and conflicting observational data regarding serum calcium levels highlights a gap in understanding how systemic calcium levels interact with PMS. Therefore, this study aims to evaluate the relationship between serum calcium levels and PMS severity among undergraduate midwifery students at Andalas University. This population represents young women of reproductive age exposed to academic stressors who are also future healthcare professionals responsible for managing women's reproductive health.

METHOD

This study was a quantitative analytical observational study using a cross-sectional design, conducted at the Undergraduate Midwifery Study Program, Faculty of Medicine, Universitas Andalas, Padang, from February to June 2026. The study population comprised all 81 undergraduate midwifery students of the 2024 cohort, with the sample size calculated using the Lemeshow formula (Z=1.96; p=0.70; d=0.10), yielding 45 respondents after a 10% correction to anticipate dropout; respondents were selected using a purposive sampling technique based on inclusion criteria (active students willing to participate, healthy and in the luteal phase, with a regular menstrual cycle of 21–35 days over the preceding three months) and exclusion criteria (currently taking psychiatric medication, hormonal medication, calcium supplements, diuretics, or lithium; having a history of hormonal disorders, thyroid disorders, or medical conditions affecting serum calcium such as renal disorders, parathyroid disorders, or thyrotoxicosis; or not meeting pre-analytical requirements). The independent variable was serum calcium level, obtained from a venous blood sample (±2 mL), centrifuged, and analysed using a Clinical Chemistry Autoanalyzer with the Direct Colorimetric Test (Arsenazo III) method at the West Sumatra Provincial Health Laboratory, expressed in mg/dL on a ratio scale, while the dependent variable was PMS severity, assessed using the self-administered Premenstrual Symptoms Screening Tool (PSST) questionnaire and categorised on an ordinal scale into no PMS/mild PMS, moderate–severe PMS, and premenstrual dysphoric disorder (PMDD) according to the criteria of Steiner, Macdougall, and Brown (2003). Two confounding variables were also collected as respondent characteristics: BMI, calculated from self-reported body weight and height using the formula weight (kg) divided by height squared (m^2) and categorised as underweight, normal, overweight, obesity I, or obesity II according to the Indonesian Ministry of Health (2018); and physical activity, measured using the Global Physical Activity Questionnaire (GPAQ), converted into Metabolic Equivalent (METs-minutes/week) values, and categorised as low, moderate, or high according to WHO (2012). Collected data were processed through editing, coding, scoring, and entry stages using Statistical Program for Social Science (SPSS) software, then analysed univariately to describe respondent

characteristics, PMS severity distribution, and serum calcium level, and bivariately using the Mann-Whitney test to examine the association between serum calcium (numerical data that were not normally distributed based on the Shapiro-Wilk test, $p<0.05$) and PMS severity, and the chi-square test to examine the associations of BMI and physical activity, as confounding variables, with PMS severity, with statistical significance set at $p<0.05$. This study received ethical approval from the Research Ethics Committee of the Faculty of Medicine, Universitas Andalas, with certificate number 304/UN16.2/KEP-FK/2026, and all respondents voluntarily signed an informed consent form after receiving an explanation of the study's purpose, procedures, benefits, and confidentiality.

RESULT

Data collection was carried out in June 2026 on 45 undergraduate midwifery students at the Faculty of Medicine, Universitas Andalas. Respondent characteristics based on age, BMI, and physical activity are presented in Table 1.

Table 1.
Frequency Distribution of Respondent Characteristics (n = 45)

Characteristic	f	%
Age		
< 20 years	17	37.8
≥ 20 years	28	62.2
Body Mass Index		
Underweight	10	22.2
Normal	19	42.2
Overweight	4	8.9
Obesity I	9	20.0
Obesity II	3	6.7
Physical Activity		
Moderate	11	24.4
Low	34	75.6

Table 1 shows that most respondents were aged ≥20 years (62.2%), had a normal BMI (42.2%), and had low physical activity (75.6%).

Table 2.
Distribution of PMS Severity (n = 45)

PMS Severity Category	f	%
No PMS/Mild PMS	31	68.9
Moderate–Severe PMS	14	31.1

Table 2, the majority of respondents fell into the no PMS/mild PMS category (68.9%), while 31.1% experienced moderate–severe PMS, and no respondent met the criteria for PMDD.

Table 3.
Serum Calcium Level (n = 45)

Variable	n	Median	Min-Max
Serum Calcium Level (mg/dL)	45	9.70	8.7-10.6

Table 4.
Association of Serum Calcium Level, BMI, and Physical Activity with PMS Severity

Variable	PMS/Mild PMS	Moderate–Severe PMS	p
Serum Calcium Level			
Serum calcium, median (min–max), mg/dL	9.60 (8.7–10.2)	9.85 (9.4–10.6)	0.019*
BMI			
Normal BMI, n	14	5	0.746
Abnormal BMI, n	17	9	
Physical Activity			
Low physical activity, n	24	10	
Moderate physical activity, n	7	4	0.717

**significant at p<0.05 (Mann-Whitney test for calcium; chi-square test for BMI and physical activity)*

Based on table 3, the median serum calcium level of respondents was 9.70 mg/dL, with a minimum of 8.7 mg/dL and a maximum of 10.6 mg/dL, generally within the normal range. The results of the bivariate analysis on the associations between serum calcium level, BMI, and physical activity with PMS severity are presented in Table 4. The Mann-Whitney test showed that the median serum calcium level in the no PMS/mild PMS group was 9.60 mg/dL (range 8.7–10.2 mg/dL), lower than that in the moderate–severe PMS group at 9.85 mg/dL (range 9.4–10.6 mg/dL), with p=0.019 (p<0.05), indicating a significant association between serum calcium level and PMS severity. In contrast, the chi-square test showed no significant association between BMI and PMS severity (p=0.746), nor between physical activity and PMS severity (p=0.717).

DISCUSSION

Serum calcium level in this study was significantly associated with PMS severity (p=0.019); however, the direction of the association was contrary to common assumptions, with the moderate–severe PMS group actually showing a higher median calcium level than the no PMS/mild group. This pattern differs from several studies, such as Mohammed and Saikia (2020) in India and Abdul-Razzak et al. (2024) in Jordan, which reported that lower calcium was associated with more severe PMS, but is consistent with the inconsistency previously reported, for example by Bahrami et al. (2018) and the systematic review by Arab et al. (2020), which found no consistent association between calcium status and PMS.

This phenomenon can be explained by several biological and methodological limitations. First, total serum calcium testing does not distinguish the physiologically active ionised calcium fraction from the protein-bound fraction, so an apparently high total level does not necessarily reflect the active calcium acting on the nervous system and muscles (Shaker & Deftos, 2023; Choy et al., 2025; Desgagnés et al., 2025). Second, serum calcium is tightly regulated by the parathyroid hormone–vitamin D axis; when vitamin D intake or status is inadequate, parathyroid hormone release draws calcium from bone to maintain serum calcium levels, so a level measured at a single time point does not always reflect long-term calcium status or biological availability (Goltzman et al., 2018; Abdi et al., 2019). Third, the interaction between calcium and magnesium is also important, as a high calcium-to-magnesium (Ca/Mg) ratio accompanied by magnesium deficiency can cause neural hyperexcitability and worsen PMS symptoms even when calcium levels appear adequate or high (Shamberger, 2003; Barbagallo et al., 2021). Because this study did not measure magnesium or vitamin D levels, the interpretation of the association between calcium alone and PMS may not fully capture what is likely an interactive mechanism. In addition, the cross-sectional design opens the possibility of reverse causation bias, for example, women with more severe PMS symptoms may consciously increase their consumption of dairy products or calcium supplements as a form of self-medication, resulting in a higher measured calcium level at the time of assessment (Bertone-Johnson et al., 2014).

BMI was not significantly associated with PMS severity in this study (p=0.746), consistent with studies by Lunardi et al. (2023), Sembiring et al. (2025), and Fatmawati and Muliawati (2022), which likewise found no meaningful association between nutritional status based on BMI and PMS incidence. This may be explained by the fact that BMI only reflects the proportion of weight to height and does not necessarily capture actual body composition related to adipose tissue hormonal activity, such as body fat percentage or central fat distribution, which have been reported to be more relevant to PMS severity in several recent studies (Ozkan et al., 2026; Sharifan et al., 2023).

Physical activity also showed no significant association with PMS severity in this study (p=0.717). Most respondents fell into the low-to-moderate physical activity category with a narrow range of intensity, so the protective effect of physical activity on PMS severity, which typically only becomes apparent at moderate-to-vigorous intensity, may not yet have manifested (Shi et al., 2023). This finding is consistent with studies by Kroll-Desrosiers et al. (2017) and Yasmin et al. (2021),

which likewise found no meaningful association between physical activity and premenstrual symptoms. The self-reported measurement of physical activity using the GPAQ questionnaire may also introduce classification bias compared with objective measurement using an accelerometer.

Overall, although a statistically significant association was found between serum calcium level and PMS severity, the direction of the association being contrary to the initial hypothesis, together with the non-significant findings for BMI and physical activity as confounders, confirms that the calcium–PMS relationship is complex and influenced by many other factors beyond the scope of this study, such as vitamin D status, magnesium level, daily calcium intake, stress level, and genetic factors (Hantsoo & Epperson, 2020; Oboza et al., 2024).

CONCLUSION

Based on the results of this study, it can be concluded that the majority of undergraduate midwifery students at the Faculty of Medicine, Universitas Andalas, were aged ≥20 years, had a normal BMI, and engaged in low levels of physical activity; the majority of respondents fell into the category of having no PMS or mild PMS, with a median serum calcium level of 9.70 mg/dL; a statistically significant association was found between serum calcium levels and PMS severity (p=0.019), although the direction of this association was contrary to the initial hypothesis; meanwhile, BMI (p=0.746) and physical activity (p=0.717)—as confounding variables—were not significantly associated with PMS severity. Future research is recommended to employ a longitudinal or prospective cohort design, measure ionized calcium, vitamin D status, and magnesium levels, and statistically analyze confounding variables regarding the relationship between serum calcium levels and PMS severity.

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