

Physical Activity, Sleep Quality, Diet Quality and Menstrual Health in Female Adolescents
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ABSTRACT

Background: Menstrual cycle disturbances are commonly reported among female adolescents and may affect physical, psychological, and academic functioning. Lifestyle-related factors such as physical activity, sleep quality, and diet quality have been increasingly recognized as potential determinants of adolescent reproductive health.

Objective: This study aimed to examine the association between physical activity, sleep quality, diet quality, and menstrual cycle status among female adolescents in Jambi City, Indonesia.

Methods: A cross-sectional study was conducted among 312 female adolescents from two public senior high schools in Jambi City, Indonesia. Data were collected using validated questionnaires assessing physical activity (IPAQ-SF), sleep quality (PSQI), diet quality, stress level, and screen time, while anthropometric measurements were used to assess body mass index (BMI). The outcome variable was classified as normal or abnormal menstrual cycle status based on standardized adolescent menstrual criteria. Chi-square tests and multivariable logistic regression were performed to identify associated factors. The final model was adjusted for age, age at menarche, BMI status, stress level, screen time, parental education, and socioeconomic status. Model diagnostics included Hosmer–Lemeshow goodness-of-fit test and area under the curve (AUC).

Results: The prevalence of abnormal menstrual cycle status was 46.8%. Bivariate analysis showed significant associations between menstrual status and low physical activity, poor sleep quality, and poor diet quality ($p < 0.001$). In multivariable analysis, poor sleep quality was the strongest associated factor (AOR = 3.27; 95% CI: 1.89–5.66), followed by low physical activity (AOR = 2.84; 95% CI: 1.61–5.02), poor diet quality (AOR = 2.41; 95% CI: 1.37–4.23), and high stress level (AOR = 2.16; 95% CI: 1.23–3.78). The model showed acceptable fit (Hosmer–Lemeshow $p = 0.41$) and good discrimination (AUC = 0.78).

Conclusion: Sleep quality, physical activity, diet quality, and stress level were significantly associated with abnormal menstrual cycle status among female adolescents.

Keywords: Menstrual Health, Physical Activity, Sleep Quality, Diet Quality, Stress, Adolescents, Reproductive Health.

INTRODUCTION

Adolescence represents a critical developmental stage characterized by rapid biological, psychological, and social changes that significantly influence future health outcomes, including reproductive health (Harvey et al., 2025; Negi et al., 2018). Among female adolescents, menstrual function is an important indicator of reproductive endocrine stability, as menstrual regularity reflects hypothalamic–pituitary–ovarian (HPO) axis functioning. Disruptions in menstrual patterns during this period may not only reflect underlying physiological imbalance but also affect academic performance, emotional well-being, and participation in daily activities. In this context, menstrual health problems can be understood as a multidimensional outcome influenced by interacting biological and behavioral determinants rather than a purely gynecological condition.

Recent evidence suggests that adolescent health profiles are increasingly shaped by lifestyle transitions, including reduced physical activity, irregular sleep patterns, and suboptimal dietary behaviors (Paes et al., 2025b, 2025a). These behavioral changes are not isolated phenomena but tend to cluster within modern adolescent lifestyles, particularly in urban school settings where academic pressure and digital exposure are high. From a theoretical perspective, these behaviors may influence reproductive function through metabolic regulation, stress-response pathways, and endocrine signaling, particularly via disruption of the HPO axis (Zhang et al., 2025). Thus, menstrual function is increasingly conceptualized within a biopsychosocial and energy balance framework rather than a single-factor model.

Physical activity, sleep quality, and dietary behavior are widely recognized as interrelated determinants of adolescent health outcomes (Zhang et al., 2025). Regular physical activity supports hormonal regulation, metabolic homeostasis, and psychological resilience, while physical inactivity is associated with increased adiposity, insulin resistance, and potential endocrine dysregulation (Cruz et al., 2024). Sleep quality is also a critical regulatory factor, as circadian misalignment and sleep deprivation may alter cortisol secretion, melatonin rhythms, and reproductive hormone signaling. Similarly, diet quality influences energy availability, micronutrient status, and inflammatory balance, all of which are essential for reproductive endocrine stability. Importantly, these three behaviors often interact synergistically, suggesting that their combined effect may be more relevant than their individual contributions.

Globally, menstrual health problems among adolescents remain highly prevalent and continue to be a public health concern. Previous international studies reported that approximately one-third to two-thirds of adolescent girls experience menstrual irregularities, including abnormal cycle length, prolonged menstruation, dysmenorrhea, and irregular bleeding patterns. Increasing sedentary behavior, declining physical activity levels, poor sleep quality, and unhealthy dietary practices have been identified as important contributors to these conditions (Fitriani et al., 2018; Isgin-Atici et al., 2020; Tada et al., 2017). However, much of the existing literature remains fragmented, often focusing on single behavioral factors and limited reproductive outcomes, thereby restricting a comprehensive understanding of lifestyle–reproductive health interactions.

In Indonesia, adolescent health surveys highlight persistent behavioral risk patterns, including insufficient physical activity, irregular sleep duration, and suboptimal dietary habits (Aningsih et al., 2025; Situmorang et al., 2025). Preliminary observations in SMA Negeri 6 and SMA Negeri 8 Jambi City also indicate similar patterns, where female students report irregular sleep schedules, inconsistent dietary habits, and varying engagement in physical activity despite the presence of school health programs. Nevertheless, empirical evidence integrating these

behaviors within a single analytical model in Indonesian school settings remains limited, particularly in relation to reproductive outcomes.

Although previous studies have examined associations between lifestyle factors and menstrual outcomes, most have focused on isolated variables or single symptom-based outcomes such as dysmenorrhea. This represents an important conceptual limitation, as menstrual function is a multidimensional construct encompassing cycle regularity, duration, and symptom burden. In addition, findings across studies remain inconsistent, particularly in adolescent populations from low- and middle-income countries, where sociocultural and environmental conditions may differ substantially from high-income settings. These gaps indicate the need for a more integrated analytical approach that considers multiple lifestyle behaviors simultaneously within a unified framework.

Therefore, this study aims to analyze the relationship between physical activity, sleep quality, and diet quality with menstrual health outcomes among female adolescents in two senior high schools in Jambi City, Indonesia. This study is grounded in a combined behavioral–endocrine framework, emphasizing the role of energy balance, circadian regulation, and lifestyle clustering in reproductive health outcomes. The findings are expected to support the development of school-based health promotion strategies that integrate physical activity promotion, sleep hygiene education, and nutritional guidance.

It is hypothesized that lower physical activity levels, poorer sleep quality, and inadequate diet quality are associated with a higher likelihood of menstrual disturbances among female adolescents.

METHODS

This study employed an analytical observational design using a cross-sectional approach to examine the association between physical activity, sleep quality, diet quality, and menstrual health among female adolescents. The cross-sectional design was selected because it allows simultaneous assessment of exposure variables and menstrual health outcomes within a defined population at a single point in time. This design is considered appropriate for identifying behavioral and lifestyle-related determinants associated with menstrual health among adolescents in school settings.

The study was conducted at SMA Negeri 6 and SMA Negeri 8, Jambi City, Indonesia. Both schools are public senior high schools located in urban areas of Jambi City and represent adolescent populations with relatively diverse socioeconomic and educational backgrounds. Data collection was conducted from August to October 2025 during the academic semester to ensure adequate student attendance and participation. Prior to data collection, coordination was conducted with school authorities, teachers, and school health units to facilitate implementation of the study procedures.

The target population consisted of all female students enrolled in grades 10 to 12 at both schools during the study period. The source population included female adolescents who had experienced menarche and were present during data collection. Participants were eligible if they met the following inclusion criteria: female students aged 15–18 years, had experienced menstruation for at least one year after menarche, were willing to participate voluntarily, and provided informed consent from both students and parents or guardians. Exclusion criteria included adolescents with previously diagnosed endocrine disorders such as polycystic ovary syndrome, thyroid disorders, diabetes mellitus, chronic renal disease, or reproductive disorders.

that could independently influence menstrual health; current use of hormonal therapy or oral contraceptives; and incomplete questionnaire responses.

The sample size was calculated using the single proportion formula for cross-sectional studies with multiple predictors. Based on previous Indonesian adolescent studies reporting a prevalence of menstrual cycle disturbances of approximately 50%, with a 95% confidence level ($Z = 1.96$), 5% margin of error ($d = 0.05$), and adjustment for 10% non-response rate, the minimum required sample size was estimated using the formula $n = Z^2P(1-P)/d^2$. This yielded a minimum sample of approximately 384 participants before adjustment; after accounting for non-response, the final minimum required sample size was approximately 422 participants. Proportional stratified random sampling was applied based on grade level to ensure balanced representation across educational strata. Student lists obtained from school administration were used as sampling frames, and participants were selected using computerized randomization.

The primary outcome variable was menstrual health status. For this study, menstrual health status was operationally redefined as a binary variable (normal vs. abnormal menstrual pattern) to improve analytical clarity. Abnormal menstrual status (menstrual health problem) was defined as the presence of at least one of the following conditions within the last six months: menstrual cycle length <21 days or >45 days, cycle variability exceeding 7 days between cycles, or menstrual bleeding duration >7 days or <2 days, based on ACOG adolescent menstrual guidelines. Participants not meeting any of these criteria were classified as having normal menstrual patterns. This operational definition was applied consistently for statistical modeling purposes.

The main exposure variables included physical activity, sleep quality, and diet quality. Physical activity was measured using the IPAQ-SF and categorized into low, moderate, and high levels based on MET-minutes/week. Sleep quality was assessed using the PSQI, with global scores >5 indicating poor sleep quality. Diet quality was assessed using a modified Adolescent Food Habit Checklist and categorized into good, moderate, and poor diet quality.

Covariates were classified into three groups for analytical clarity: (1) sociodemographic variables (age, parental education, socioeconomic status), (2) anthropometric variables (BMI-for-age), and (3) behavioral/psychosocial variables (age at menarche, screen time, and perceived stress). Stress level was measured using the PSS-10, and BMI was calculated using standard anthropometric procedures and categorized using WHO adolescent BMI-for-age standards. Data were collected using structured self-administered questionnaires and direct anthropometric measurements. Research assistants were trained prior to data collection to ensure standardization. Pilot testing was conducted on a small group outside the study population.

To reduce bias, random sampling was applied to minimize selection bias, and validated instruments were used to reduce information bias. Recall bias was minimized by restricting recall periods (7 days for physical activity and diet, 1 month for sleep quality, and 6 months for menstrual history). Social desirability bias was reduced through anonymity and supervised self-administration.

Data analysis was performed using IBM SPSS Statistics. Descriptive statistics were used to summarize participant characteristics. Bivariate analysis was conducted using chi-square tests. Variables with $p < 0.25$ in bivariate analysis and those with theoretical relevance were included in multivariable logistic regression. Before performing logistic regression, model assumptions were assessed, including (1) absence of multicollinearity using Variance Inflation Factor ($VIF < 10$), (2) linearity in the logit for continuous variables using the Box–Tidwell test, (3) independence of observations, and (4) adequacy of model fit using the Hosmer–Lemeshow goodness-of-fit test. Model discrimination was evaluated using the area under the ROC curve (AUC). Adjusted odds

ratios (AORs) with 95% confidence intervals were reported, and statistical significance was set at $p < 0.05$.

Ethical Approval

Ethical clearance for this study was obtained from the Health Research Ethics Committee of Poltekkes Kemenkes Jambi with Ethical Exemption Number LB.02.06/2/66/2025. The study was conducted in accordance with the principles of the Declaration of Helsinki. All participants were informed about the objectives and procedures of the study, and confidentiality of participant information was strictly maintained throughout the research process.

RESULTS

Table 1. Characteristics of Participants (n = 312*)

Variables	Frequency (n)	Percentage (%)
Age (years)		
15	74	23.7
16	128	41.0
17	92	29.5
18	18	5.8
Age at menarche		
<12 years	69	22.1
12–13 years	198	63.5
>13 years	45	14.4
Body mass index status		
Underweight	41	13.1
Normal	191	61.2
Overweight/obese	68	21.8
Missing data	12	3.9
Physical activity level		
Low	138	44.2
Moderate	112	35.9
High	62	19.9
Sleep quality		
Good sleep quality	130	41.7
Poor sleep quality	182	58.3
Diet quality		
Good	71	22.8
Moderate	76	24.3
Poor	165	52.9
Screen time duration		
Low (<4 hours/day)	124	39.7
High (≥ 4 hours/day)	188	60.3
Stress level		
Low stress	141	45.2
High stress	171	54.8
Parental educational level		
High	163	52.2
Low	149	47.8
Socioeconomic status		
High	137	43.9
Low	175	56.1

Menstrual health status		
Normal menstrual health	166	53.2
Menstrual health problems	146	46.8

Table 1 presents the characteristics of female adolescents. The majority of participants were aged 16 years (41.0%) and had menarche at 12–13 years (63.5%). Most respondents had normal BMI status (61.2%), while 21.8% were categorized as overweight/obese. Missing BMI data accounted for 3.9% of responses and were handled using listwise deletion in regression analysis due to their low proportion. Unhealthy lifestyle behaviors were common, including low physical activity (44.2%), poor sleep quality (58.3%), and poor diet quality (52.9%). Additionally, 60.3% reported high screen time and 54.8% reported high stress levels. Overall, 46.8% of respondents were classified as having menstrual problems based on the predefined operational criteria.

Table 2. Association Between Physical Activity Level and Menstrual Health Among Female Adolescents

Physical Activity Level	Normal Menstrual Health n (%)	Menstrual Health Problems n (%)	Total	p-value
Low	51 (37.0)	87 (63.0)	138	
Moderate	71 (63.4)	41 (36.6)	112	
High	44 (71.0)	18 (29.0)	62	< 0.001

Table 2 shows a significant association between physical activity and menstrual status ($p < 0.001$). The proportion of menstrual problems was highest among adolescents with low physical activity (63.0%) compared to those with moderate (36.6%) and high activity levels (29.0%).

Table 3. Association Between Sleep Quality and Menstrual Health Among Female Adolescents

Sleep Quality	Normal Menstrual Health n (%)	Menstrual Health Problems n (%)	Total	p-value
Good sleep quality	93 (71.5)	37 (28.5)	130	
Poor sleep quality	73 (40.1)	109 (59.9)	182	< 0.001

Table 3 indicates that sleep quality was significantly associated with menstrual status ($p < 0.001$). Adolescents with poor sleep quality showed a higher proportion of menstrual problems (59.9%) compared to those with good sleep quality (28.5%).

Table 4. Association Between Diet Quality and Menstrual Health Among Female Adolescents

Diet Quality	Normal Menstrual Health n (%)	Menstrual Health Problems n (%)	Total	p-value
Good	52 (73.2)	19 (26.8)	71	
Moderate	45 (59.2)	31 (40.8)	76	
Poor	69 (41.8)	96 (58.2)	165	< 0.001

Table 4 demonstrates a significant association between diet quality and menstrual status ($p < 0.001$). The prevalence of menstrual problems was highest among adolescents with poor diet quality (58.2%) and lowest among those with good diet quality (26.8%).

Table 5. Multivariable Logistic Regression of Factors Associated with Menstrual Problems

Variable	AOR	95% CI	p-value
Low physical activity	2.84	1.61–5.02	<0.001
Poor sleep quality	3.27	1.89–5.66	<0.001
Poor diet quality	2.41	1.37–4.23	0.002
High stress level	2.16	1.23–3.78	0.007
Age ≥17 years	1.21	0.73–2.01	0.452
Early menarche (<12 years)	1.64	0.98–2.83	0.074
Overweight/obese BMI	1.58	0.91–2.73	0.101
High screen time	1.44	0.88–2.42	0.139
Low parental education	1.32	0.79–2.19	0.281
Low socioeconomic status	1.49	0.89–2.50	0.126

Table 5 presents the results of multivariable logistic regression analysis. The final model was adjusted for all covariates including age, BMI status, age at menarche, screen time, stress level, parental education, and socioeconomic status. Poor sleep quality was the strongest predictor of menstrual problems (AOR = 3.27; 95% CI: 1.89–5.66), followed by low physical activity (AOR = 2.84; 95% CI: 1.61–5.02) and poor diet quality (AOR = 2.41; 95% CI: 1.37–4.23). High stress level was also significantly associated with increased odds of menstrual problems (AOR = 2.16; 95% CI: 1.23–3.78). Other covariates were not statistically significant.

Model diagnostics indicated acceptable goodness of fit (Hosmer–Lemeshow test, $p = 0.41$), suggesting that the model adequately fits the data. The model also demonstrated acceptable discrimination ability (AUC = 0.78), indicating good predictive performance. No multicollinearity was detected among independent variables (all VIF values < 2.5).

DISCUSSION

This study successfully identified significant associations between physical activity, sleep quality, diet quality, and menstrual health among female adolescents at SMA Negeri 6 Kota Jambi and SMA Negeri 8 Kota Jambi. The findings demonstrated that menstrual health problems were relatively common among respondents, with nearly half of the participants experiencing menstrual irregularities or related menstrual disturbances. The study objectives were achieved through the identification of lifestyle-related behavioral factors associated with menstrual health outcomes among adolescents. Among the investigated variables, poor sleep quality emerged as the strongest predictor of menstrual health problems, followed by low physical activity and poor diet quality. These findings indicate that adolescent menstrual health is strongly influenced by multidimensional behavioral and physiological factors rather than by isolated reproductive mechanisms. However, given the cross-sectional design, these findings should be interpreted as associations rather than causal relationships. The results also suggest that school-aged female adolescents are increasingly exposed to unhealthy lifestyle patterns that may disrupt hormonal balance and reproductive function during adolescence.

The significant relationship between physical activity and menstrual health found in this study is consistent with previous studies reporting that physically inactive adolescents have a higher risk of menstrual irregularities. A study conducted by Nattiv (Nattiv et al., 2007) reported that inadequate or excessive physical activity may disrupt hypothalamic-pituitary-ovarian axis regulation and contribute to menstrual dysfunction among young women. Similarly, research by De Sanctis (De Sanctis et al., 2016) showed that low physical activity levels were associated with poor reproductive health outcomes among adolescents. Another study by (Majeed et al., 2022) demonstrated that moderate physical activity contributed to improved menstrual regularity and reduced menstrual complaints among adolescent girls. These findings support the theory that regular physical activity improves insulin sensitivity, stabilizes body fat composition, reduces systemic inflammation, and enhances endorphin secretion, all of which contribute to hormonal balance and reproductive health regulation. In this study, adolescents with low physical activity levels may have experienced increased sedentary behavior, metabolic imbalance, and reduced cardiovascular fitness, thereby increasing susceptibility to menstrual disturbances (Baker & Driver, 2007). Nevertheless, this interpretation remains theoretical, as temporal directionality cannot be established from the present study design.

The present study also identified poor sleep quality as the strongest determinant of menstrual health problems among female adolescents. This finding aligns with previous studies indicating that sleep disturbances significantly influence reproductive hormonal regulation. Research by Baker (Baker & Driver, 2007) reported that poor sleep quality alters melatonin secretion, increases cortisol production, and disrupts circadian rhythm regulation, which may interfere with menstrual cycle stability. Similar findings were reported by Kiss et al (Kiss et al., 2024; Majeed et al., 2022), who found that adolescents with inadequate sleep duration and poor sleep quality were more likely to experience irregular menstruation and severe menstrual symptoms. Theoretically, sleep quality is closely linked to the hypothalamic-pituitary-ovarian axis because sleep deprivation increases physiological stress responses and dysregulates gonadotropin-releasing hormone secretion. Adolescents in this study may have experienced poor sleep quality due to academic demands, prolonged smartphone use, social media exposure, and irregular sleeping schedules. However, these contextual explanations were not directly measured in the present study and should therefore be interpreted cautiously as hypothesized contributing factors rather than confirmed determinants.

Diet quality was also significantly associated with menstrual health among female adolescents (Isgin-Atici et al., 2020). Respondents with poor dietary patterns had a higher prevalence of menstrual health problems compared with adolescents reporting healthier dietary behaviors. This finding is consistent with studies conducted by Cheng, Montero, and Fujiwara, which demonstrated that unhealthy dietary intake contributes to menstrual irregularities through metabolic and hormonal pathways. Poor diet quality may result in deficiencies of iron, magnesium, calcium, vitamin B complex, and essential fatty acids, which are important for reproductive endocrine function and uterine health. Frequent consumption of high-fat foods, sugary beverages, and ultra-processed foods may also increase inflammatory responses and insulin resistance, contributing to hormonal imbalance. Nevertheless, dietary intake in this study was self-reported and not quantitatively assessed, which may limit precision in estimating true dietary exposure. These findings emphasize that adolescent nutritional behaviors play important roles in maintaining reproductive health stability during adolescence (Günel, 2023; Mondal & Sahu, 2026).

The correlations among physical activity, sleep quality, and diet quality identified in this study indicate that adolescent menstrual health is influenced by interconnected lifestyle behaviors (Arslan & Deniz, 2025; Semplonius & Willoughby, 2018). Adolescents with low physical activity

levels frequently demonstrated poorer sleep quality and unhealthy dietary habits, suggesting clustering of unhealthy behaviors. This pattern is theoretically explained by the Biopsychosocial Model, which states that biological, psychological, and behavioral factors interact simultaneously in influencing health outcomes. Poor lifestyle behaviors may collectively affect neuroendocrine regulation, increase stress responses, alter metabolic homeostasis, and disturb reproductive hormone secretion. For example, inadequate physical activity may reduce sleep efficiency, while poor sleep quality may increase cravings for unhealthy foods and reduce motivation for physical exercise. These interactions contribute to cumulative physiological stress affecting menstrual regulation. However, because clustering was not analyzed using a longitudinal or behavioral pattern approach, these relationships should be interpreted as co-occurring associations rather than behavioral trajectories.

In addition, the findings may also be explained using the Energy Availability Theory and Hypothalamic-Pituitary-Ovarian Axis Theory. According to Energy Availability Theory, imbalance between energy intake and energy expenditure may disrupt reproductive function through impaired hormonal signaling pathways (Baroah et al., 2025; Domaradzki, 2025). Adolescents with inadequate nutrition combined with irregular physical activity may experience metabolic stress that interferes with ovarian function and menstrual regularity (Lim et al., 2018). Meanwhile, chronic sleep disturbances and psychological stress may increase cortisol secretion, suppress gonadotropin-releasing hormone release, and alter ovarian hormonal production. While these mechanisms are biologically plausible, the present study did not directly assess hormonal biomarkers; therefore, mechanistic explanations remain inferential. The interconnected nature of these variables suggests that menstrual health promotion among adolescents should not focus solely on reproductive education but also on broader healthy lifestyle interventions integrating physical activity, nutrition, and sleep management (Aningsih et al., 2025; Rahmayani et al., 2025).

The findings of this study have important implications for adolescent public health and school health promotion programs. The results indicate that improving menstrual health among adolescents requires integrated behavioral interventions targeting multiple modifiable lifestyle factors simultaneously. From an educational perspective, schools have a strategic role in embedding menstrual health education within physical education curricula, particularly through structured physical activity programs that promote regular exercise habits among female students. Schools may also implement health promotion strategies that integrate sleep hygiene education, balanced nutrition counseling, and reproductive health literacy within school health units. In addition, school-based physical education programs should emphasize not only fitness outcomes but also their relevance to hormonal balance and reproductive health, thereby strengthening students' understanding of the health benefits of active lifestyles. Such interventions may help reduce menstrual-related problems that interfere with academic performance, emotional well-being, and social participation among female students.

However, several limitations should be acknowledged. The cross-sectional design limits causal interpretation between variables, and self-reported questionnaires may increase the possibility of recall bias and reporting bias. In addition, the absence of objective measurements (e.g., hormonal assays, actigraphy for sleep, or accelerometer-based physical activity data) may reduce measurement precision and increase the risk of misclassification bias. Furthermore, the study was conducted in two urban public schools in Jambi City, which may limit generalizability to adolescents from rural or different sociocultural settings. Future studies using longitudinal designs and objective behavioral measurements are recommended to better establish temporal relationships and strengthen causal inference. Despite these limitations, the study provides

important evidence regarding the multidimensional relationship between lifestyle behaviors and menstrual health among Indonesian female adolescents and contributes valuable insights for adolescent reproductive health promotion in educational settings.

CONCLUSION

This study demonstrated that physical activity, sleep quality, and diet quality were significantly associated with menstrual health among female adolescents at SMA Negeri 6 Kota Jambi and SMA Negeri 8 Kota Jambi. Adolescents with low physical activity levels, poor sleep quality, and inadequate diet quality were more likely to experience menstrual health problems compared with adolescents who maintained healthier lifestyles. Poor sleep quality was identified as the most dominant factor influencing menstrual health. These findings indicate that menstrual health among adolescents is influenced by interconnected behavioral and lifestyle-related factors.

Schools are expected to strengthen adolescent health promotion programs through education related to physical activity, healthy sleep patterns, and balanced nutritional intake to support female adolescent reproductive health. Adolescents are also encouraged to adopt healthier lifestyles in order to maintain menstrual health and overall quality of life. Future studies are recommended to apply longitudinal designs and involve larger populations to obtain a deeper understanding of causal relationships among the studied variables.

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