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Factors associated with anemia among adolescents in junior high school

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***Abstract*:**
Anemia remains a major public health problem among adolescents, particularly adolescent girls, due to its negative impact on physical growth, cognitive performance, and overall health status. This study aimed to analyze factors associated with anemia among adolescents at SMP K. Santo Gerardus Mayella Kalembuweri. A quantitative descriptive study with a cross-sectional design was conducted involving 80 adolescents from grades VII to IX selected using a total sampling technique. Data were collected using structured questionnaires to assess knowledge regarding anemia, dietary patterns, breakfast habits, menstrual characteristics, and adherence to iron tablet supplementation. Hemoglobin levels were measured using a digital hemoglobin testing device to determine anemia status. Data were analyzed using descriptive statistics and Chi-square tests to examine the association between independent variables and anemia status. The findings showed that 52.5% of respondents were classified as anemic. Chi-square analysis revealed significant associations between anemia and knowledge regarding anemia ($p = 0.012$), dietary patterns ($p = 0.001$), menstrual characteristics ($p = 0.020$), breakfast habits ($p = 0.008$), and adherence to iron tablet supplementation ($p < 0.001$). Adolescents with poor dietary patterns, irregular breakfast habits, prolonged menstruation, low knowledge levels, and poor adherence to iron supplementation were more likely to experience anemia. Dietary patterns and adherence to iron tablet supplementation emerged as the most dominant factors associated with anemia occurrence. The study concludes that adolescent anemia is influenced by multiple interrelated behavioral and physiological factors. Comprehensive school-based interventions focusing on nutrition education, healthy dietary practices, menstrual health awareness, and regular iron supplementation are recommended to reduce anemia prevalence among adolescents.

***Keywords*:**
anemia; breakfast; diet; iron; menstruation

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INTRODUCTION

Anemia remains a major global public health problem among adolescents, particularly adolescent girls, due to its substantial impact on physical growth, cognitive performance, academic productivity, and future reproductive health outcomes. The World Health Organization identifies iron deficiency anemia as one of the most prevalent nutritional disorders worldwide, especially in low-

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and middle-income countries where nutritional inadequacies and limited health literacy persist among young populations. During adolescence, rapid growth and increased physiological demands significantly elevate iron requirements, making adolescents more vulnerable to hemoglobin deficiency when nutritional intake is inadequate. Persistent anemia during adolescence may lead to fatigue, impaired concentration, decreased immunity, reduced school performance, and long-term adverse reproductive consequences (Lubis et al., 2025).

In Indonesia, anemia among adolescents continues to be a serious health concern, particularly among female students at junior and senior high school levels. The high prevalence of anemia is associated with inadequate dietary intake, poor eating habits, low adherence to iron-folic acid supplementation, and insufficient knowledge regarding balanced nutrition and anemia prevention. Adolescent girls are biologically more susceptible because menstrual blood loss increases iron depletion every month. Furthermore, modern dietary transitions characterized by increased fast-food consumption and breakfast skipping behaviors have further contributed to poor nutritional status among adolescents. Previous studies in Indonesia have demonstrated that many adolescent girls still show low compliance with iron tablet consumption despite the implementation of national school-based supplementation programs (Hidayanty et al., 2025).

Recent studies have demonstrated that adolescent anemia is influenced by multidimensional and interconnected factors, including nutritional knowledge, dietary patterns, menstrual characteristics, breakfast habits, and adherence to iron supplementation programs. Adolescents with poor dietary practices, particularly low consumption of iron-rich foods and vitamin C sources, are more likely to experience lower hemoglobin levels compared with those who maintain balanced nutritional intake. In addition, prolonged menstruation and excessive menstrual blood loss have been consistently identified as significant contributors to anemia among adolescent girls (Wulandari et al., 2024). A recent systematic review also emphasized that school-based nutrition education interventions are effective in improving adolescents' awareness and preventive behaviors regarding anemia and iron supplementation (Febrianti et al., 2023).

Although numerous studies regarding adolescent anemia have been conducted, most previous investigations have primarily focused on single determinants such as dietary intake or iron supplementation adherence alone, without comprehensively examining multiple contributing factors simultaneously. Furthermore, many studies were conducted among older adolescents or senior high school students, whereas evidence regarding early adolescents aged 12–14 years remains relatively limited. Contextual differences related to socioeconomic conditions, local dietary culture, and access to health education may also influence the pattern of anemia determinants across different regions. Therefore, contextualized studies examining various risk factors collectively among junior high

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school adolescents are still urgently needed to provide more comprehensive evidence regarding anemia among Indonesian adolescents (Maubesi et al., 2025).

The current state-of-the-art evidence suggests that anemia prevention strategies among adolescents should not solely rely on iron supplementation but also integrate nutrition education, healthy eating promotion, behavioral modification, and strengthening school-based health programs. Recent Indonesian studies have shown that school health promotion interventions effectively improve adolescents' knowledge and awareness regarding anemia prevention and iron tablet consumption. However, implementation barriers such as fear of side effects, poor motivation, lack of family support, and inadequate monitoring systems remain substantial challenges affecting adolescents' compliance with supplementation programs (Irmayanti et al., 2025). These findings indicate that adolescent anemia is a multifactorial health problem requiring comprehensive preventive approaches involving behavioral, educational, and physiological dimensions simultaneously.

This study offers novelty by comprehensively analyzing multiple determinants of anemia among junior high school adolescents, including nutritional knowledge, dietary patterns, menstrual characteristics, breakfast habits, and adherence to iron tablet consumption within a single contextual framework at SMP K. Santo Gerardus Mayella Kalembuweri. Unlike many previous studies that focused on isolated determinants, this study addresses the interaction of behavioral and biological factors influencing anemia among early adolescents in a local school-based setting that has received limited scientific attention. The findings are expected to enrich local evidence regarding adolescent anemia determinants and contribute to the development of context-specific intervention strategies in Indonesia.

Therefore, this study aims to analyze the factors associated with anemia among adolescents at SMP K. Santo Gerardus Mayella Kalembuweri. The study is considered urgent because its findings may provide an evidence-based foundation for strengthening school-based nutrition education, improving adherence to iron supplementation programs, and developing integrated preventive interventions to reduce anemia prevalence among adolescents. In addition to contributing to public health and community nursing knowledge, this study also supports broader efforts to improve adolescent health as an essential investment in future human capital development.

METHODS

This study employed a quantitative descriptive design with a cross-sectional approach to identify factors associated with anemia among adolescents at SMP K. Santo Gerardus Mayella

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Kalembuweri. The cross-sectional design was selected because it allows the simultaneous assessment of exposure variables and anemia status within a single observation period. This design was considered appropriate for describing the prevalence of anemia and for examining the relationships among knowledge, dietary patterns, menstrual characteristics, breakfast habits, and adherence to iron supplementation among adolescents.

The study was conducted at SMP K. Santo Gerardus Mayella Kalembuweri involving adolescent students enrolled in grades VII to IX. The target population consisted of all students attending the school during the data collection period. Given the relatively small population, the study used a total sampling approach, recruiting all eligible students as study participants. A total of 80 adolescents participated in this study. Inclusion criteria included students who were willing to participate, were present during data collection, and were able to complete the questionnaire independently. Students with incomplete data or who declined hemoglobin examination were excluded from the study.

The dependent variable in this study was anemia status, while the independent variables included knowledge regarding anemia, dietary patterns, menstrual characteristics, breakfast habits, and adherence to iron tablet supplementation. Anemia status was determined based on hemoglobin levels measured with a digital hemoglobin testing device; hemoglobin levels below 12 g/dL were categorized as anemia according to adolescent female anemia criteria.

Knowledge regarding anemia was assessed using a structured questionnaire developed based on adolescent nutrition and anemia prevention concepts. The questionnaire evaluated participants' understanding of anemia causes, symptoms, prevention strategies, and the importance of iron intake. Dietary patterns were assessed using an observation sheet that explored the frequency of consumption of iron-rich foods, vegetables, and fruits, as well as breakfast habits. Menstrual characteristics were categorized by menstrual duration and bleeding patterns, with particular attention to menstruation lasting 7 days or longer. Adherence to iron tablet supplementation was measured by the regularity of consumption of iron-folic acid tablets distributed through school health programs.

Data collection was conducted after obtaining permission from the school administration and informed consent from participants. Participants were first asked to complete the structured questionnaire under the researcher's supervision to ensure complete and clear responses. Subsequently, observational assessments regarding dietary habits and breakfast practices were conducted using standardized forms. Hemoglobin levels were then measured individually using a portable digital hemoglobin device operated according to the manufacturer's standard procedures. All collected data were checked for completeness before analysis.

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The collected data were analyzed using descriptive and inferential statistical approaches. Descriptive statistics were used to summarize participant characteristics and study variables, including frequencies, percentages, means, and standard deviations where appropriate. The association between independent variables and anemia status was analyzed using the Chi-square test to determine statistical significance. A p-value of less than 0.05 was considered statistically significant. Data analysis was performed using statistical software to ensure the accuracy and reliability of the findings.

This study adhered to ethical principles involving human participants, including voluntary participation, confidentiality, anonymity, and the right to withdraw from the study at any stage without consequences. Prior to data collection, participants were informed about the study objectives, procedures, benefits, and confidentiality of their responses. Permission to conduct the study was obtained from the school administration, and all participant data were securely maintained and used solely for research purposes.

RESULTS

A total of 80 adolescents participated in this study. Most respondents were aged 12-14, and the majority were female students. The findings revealed that more than half of the participants experienced anemia, indicating that anemia remains a significant health problem among adolescents at SMP K. Santo Gerardus Mayella Kalembuweri.

Table 1. Distribution of Factors Associated with Anemia Among Adolescents (n = 80)

Variable	Category	Frequency (n)	Percentage (%)
Knowledge	Good	25	31.2
	Moderate	30	37.5
	Poor	25	31.2
Dietary patterns	Good	20	25.0
	Moderate	35	43.7
	Poor	25	31.2
Menstrual characteristics	Normal	40	50.0
	Abnormal (≥7 days)	40	50.0
Breakfast habits	Regular	28	35.0
	Irregular	52	65.0
Iron tablet supplementation	Regular	15	18.7
	Irregular	65	81.2
Anemia status (Hb <12 g/dL)	Anemia	42	52.5
	Non-anemia	38	47.5

Table 1 presents the distribution of variables related to anemia among adolescents. Regarding knowledge of anemia, most respondents had moderate knowledge (37.5%), while the proportions

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with good and poor knowledge were equal (31.2% each). Regarding dietary patterns, nearly half of the participants (43.7%) had moderate dietary habits, whereas 31.2% had poor dietary habits.

Menstrual characteristics showed that half of the female respondents experienced abnormal menstruation lasting seven days or longer. Regarding breakfast habits, the majority of respondents reported irregular breakfast consumption (65.0%). Similarly, adherence to iron tablet supplementation was low, with only 18.7% of adolescents regularly taking them. Hemoglobin testing showed that 52.5% of respondents were anemic.

Table 2. Association Between Independent Variables and Anemia Status Among Adolescents

Variable	p-value	Interpretation
Knowledge regarding anemia	0.012	Significant association
Dietary patterns	0.001	Highly significant association
Menstrual characteristics	0.020	Significant association
Breakfast habits	0.008	Significant association
Iron tablet supplementation adherence	<0.001	Highly significant association

Chi-square analysis demonstrated that all investigated variables were significantly associated with anemia among adolescents. Knowledge regarding anemia was significantly associated with anemia status ($p = 0.012$), indicating that adolescents with lower knowledge levels were more likely to experience anemia. Dietary patterns showed a highly significant relationship with anemia ($p = 0.001$), suggesting that inadequate nutritional intake substantially contributed to lower hemoglobin levels. Menstrual characteristics were also significantly associated with anemia occurrence ($p = 0.020$). Female adolescents who experienced prolonged menstruation or excessive menstrual bleeding were more vulnerable to anemia due to increased iron loss during menstruation. Breakfast habits showed a significant association with anemia status ($p = 0.008$): adolescents who frequently skipped breakfast had a higher risk of anemia than those who regularly consumed breakfast. Furthermore, adherence to iron tablet supplementation emerged as the most significant factor associated with anemia ($p < 0.001$). Adolescents who did not regularly take iron tablets had a substantially higher prevalence of anemia than those who adhered to supplementation programs.

DISCUSSION

The findings of this study demonstrated that anemia among adolescents at SMP K. Santo Gerardus Mayella Kalembuweri was significantly associated with multiple interrelated factors, including knowledge regarding anemia, dietary patterns, menstrual characteristics, breakfast habits, and adherence to iron tablet supplementation. Among these variables, dietary patterns and

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adherence to iron supplementation emerged as the most dominant determinants associated with anemia status. More than half of the respondents were classified as anemic, indicating that adolescent anemia remains a major nutritional and public health concern requiring comprehensive preventive interventions. These findings suggest that anemia among adolescents cannot be explained by a single determinant but rather reflects the interaction between behavioral, physiological, and nutritional factors that collectively influence hemoglobin levels and adolescent health outcomes.

The results of this study are consistent with previous international and national studies reporting that inadequate dietary intake, low adherence to iron supplementation, and menstrual-related blood loss are major predictors of anemia among adolescent girls. A systematic review found that poor nutritional practices and insufficient iron intake substantially increase the risk of anemia among adolescents in developing countries (Hidayanty et al., 2025). Similarly, studies conducted in Southeast Asia and Sub-Saharan Africa have shown that adolescents with unhealthy eating behaviors, low nutrition literacy, and poor compliance with supplementation programs exhibit significantly lower hemoglobin levels than those who maintain healthier lifestyles (Mabry-Hernandez et al., 2022). The consistency between the current findings and previous literature strengthens the reliability of the present study and confirms that adolescent anemia remains a multifactorial health issue across different sociocultural settings.

Knowledge regarding anemia was significantly associated with anemia status in this study, indicating that adolescents with lower health literacy were more likely to experience anemia. This finding supports behavioral health theories suggesting that knowledge serves as a foundation for shaping healthy practices and preventive behaviors. Adolescents who understand the importance of iron-rich foods, balanced nutrition, and anemia prevention strategies are more likely to adopt healthier dietary behaviors and maintain adequate hemoglobin levels. Conversely, limited knowledge may reduce adolescents' awareness regarding nutritional needs and increase vulnerability to unhealthy dietary choices. Previous studies have similarly reported that nutrition education interventions significantly improve adolescents' understanding of anemia prevention and positively influence dietary practices and adherence to iron supplementation (Febrianti et al., 2023; Rahman et al., 2021).

Dietary patterns emerged as one of the strongest factors associated with anemia in this study, emphasizing the critical role of nutritional intake during adolescence. Adolescents with inadequate consumption of iron-rich foods such as red meat, liver, eggs, and green leafy vegetables were more likely to exhibit lower hemoglobin levels. This finding is biologically plausible because iron is an essential component of hemoglobin synthesis, and inadequate dietary intake directly impairs oxygen

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transport capacity in the body. In addition, the increasing consumption of fast food and processed meals among adolescents may contribute to poor micronutrient intake and reduced dietary quality. Previous studies have demonstrated that adolescents who consume diversified diets rich in heme iron and vitamin C tend to have significantly lower anemia prevalence compared with those with monotonous or nutrient-poor dietary patterns (Wulandari et al., 2024; Gebreyesus et al., 2020).

Menstrual characteristics were also significantly associated with anemia occurrence among adolescent girls. Female adolescents experiencing prolonged menstruation lasting seven days or longer demonstrated a higher prevalence of anemia due to increased blood and iron loss during menstruation. This finding aligns with physiological evidence showing that adolescent girls naturally require higher iron intake than boys because of regular menstrual blood loss combined with rapid growth demands. Excessive menstrual bleeding may gradually deplete body iron stores, thereby impairing erythropoiesis and reducing hemoglobin concentration. Similar findings have been reported in previous studies indicating that menstrual duration and heavy menstrual bleeding are important predictors of iron deficiency anemia among adolescent females (Zhafirah et al., 2025; Kinyoki et al., 2021).

Breakfast habits were significantly associated with anemia status, suggesting that adolescents who regularly skipped breakfast were more likely to experience inadequate nutritional intake throughout the day. Breakfast contributes substantially to daily nutrient requirements, including iron, protein, vitamins, and calories necessary for metabolic and cognitive functions. Adolescents who frequently miss breakfast may compensate by consuming unhealthy snacks or nutritionally imbalanced meals later in the day, resulting in insufficient micronutrient intake. Previous studies have consistently shown that breakfast skipping behaviors are associated with poorer nutritional status, reduced dietary quality, and increased risk of anemia among school-aged adolescents (Arlinghaus & Johnston, 2021; Monzani et al., 2019).

Adherence to iron tablet supplementation demonstrated the strongest association with anemia in this study, highlighting the importance of school-based iron supplementation programs for adolescent girls. Adolescents who did not regularly consume iron tablets were substantially more likely to experience anemia compared with those who adhered to supplementation recommendations. Iron-folic acid supplementation has been widely recognized as one of the most effective public health interventions for reducing anemia prevalence among adolescents, particularly in low- and middle-income countries. However, adherence to supplementation programs remains challenging due to factors such as fear of side effects, forgetfulness, low motivation, and insufficient family or school support. Previous studies similarly reported that poor adherence to iron supplementation programs significantly contributes to persistent anemia prevalence among

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adolescent girls despite government-led preventive initiatives (Pasricha et al., 2021; Hidayanty et al., 2025).

The interrelationship between the identified factors indicates that adolescent anemia should be understood within a broader framework of health determinants involving behavioral, biological, educational, and environmental dimensions. Adolescents with poor knowledge often exhibit unhealthy eating patterns, irregular breakfast habits, and low adherence to supplementation programs, thereby increasing their cumulative risk of anemia. This multidimensional interaction highlights the importance of integrated school-based interventions combining nutrition education, reproductive health counseling, dietary improvement, and routine monitoring of iron supplementation adherence. Such comprehensive approaches are necessary because isolated interventions targeting only one determinant may not sufficiently address the complexity of adolescent anemia.

The findings of this study have important implications for nursing practice, school health programs, and adolescent public health interventions. Schools and healthcare providers should collaborate to strengthen nutrition education programs emphasizing balanced diets, iron-rich food consumption, and the importance of regular breakfast habits among adolescents. In addition, routine screening for anemia and menstrual health problems should be incorporated into school health services to facilitate early detection and intervention. Strengthening monitoring systems for iron tablet supplementation programs may also improve adolescents' adherence and reduce anemia prevalence. These findings further suggest that nurses, teachers, and parents play essential roles in supporting healthy nutritional behaviors and reinforcing preventive strategies against anemia among adolescents.

Several limitations should be considered when interpreting the findings of this study. First, the cross-sectional design limits the ability to establish causal relationships between the investigated variables and anemia status. Second, the study relied partially on self-reported data on dietary patterns, breakfast habits, and iron tablet consumption, which may introduce recall and social desirability biases. Third, this study was conducted in a single junior high school setting and had a relatively small sample size, potentially limiting the generalizability of the findings to broader adolescent populations. Future studies are recommended to employ longitudinal or multicenter designs with larger samples and more comprehensive nutritional assessments to better understand the complex determinants of adolescent anemia.

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CONCLUSION

This study demonstrated that anemia remains a significant health problem among adolescents at SMP K. Santo Gerardus Mayella Kalembuweri, with more than half of the respondents classified as anemic. The findings revealed that knowledge regarding anemia, dietary patterns, menstrual characteristics, breakfast habits, and adherence to iron tablet supplementation were significantly associated with anemia status among adolescents. Among these variables, inadequate dietary patterns and poor adherence to iron supplementation emerged as the most dominant factors contributing to anemia occurrence. Adolescents with limited knowledge of nutrition and anemia prevention were more likely to exhibit unhealthy eating behaviors, irregular breakfast habits, and lower compliance with iron supplementation, thereby increasing their risk of reduced hemoglobin levels.

The findings highlight that adolescent anemia is a multifactorial condition that requires comprehensive, integrated prevention strategies. School-based interventions emphasizing nutrition education, promoting healthy dietary habits, encouraging regular breakfast consumption, increasing menstrual health awareness, and strengthening adherence to iron tablet supplementation are essential to reduce anemia prevalence among adolescents. Collaboration between schools, healthcare professionals, families, and community health services is necessary to support sustainable anemia prevention programs and improve adolescent health outcomes in both educational and community settings.

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