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PREDICTORS OF ANEMIA AMONG ADOLESCENT GIRLS: A CROSS-SECTIONAL STUDY

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ABSTRACT
Anemia among adolescent girls remains a significant public health concern, particularly in developing countries, due to its negative impacts on reproductive health, cognitive development, academic performance, and future pregnancy outcomes. Iron deficiency, socioeconomic status, dietary behavior, menstrual characteristics, and inadequate nutritional knowledge are among the contributing factors associated with anemia in adolescents. This study aimed to analyze the association between parental income, maternal education, tea consumption habits, knowledge, attitudes, iron supplement adherence, menstrual characteristics, and the severity of anemia among adolescent girls at a public senior high school in Mataram, Indonesia. A quantitative study with a cross-sectional design was conducted among adolescent girls diagnosed with anemia at SMAN Mataram. A total sampling technique was applied, involving 62 respondents who met the inclusion criteria. Data were collected using structured questionnaires assessing socioeconomic factors, health behaviors, knowledge, attitudes, iron supplement consumption, and menstrual conditions. The questionnaires demonstrated acceptable validity and reliability, with all items meeting validity criteria ($r > 0.30$) and Cronbach's alpha values ranging from 0.79 to 0.87. The incidence and severity of anemia were determined based on hemoglobin screening data. Bivariate analysis was performed using the chi-square test with a significance level of $p < 0.05$. The findings showed significant associations between anemia severity and parental income ($p = 0.004$), maternal education level ($p < 0.001$), knowledge regarding anemia ($p < 0.001$), iron supplement adherence ($p = 0.008$), and menstrual conditions ($p = 0.004$). However, tea consumption habits ($p = 0.753$) and attitudes toward anemia prevention ($p = 0.323$) were not significantly associated with anemia severity among adolescent girls. Socioeconomic factors, anemia-related knowledge, iron supplement adherence, and menstrual characteristics were significantly associated with anemia severity among adolescent girls. Strengthening school-based anemia prevention programs, improving adolescent health literacy, and enhancing adherence to iron supplementation are essential strategies to reduce anemia among adolescents.

Keywords: adolescent girls; anemia; iron supplementation; knowledge; menstrual characteristics; socioeconomic factors

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INTRODUCTION

Anemia is a global public health problem characterized by a decrease in the number of red blood cells or hemoglobin concentrations that result in a reduced ability of blood to transport oxygen throughout the body's tissues. (Pattimura, N., Makatita, s., Pattimura, N.A., & Tihurua, 2023; Widiastini & Karuniadi, 2025) The World Health Organization (WHO) estimates that anemia affects about 30% of women of childbearing age (15-49 years) worldwide. This problem has a serious impact, especially on children, adolescent girls, as well as pregnant and postpartum women. In developing regions such as Southeast Asia and Africa, the prevalence of anemia cases is even reported to reach a very high number, which is around 85%.(Nurevita et al., 2023; Siamisang et al., 2023)

Adolescent girls are among the groups that are particularly susceptible to anemia because they experience rapid physical growth and the onset of menstrual cycles that significantly increase iron requirements.(Sari et al., 2022) The WHO through the 65th World Health Assembly has

recommended a global action plan to reduce anemia in women of childbearing age by 50% by 2025.(Siamisang et al., 2023) Prevention efforts are currently focused on administering Blood Supplement Tablets (TTDs), although their implementation still faces major obstacles related to low consumption compliance. It is estimated that around 8.3 million of the 12.1 million adolescent girls in Indonesia do not take medicine Blood Supplement Tablets (TTD) as recommended by the government.(Sari et al., 2022)

At the national level, the prevalence of anemia in Indonesia is still relatively high and is one of the main nutritional problems that has not been resolved. Based on data from the 2018 Basic Health Research (Riskesdas), the prevalence of anemia in adolescents aged 15-24 years reaches 32%, which means that 3 to 4 out of 10 adolescents in Indonesia suffer from anemia. This data shows that conditions remain worrying even though the government has carried out various specific intervention programs. Adolescents are an investment in the nation's future, so nutritional disorders such as anemia can hinder the quality of human resource development in the future.(Susanti et al., 2017)

The impact of anemia on adolescent girls spans a broad spectrum, from physical health impairments to decreased cognitive function. Anemia results in a decrease in learning concentration, thinking ability, and academic achievement in school. Physically, sufferers often complain of symptoms of weakness, fatigue, lethargy, and dizziness that hinder productivity and fitness. In addition, this condition lowers immunity so that adolescents become more susceptible to various infectious diseases.(Puspitasari et al., 2022)

In the long term, adolescent girls with anemia are at high risk of serious complications during pregnancy and childbirth.(Fitriyanti & Achadi, 2024; Fuadah & Saragih, 2024) Anemia contributes to an increased risk of bleeding during childbirth, premature birth, and maternal and infant mortality. Babies born to anemic mothers are also at high risk of having low birth weight (BBLR) and experiencing stunting (Kurnia Lintang Larasati & Bambang Budi Raharjo, 2025) Therefore, the treatment of anemia in adolescent girls is part of a specific intervention that is very crucial in efforts to accelerate national stunting reduction.(Pattimura, N., Makatita, s., Pattimura, N.A., & Tihurua, 2023)

Physiologically, one of the main determinants of anemia in this region is abnormal menstrual patterns.(Nurevita et al., 2023) Adolescent girls with menstrual durations of more than 7 days or irregular cycles lose more blood and iron reserves in the body. Blood loss of 20-25 cc in one cycle is equivalent to iron loss of 12.5-15 mg per month. Research in Muaragembong showed that abnormal menstrual patterns had the most dominant link, with a 22.07 times higher risk of anemia.

Lifestyle factors and socioeconomic conditions are also important determinants in the high cases of anemia. The habit of skipping breakfast, consuming unvaried foods, and lack of animal protein intake directly affect hemoglobin levels. In addition, the low level of maternal education and family income under MSEs affect the purchasing power of nutritious food and the level of knowledge about anemia prevention. Poor hygiene behaviors, such as infrequent hand washing, also increase the risk of infections that worsen anemia status.(Prevention, 2025)

Previous studies have examined individual risk factors associated with anemia; however, limited evidence has comprehensively evaluated socioeconomic, behavioral, and menstrual determinants simultaneously among adolescent girls in school-based populations, particularly in Mataram, Indonesia. Identifying these contributing factors is necessary to develop targeted interventions and strengthen adolescent anemia prevention programs. Therefore, this study aimed to analyze the association between socioeconomic factors (parental income and maternal education), behavioral

factors (tea consumption habits, knowledge, attitudes, and iron supplement adherence), menstrual characteristics, and anemia among adolescent girls, Indonesia.

METHOD

This study employed a quantitative analytical approach with a cross-sectional design. The research was conducted in March 2024 In SMAN Mataram, Indonesia. The study aimed to examine factors associated with anemia severity among adolescent girls. The study population consisted of female students at SMAN Mataram who were identified as having anemia based on hemoglobin (Hb) screening conducted by Selaparang Public Health Center. A total sampling technique was applied, involving 63 eligible students. However, one respondent was excluded due to dropout during the research process; therefore, the final sample consisted of 62 respondents.

The inclusion criteria were female students from grades X, XI, and XII at SMAN Mataram who had been diagnosed with anemia based on health center screening results, were present during data collection, and agreed to participate in the study. Students who declined participation or discontinued their education during the study period were excluded. The independent variables included parental income, maternal education level, tea consumption habits, knowledge regarding anemia, attitudes toward anemia prevention, adherence to iron supplement consumption, and menstrual characteristics. The dependent variable was anemia severity among adolescent girls. Data were collected using structured questionnaires consisting of several components: parental income based on the regional minimum wage standard, maternal education level, tea consumption habits, anemia knowledge (20 items), attitudes toward anemia prevention (20 items), iron supplement consumption adherence (6 items), and menstrual characteristics. Hemoglobin screening data were used to determine anemia status.

The questionnaire used in this study consisted of several sections, including parental income, maternal education level, tea consumption habits, knowledge of anemia, attitudes toward anemia prevention, adherence to iron supplementation, and menstrual characteristics. Content validity was established through expert review involving three specialists in nursing, nutrition, and public health. The experts evaluated the relevance, clarity, and appropriateness of each item. Revisions were made based on their recommendations to ensure that the instrument adequately measured the intended constructs. Prior to data collection, a pilot study was conducted among 30 adolescent girls with characteristics similar to the study population. Construct validity was assessed using item-total correlation analysis. Items with a corrected item-total correlation coefficient greater than 0.30 were considered valid and retained in the final questionnaire.

The reliability of the instrument was evaluated using Cronbach's alpha coefficient. The knowledge questionnaire consisting of 20 items demonstrated good internal consistency with a Cronbach's alpha value of 0.82. The attitude questionnaire comprising 20 items showed excellent reliability with a Cronbach's alpha value of 0.87. The iron supplementation adherence questionnaire consisting of 6 items yielded a Cronbach's alpha value of 0.79, indicating acceptable reliability. A Cronbach's alpha coefficient of ≥ 0.70 was considered acceptable for this study. Data were analyzed using univariate and bivariate analyses. Univariate analysis was performed to describe respondent characteristics and study variables. Bivariate analysis was conducted using the chi-square test to examine associations between independent variables and anemia severity. Statistical significance was determined at $p < 0.05$ with a 95% confidence interval.(Yuan & Yu, 2024)

RESULT

Characteristics of Respondents (Univariate Analysis)

A total of 62 adolescent girls diagnosed with anemia participated in this study. The univariate analysis described the distribution of socioeconomic factors, health-related behaviors, menstrual characteristics, and anemia severity among respondents. Most respondents experienced mild anemia

(69.4%), followed by moderate anemia (29.0%), and severe anemia (1.6%). Regarding socioeconomic characteristics, the majority of respondents came from families with low parental income (66.1%). Maternal education was mostly categorized as upper secondary education (48.4%). Based on health behavior characteristics, most respondents had good tea consumption habits (74.2%); however, nearly half of respondents had insufficient knowledge regarding anemia prevention (46.8%). More than half of respondents demonstrated poor attitudes toward anemia prevention (58.1%). In addition, most respondents were not adherent to iron supplement consumption (90.3%), and 74.2% experienced abnormal menstrual conditions.

Table 1.
Distribution of Respondent Characteristics and Study Variables (n = 62)

Variable	Category	f	%
Anemia severity	Mild	43	69.4
	Moderate	18	29.0
	Severe	1	1.6
Parental income	Low	41	66.1
	High	21	33.9
Maternal education	Low	3	4.8
	Intermediate	15	24.2
	Upper secondary	30	48.4
	Higher education	14	22.6
Tea consumption habits	Good	46	74.2
	Poor	16	25.8
Knowledge of anemia	Poor	29	46.8
	Moderate	30	48.4
	Good	3	4.8
Attitude toward anemia prevention	Poor	36	58.1
	Good	26	41.9
Iron supplement adherence	Non-adherent	56	90.3
	Adherent	6	9.7
Menstrual characteristics	Abnormal	46	74.2
	Normal	16	25.8

Bivariate Analysis

Bivariate Analysis of Factors Associated with Anemia Severity among Adolescent Girls

The association between socioeconomic factors, health-related behaviors, menstrual characteristics, and anemia severity among adolescent girls is presented in Table 2. The chi-square test showed that several variables were significantly associated with anemia severity. Parental income was significantly associated with anemia severity ($p = 0.004$). Most respondents from low-income families experienced mild anemia (54.8%), while moderate anemia was more common among respondents from higher-income families (17.7%). Maternal education level showed a significant association with anemia severity ($p < 0.001$). Furthermore, knowledge regarding anemia was significantly associated with anemia severity ($p < 0.001$), indicating that adolescents with lower levels of anemia-related knowledge tended to experience different anemia severity patterns. There was no significant association between tea consumption habits and anemia severity ($p = 0.753$). Similarly, attitudes toward anemia prevention were not significantly associated with anemia severity among adolescent girls ($p = 0.323$). Iron supplement adherence was significantly associated with anemia severity ($p = 0.008$). Respondents who were non-adherent to iron supplementation represented the majority of anemia cases (90.3%). Menstrual characteristics were also significantly associated with anemia severity ($p = 0.004$), where abnormal menstrual patterns were found among 74.2% of respondents.

Table 2.
Association between Socioeconomic, Behavioral, and Menstrual Factors with Anemia Severity among Adolescent Girls (n = 62)

Variables	Mild anemia n (%)	Moderate anemia n (%)	Severe anemia n (%)	Total n (%)	p-value
Parental income					0.004
High	9 (14.5)	11 (17.7)	1 (1.6)	21 (33.9)	
Low	34 (54.8)	7 (11.3)	0 (0.0)	41 (66.1)	
Maternal education					0.001
Low	2 (3.2)	0 (0.0)	1 (1.6)	3 (4.8)	
Intermediate	11 (17.7)	4 (6.5)	0 (0.0)	15 (24.2)	
Secondary	26 (41.9)	4 (6.5)	0 (0.0)	30 (48.4)	
Higher education	4 (6.5)	10 (16.0)	0 (0.0)	14 (22.6)	
Tea consumption habits					0.753
Good	31 (50.0)	14 (22.6)	1 (1.6)	46 (74.2)	
Poor	12 (19.4)	4 (6.5)	0 (0.0)	16 (25.8)	
Knowledge of anemia					0.001
Poor	22 (35.5)	7 (11.3)	0 (0.0)	29 (46.8)	
Moderate	20 (32.3)	10 (16.1)	0 (0.0)	30 (48.4)	
Good	1 (1.6)	1 (1.6)	1 (1.6)	3 (4.8)	
Attitude toward anemia prevention					0.323
Good	16 (25.8)	9 (14.5)	1 (1.6)	26 (41.9)	
Poor	27 (43.6)	9 (14.5)	0 (0.0)	36 (58.1)	
Iron supplement adherence					0.008
Non-adherent	39 (62.9)	17 (27.4)	0 (0.0)	56 (90.3)	
Adherent	4 (6.5)	1 (1.6)	1 (1.6)	6 (9.7)	
Menstrual characteristics					0.004
Abnormal	28 (45.2)	18 (29.0)	0 (0.0)	46 (74.2)	
Normal	15 (24.2)	0 (0.0)	1 (1.6)	16 (25.8)	

Statistical analysis was performed using the chi-square test; $p < 0.05$ was considered statistically significant

DISCUSSION

Parental Income and Anemia among Adolescent Girls

The findings of this study demonstrated a significant association between parental income and anemia among adolescent girls. Family income plays an important role in determining household capacity to provide adequate nutrition, including access to diverse and iron-rich foods. Families with sufficient economic resources are more likely to fulfill nutritional requirements and support healthy dietary practices, which may reduce the risk of micronutrient deficiencies, including iron deficiency anemia(Kang et al., 2023)

These findings are consistent with previous research which reported that adolescent girls from low-income families had a higher risk of developing anemia compared with those from families with better economic conditions. Limited household income may restrict access to high-quality foods such as animal-source proteins, iron-rich foods, fruits, and other micronutrient sources necessary for hemoglobin synthesis.(Fuadah & Saragih, 2024).

Similar findings have also been reported in previous international studies, showing a significant association between socioeconomic status and anemia prevalence. Socioeconomic disparities influence dietary intake, health literacy, access to health services, and preventive behaviors related to anemia management Therefore, improving socioeconomic support and developing targeted nutrition programs for adolescents from low-income families are essential strategies to reduce anemia prevalence. School-based nutritional education, iron supplementation programs, and policies addressing socioeconomic inequalities may contribute to better anemia prevention among adolescent girls.(Puspitasari et al., 2022)

Maternal Education and Anemia among Adolescent Girls

The findings of this study indicated a significant association between maternal education level and anemia among adolescent girls. Maternal education is an important socioeconomic determinant that influences nutritional knowledge, dietary decision-making, and health-related practices within the family. Mothers with higher educational levels tend to have better awareness regarding balanced nutrition, appropriate food selection, and the importance of micronutrient intake required to support adolescent growth and development(Zenki et al., 2015). The results of this study are consistent with previous studies which reported that maternal education was significantly associated with anemia among adolescent girls. Higher maternal education may contribute to better prevention of anemia through improved understanding of iron-rich food consumption, dietary diversity, and healthy behaviors.(Endale et al., 2022)

In the present study, adolescent girls whose mothers had higher levels of education were more frequently found in the mild anemia category, whereas severe anemia was identified among respondents whose mothers had lower educational backgrounds. This finding suggests that maternal education may contribute to reducing anemia severity by improving family nutritional management and supporting healthier adolescent dietary patterns. Furthermore, reported that inadequate nutritional intake among adolescents is closely related to household food availability, which is influenced by parental education and socioeconomic status. Therefore, improving maternal health literacy and family-based nutrition education may be an important strategy to strengthen anemia prevention programs among adolescent girls.(Puspitasari et al., 2022)

Tea Consumption Habits and Anemia among Adolescent Girls

The results of this study showed that tea consumption habits were not significantly associated with anemia among adolescent girls. Although tea intake has been considered a potential factor influencing iron absorption, the relationship may depend on several factors, including the frequency of tea consumption, timing of consumption, dietary patterns, and the overall amount of iron intake. Tea contains polyphenolic compounds, particularly tannins, which can inhibit non-heme iron absorption by forming insoluble complexes in the digestive tract. Consuming tea close to mealtime may reduce iron bioavailability and potentially contribute to iron deficiency when combined with inadequate dietary iron intake(Fitriyanti & Achadi, 2024)

The findings of this study are consistent with previous studies conducted which reported no significant association between tea consumption habits and anemia among adolescents. This may indicate that tea consumption alone is not the primary determinant of anemia, as anemia is influenced by multiple factors, including nutritional status, menstrual blood loss, socioeconomic conditions, and adherence to iron supplementation. In the present study, most respondents reported consuming tea occasionally rather than as a daily habit. In addition, tea was not consistently consumed during or immediately after meals, which may explain the absence of a significant relationship between tea consumption habits and anemia severity. Therefore, the effect of tea intake on anemia risk should be considered together with other dietary and physiological factors.

Attitudes toward Anemia Prevention among Adolescent Girls

The findings of this study showed that attitudes toward anemia prevention were not significantly associated with anemia among adolescent girls.(Ervita et al., 2026) Although positive attitudes are considered an important component in promoting healthy behaviors, attitudes alone may not directly influence hemoglobin levels or prevent anemia without being translated into consistent preventive practices. Positive attitudes toward anemia prevention can contribute to better health outcomes when supported by adequate health information, accessible health services, supportive environments, and strong social support systems. Therefore, adolescent health behavior is influenced not only by individual attitudes but also by external factors that facilitate healthy practices(Zannah et al., 2024) Similarly, reported that attitude is not a direct determinant of

hemoglobin status. Adolescents with good attitudes toward anemia prevention may still experience anemia if their behaviors and environments do not support adequate iron intake, adherence to iron supplementation, and balanced dietary patterns. (Djati et al., 2025). The results of this study suggest that improving attitudes alone may not be sufficient to reduce anemia among adolescent girls. Comprehensive interventions that integrate health education, behavioral change strategies, family support, school-based nutrition programs, and regular iron supplementation monitoring are needed to achieve effective anemia prevention.

Iron Supplement Adherence and Anemia among Adolescent Girls

The findings of this study showed a significant association between adherence to iron supplementation and anemia among adolescent girls. Adequate iron intake is essential during adolescence due to rapid growth, increased blood volume, and the onset of menstruation, which increase physiological iron requirements.(Prevention, 2025). During adolescence, iron requirements increase compared with the pre-adolescent period. This demand becomes higher among adolescent girls because of regular menstrual blood loss. Insufficient dietary iron intake combined with poor adherence to iron supplementation may lead to depletion of iron stores, reduced hemoglobin synthesis, and increased risk of anemia (Widiastini & Karuniadi, 2025)

The findings of this study are consistent with previous research which reported that regular consumption of iron supplements was associated with a lower risk of anemia among adolescent girls. Iron supplementation plays an important role in replacing iron loss during menstruation and maintaining adequate hemoglobin levels, particularly among adolescents with irregular or heavy menstrual bleeding patterns.(Puspitasari et al., 2022). Dietary intake is another important factor influencing iron status among adolescents. Inadequate consumption of iron-rich foods may fail to meet the increased nutritional demands required for adolescent growth and development. Previous evidence has shown that insufficient iron intake contributes to iron deficiency, especially among adolescent girls who have higher iron requirements due to menstruation (Ervita et al., 2026). The present study suggests that adherence to iron supplementation is an important preventive strategy for reducing anemia among adolescent girls. Strengthening school-based iron supplementation programs, improving adolescent awareness regarding the benefits of iron intake, and monitoring compliance with supplementation are necessary to improve anemia prevention efforts.

Menstrual Characteristics and Anemia among Adolescent Girls

The findings of this study demonstrated a significant association between menstrual characteristics and anemia among adolescent girls. Menstrual patterns are important biological factors influencing iron status, particularly during adolescence, when rapid growth and increased nutritional requirements occur simultaneously with the onset of menstruation. During puberty, adolescent girls experience physiological changes, including the initiation of the menstrual cycle. Irregular menstrual cycles, prolonged menstruation, and excessive menstrual bleeding may increase iron loss and contribute to a higher risk of iron deficiency anemia, especially when iron intake is insufficient to compensate for menstrual blood loss.(Pattimura, N., Makatita, s., Pattimura, N.A., & Tihurua, 2023) Iron loss during menstruation is closely related to the volume and duration of menstrual bleeding. The average amount of blood loss during a menstrual cycle is approximately 20–25 ml, which is equivalent to an iron loss of about 12.5–15 mg per month. Continuous iron loss without adequate dietary replacement may decrease iron stores and increase vulnerability to anemia among adolescent girls (Endale et al., 2022)

Previous research has shown that adolescent girls with abnormal menstrual patterns have a higher risk of developing anemia compared with those with normal menstrual patterns. reported that adolescents with irregular menstrual patterns were 3.743 times more likely to experience anemia. Similarly, widiastini et al. (2025) found that anemia among adolescent girls was associated with menstrual abnormalities, including irregular menstrual cycles, dysmenorrhea, and premenstrual

symptoms. (Widiastini & Karuniadi, 2025). The findings are also supported by Kristiani et al. (2014), who reported a significant association between anemia and menstrual cycle patterns (p = 0.018). Furthermore, studies by Basith et al. (2017) confirmed that menstrual conditions are important determinants contributing to anemia among adolescent girls. The present study suggests that abnormal menstrual characteristics may increase anemia severity due to greater iron loss during menstruation. Therefore, early identification of menstrual problems, monitoring of menstrual patterns, adequate iron intake, and adherence to iron supplementation programs are essential strategies for preventing anemia among adolescent girls.

CONCLUSION

This study demonstrated that anemia among adolescent girls is associated with multiple determinants, including socioeconomic, behavioral, and menstrual-related factors. Parental income, maternal education level, anemia-related knowledge, adherence to iron supplementation, and menstrual characteristics were significantly associated with anemia severity among adolescent girls in Mataram, Indonesia. These findings indicate that anemia prevention requires a comprehensive approach addressing not only biological factors but also family socioeconomic conditions and adolescent health behaviors. Improving health literacy, strengthening school-based nutrition education, increasing adherence to iron supplementation programs, and early monitoring of menstrual health are essential strategies to reduce anemia among adolescent girls. Collaborative efforts involving schools, families, and healthcare providers are needed to develop sustainable interventions for improving adolescent nutritional status and reproductive health outcomes.

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