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Nutritional and Behavioral Characteristics According to Anemia Status among Adolescent Girls in Indonesia

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ABSTRACT

Anemia remains a major nutritional problem among adolescent girls, particularly in low- and middle-income countries. Increased nutritional requirements during growth, menstrual blood loss, dietary inadequacy, and poor nutritional behaviors contribute to a higher risk of anemia during adolescence. A comprehensive assessment of nutritional and behavioral characteristics is needed to support effective anemia prevention strategies. This study aimed to compare nutritional and behavioral characteristics according to anemia status among adolescent girls in a junior high school setting in Madiun Regency, Indonesia. A cross-sectional study was conducted among 123 female students aged 12–15 years at SMP Negeri 2 Balerejo, Madiun Regency, Indonesia, in June 2026. Participants were selected using a total sampling approach. Hemoglobin levels were measured using the Point-of-Care Testing (POCT) method, with anemia defined as hemoglobin concentration <12 g/dL. Nutritional status was assessed through anthropometric measurements. Dietary intake was evaluated using a Semi-Quantitative Food Frequency Questionnaire (SQ-FFQ) and 3×24-hour dietary recall. Nutritional knowledge, attitudes, and anemia-prevention practices were assessed using structured questionnaires. Comparative analyses were performed between anemia and non-anemia groups. Among participants, 26 (21.1%) were classified as anemic and 97 (78.9%) had normal hemoglobin status. The anemia group had significantly lower hemoglobin levels than the non-anemia group (10.87±0.83 vs. 13.30±1.05 g/dL; $p<0.001$). However, no significant differences were found in nutritional status, energy, protein, fat, carbohydrate, vitamin C, iron intake, knowledge, attitudes, or anemia-prevention practices ($p>0.05$). Anemia remains a nutritional concern among adolescent girls. The findings suggest that anemia status cannot be explained solely by nutrient intake or anthropometric indicators. School-based interventions should integrate anemia screening, dietary diversification, promotion of iron- and vitamin C-rich foods, and nutrition education.

INTRODUCTION

Anemia remains a major nutritional problem among adolescent girls worldwide, particularly in low- and middle-income countries. According to the World Health Organization (WHO), anemia in adolescent girls is defined as a hemoglobin concentration below 12 g/dL and represents an important public health concern because of its consequences on physical performance, cognitive function, learning achievement, and future reproductive health. Adolescence is a critical stage of development characterized by rapid growth, increased nutrient requirements, and physiological changes that increase the demand for essential nutrients, particularly iron [1].

Adolescent girls are more vulnerable to anemia due to increased iron requirements during growth and additional iron loss associated with menstruation. Inadequate dietary intake, low consumption of iron-rich foods, insufficient intake of vitamin C, and limited dietary diversity may reduce iron availability and contribute to impaired hemoglobin formation. Iron plays an essential role in erythropoiesis and oxygen transport, while vitamin C enhances the absorption of non-heme iron from plant-based foods. Therefore, maintaining adequate nutritional intake and improving dietary quality are important strategies for preventing anemia among adolescents[2–4].

Dietary patterns among adolescents are often characterized by high consumption of staple foods, limited intake of fruits and vegetables, and insufficient consumption of animal-source foods. These patterns may result in adequate energy intake but inadequate micronutrient intake, particularly iron and other nutrients involved in hematopoiesis. Consequently, adolescents may experience micronutrient deficiencies despite having normal anthropometric indicators, a condition commonly described as hidden hunger. This highlights the importance of assessing anemia through a multidimensional approach that includes dietary intake, nutritional status, and nutrition-related behaviors[8–12].

In Indonesia, anemia among adolescent girls remains a significant public health challenge. The government has implemented anemia prevention programs through weekly iron and folic acid supplementation (Tablet Tambah Darah/TTD) targeting adolescent girls, particularly through school-based interventions. However, the effectiveness of these programs may be influenced by several factors, including adherence to supplementation, nutritional knowledge, dietary practices, family support, and school health promotion activities. Therefore, anemia prevention requires not only supplementation programs but also improvement of overall dietary patterns and nutritional behaviors[5,6].

Previous studies among adolescent girls have mainly focused on individual aspects, such as iron supplementation adherence, iron intake, or nutritional knowledge. However, anemia is a complex nutritional condition, and comprehensive studies evaluating dietary intake, nutritional status, food consumption patterns, and anemia-related behaviors simultaneously remain limited, particularly among junior high school students in Indonesia. Local evidence is important because dietary patterns, food availability, and school-based nutrition programs may vary between regions[7].

Although previous research has investigated anemia among adolescent girls, several gaps remain. Many studies have focused primarily on iron supplementation adherence or single nutrient intake, while comprehensive assessments of dietary patterns, macronutrient and micronutrient intake, nutritional status, and preventive behaviors are still limited, particularly among junior high school students. Furthermore, differences in local food habits, cultural practices, and food accessibility may influence nutritional patterns and anemia prevalence; therefore, local evidence is required to support context-specific anemia prevention strategies[10–15]. Madiun Regency, East Java, provides an important setting for examining adolescent nutritional characteristics related to anemia status. However, evidence regarding differences in nutritional and behavioral characteristics between adolescent girls with anemia and those with normal hemoglobin status remains limited. Therefore, this study aimed to compare nutritional and behavioral characteristics according to anemia status among adolescent girls at SMP Negeri 2 Balerejo, Madiun Regency, Indonesia.

MATERIALS AND METHODS

This study employed an observational analytical study with a cross-sectional design to compare nutritional and behavioral characteristics according to anemia status among adolescent girls. The study was conducted at SMP Negeri 2 Balerejo, Madiun Regency, East Java, Indonesia, in June 2026. The research setting was selected because adolescent girls represent a vulnerable population for anemia due to increased nutritional requirements during growth and physiological changes during adolescence, including menstrual-related iron loss. School-based settings provide an appropriate environment for assessing adolescent nutritional status, dietary characteristics, and anemia prevention behaviors.

The study population consisted of all female students enrolled in grades VII–IX at SMP Negeri 2 Balerejo. A total sampling technique was applied, involving all eligible female students who participated during the study period. The inclusion criteria were: female students aged 12–15 years; actively enrolled at SMP Negeri 2 Balerejo during the study period; willing to participate in the study; able to complete anthropometric measurements, hemoglobin examination, dietary assessment, and questionnaires. Participants were excluded if they had medical conditions that could influence hemoglobin status, including hemoglobin disorders, chronic infectious diseases, tuberculosis, malaria, cancer, or HIV infection. Students who were absent during data collection, unable to complete the assessment procedures, or had incomplete data were excluded from the final analysis. A total of 123 adolescent girls were included in the final analysis. Participants were classified into two groups based on hemoglobin concentration: anemia group: hemoglobin <12 g/dL; non-anemia group: hemoglobin ≥12 g/dL. The anemia classification followed the World Health Organization (WHO) criteria for adolescent girls.

The main outcome variable in this study was anemia status, determined based on hemoglobin concentration. Independent variables included nutritional status, dietary intake, food consumption characteristics, nutritional knowledge, attitudes, and anemia-prevention practices. Data collection was performed through direct measurement and structured questionnaires. Information collected included: Participant characteristics age; grade level; anthropometric measurements; hemoglobin concentration. Dietary intake assessment Dietary intake was assessed using two approaches: Semi-Quantitative Food Frequency Questionnaire (SQ-FFQ) The SQ-FFQ was used to assess habitual food consumption patterns during the previous three months. The questionnaire evaluated the frequency and estimated portion size of commonly consumed food items. Daily nutrient intake was assessed using a 3×24-hour dietary recall method to estimate average intake of: energy; protein; fat; carbohydrate; vitamin C; iron (Fe). Dietary data were converted into nutrient values for statistical analysis. Food consumption patterns were further categorized based on major nutrient sources, including: carbohydrate sources; protein sources; fat sources; vitamin C sources; iron-containing foods.

Body weight was measured using a digital weighing scale, while height was measured using standardized anthropometric procedures. Body Mass Index (BMI) was calculated using the following formula: $BMI= weight(kg)/height(m)^2$. Hemoglobin concentration was measured using the Point-of-Care Testing (POCT) method. Hemoglobin measurement was performed according to standardized procedures, and the obtained hemoglobin concentration was used to determine anemia status. Based on WHO criteria: hemoglobin concentration <12 g/dL was categorized as anemia; hemoglobin concentration ≥12 g/dL was categorized as non-anemia. Nutritional knowledge, attitudes, and anemia-prevention practices were assessed using structured questionnaires. The questionnaire evaluated adolescent understanding and behaviors related to anemia prevention, including: knowledge regarding anemia causes and prevention; attitudes toward anemia prevention; preventive practices related to dietary habits and anemia prevention behaviors. Scores were calculated according to questionnaire responses and analyzed as continuous variables.

Statistical analysis was performed using SPSS Statistics version 25.0. Descriptive analysis was conducted to summarize participant characteristics, hemoglobin concentration, nutritional status, nutrient intake, and behavioral scores. Continuous variables were presented as mean ± standard deviation (SD), minimum, and maximum values, while categorical variables were presented as frequencies and percentages. Comparative analyses were conducted to examine differences between anemia and non-anemia groups. The selection of statistical tests was based on data distribution. Normally distributed continuous variables were analyzed using the independent t-test, whereas non-normally distributed variables were analyzed using the Mann–Whitney U test. Categorical variables were analyzed using the Chi-square test or Fisher’s exact test when appropriate. A p-value of <0.05 was considered statistically significant. Ethical approval was obtained from the Health Research Ethics Committee, Faculty of Medicine, Sebelas Maret University, Surakarta, Indonesia, with approval letter No. 90/UN27.06.11/KEP/EC/2025 dated June 18, 2025 valid until June 2026. The research implementation also received authorization from the National Unity and Political Agency of Madiun

Regency through recommendation letter No. 000.9.2/220/402.301/2025. Before data collection, participants and their parents or guardians received information regarding the study objectives, procedures, potential benefits, and confidentiality of data. Written informed consent was obtained before participation.

RESULTS

A total of 123 adolescent girls participated in this study. Based on hemoglobin measurement, 26 participants (21.1%) were classified as anemia, while 97 participants (78.9%) had normal hemoglobin status. The characteristics of participants according to anemia status are presented in Table 1. The mean body weight was 44.34±6.79 kg in the anemia group and 46.14±11.82 kg in the non-anemia group. The difference in body weight between groups was not statistically significant ($p=0.318$). The mean BMI was 19.06±3.07 kg/m² in the anemia group and 20.32±4.83 kg/m² in the non-anemia group. No significant difference in BMI was observed between groups ($p=0.110$). As expected, hemoglobin concentration differed significantly between groups. The anemia group had a lower mean hemoglobin concentration compared with the non-anemia group (10.87±0.83 vs. 13.30±1.05 g/dL; $p<0.001$). Nutritional knowledge, attitudes, and anemia-prevention practice scores were not significantly different between the anemia and non-anemia groups ($p>0.05$).

Table 1. Characteristics of Respondents Based on Anemia Status in Adolescent Girls of SMP Negeri 2 Balerejo (n=123)

Variable	Anemia (n=26) Mean ± SD / n (%)	Non-Anemia (n=97) Mean ± SD / n (%)	p-value
Weight (kg)	44,34 ± 6,79	46,14 ± 11,82	0,318
Height (cm)	154,90 ± 3,07	149,87 ± 3,91	-
BMI (kg/m²)	19,06 ± 3,07	20,32 ± 4,83	0,110
Hemoglobin (g/dL)	10,87 ± 0,83	13,30 ± 1,05	<0,001
Knowledge	68,19 ± 21,15	65,51 ± 21,59	0,571
Attitude	34,04 ± 2,49	33,18 ± 3,03	0,141
Practices	18,38 ± 3,96	18,34 ± 3,11	0,958

The comparison of dietary intake between anemia and non-anemia groups is presented in Table 2. The mean intake of energy, protein, fat, carbohydrate, vitamin C, and iron was relatively similar between groups. The anemia group had slightly lower energy intake and vitamin C intake compared with the non-anemia group, whereas protein and carbohydrate intake were slightly higher. However, none of the dietary intake variables showed statistically significant differences between the anemia and non-anemia groups (all p-values >0.05). The mean iron intake was 28.02±28.75 mg/day in the anemia group and 31.92±27.13 mg/day in the non-anemia group, with no significant difference (p=0.539).

Table 2. Comparison of Descriptive Statistics of Nutritional Intake Based on Anemia Status

Intake	Anemia (n=26) Mean ± SD	Non-Anemia (n=97) Mean ± SD	p-value
Energy (kkal/hari)	1463,32 ± 298,85	1498,01 ± 371,77	0,621
Protein (g/hari)	53,22 ± 12,76	49,26 ± 13,56	0,174
Fat (g/hari)	51,18 ± 15,94	52,04 ± 16,71	0,809
Carbohydrates (g/hari)	235,02 ± 70,52	228,85 ± 70,94	0,694
Vitamin C (mg/hari)	16,55 ± 12,96	16,51 ± 13,01	0,989
Fe (mg/hari)	28,02 ± 28,75	31,92 ± 27,13	0,539

The distribution of anemia status according to nutritional status categories is presented in Table 3. Anemia was observed across all nutritional status categories. The highest proportion of anemia was found among participants with normal nutritional status (25.0%), followed by underweight participants (19.6%) and overweight participants (8.3%). Most participants in each nutritional status category had normal hemoglobin status.

Table 3. Distribution of Nutritional Status Based on Incidence of Anemia

Nutritional Status	Anemia n (%)	Non-Anemia n (%)	Total
Underweight	10 (19,6%)	41 (80,4%)	51
Normal	15 (25,0%)	45 (75,0%)	60
Overweight	1 (8,3%)	11 (91,7%)	12
Total	26	97	123

Table 4 presents the comparison of BMI and behavioral scores according to anemia status. The anemia group had a slightly lower BMI compared with the non-anemia group; however, the difference was not statistically significant (19.06±3.07 vs. 20.32±4.83 kg/m²; p=0.110). Similarly, nutritional knowledge, attitudes, and preventive practice scores did not differ significantly between groups (p>0.05). These findings indicate that measured nutritional and behavioral characteristics were comparable between adolescent girls with anemia and those with normal hemoglobin status.

Table 4. Comparison of Nutritional Status and Behavioral Scores According to Anemia tatus

Variable	Anemia Mean ± SD	Non-anemia Mean ± SD	p-value
BMI (kg/m²)	19.06 ± 3.07	20.32 ± 4.83	0.110
Knowledge score	68.19 ± 21.15	65.51 ± 21.59	0.571
Attitude score	34.04 ± 2.49	33.18 ± 3.03	0.141
Preventive practice score	18.38 ± 3.96	18.34 ± 3.11	0.958

The food consumption pattern according to anemia status is presented in Table 5. The dietary pattern of adolescent girls was generally similar between the anemia and non-anemia groups. White rice was the most frequently consumed carbohydrate source in both groups, indicating a high dependence on staple carbohydrate-based foods. Protein sources were mainly derived from fried chicken, eggs, and tempeh. The non-anemia group showed higher consumption frequency of fried tempeh and tempeh compared with the anemia group. For vitamin C sources, consumption was relatively limited and dominated by vegetables, including sayur asem, spinach soup, vegetable soup, and kangkung. Consumption of vitamin C-rich fruits was not frequently reported among participants. Iron-containing food sources were primarily obtained from animal-source foods, including fried chicken and eggs, as well as plant-based sources such as tempeh. Although these foods contribute to iron intake, the availability and absorption of iron may vary depending on food sources and dietary combinations. Overall, the dietary pattern suggests that improving food diversity, increasing consumption of heme iron sources, and encouraging vitamin C-rich food intake may support anemia prevention strategies among adolescent girls.

Table 5. Food Consumption Pattern According to Anemia Status among Adolescent Girls

Food group	Rank	Food items	Anemia group (n=26)	Non-anemia group (n=97)
Carbohydrate sources	1	White rice	47	121
	2	Fried rice	10	9
	3	Bakpia	4	12
	4	Instant noodles	2	–
	5	Fried noodles	2	6
Protein sources	1	Fried chicken	11	16

Food group	Rank	Food items	Anemia group (n=26)	Non-anemia group (n=97)
	2	Fried egg	7	23
	3	Fried tempeh	6	34
	4	Omelet	5	16
	5	Tempeh	–	10
Fat sources	1	Fried tempeh	6	34
	2	Fried chicken	11	16
	3	Fried rice	10	9
	4	Bakpia	4	12
	5	Fried noodles	2	6
Vitamin C sources	1	(tamarind vegetable soup)	4	9
	2	Spinach soup	3	2
	3	Vegetable soup	3	4
	4	Orange ice drink	–	4
	5	Water spinach (kangkung)	–	4
Iron (Fe) sources	1	Fried chicken	11	16
	2	Fried egg	7	23
	3	Fried tempeh	6	34
	4	Omelet	5	16
	5	Tempeh	–	10

DISCUSSION

This study identified that anemia remains a nutritional concern among adolescent girls at SMP Negeri 2 Balerejo, Madiun Regency, Indonesia, with a prevalence of 21.1%. Although the prevalence observed in this study was lower than several reports from low- and middle-income countries, anemia among adolescent girls remains an important public health issue because adolescence is a critical period characterized by rapid growth, increased nutrient requirements, and physiological changes, including menstrual blood loss. These conditions increase vulnerability to inadequate iron status and impaired hemoglobin formation[1,16–18]. The present study found that hemoglobin concentration was significantly different between the anemia and non-anemia groups, which reflects the classification criteria used in this study. However, nutritional intake variables, including energy, protein, fat, carbohydrate, vitamin C, and iron intake, did not show statistically significant differences between groups. These findings indicate that anemia status among adolescent girls cannot be interpreted solely based on quantitative nutrient intake. Previous studies have suggested that anemia is influenced by multiple nutritional and biological processes, including iron absorption, iron bioavailability, inflammation, infection, menstrual blood loss, and compliance with iron supplementation programs.[19–21]

In Indonesia, adolescent anemia prevention has been strengthened through the weekly iron and folic acid supplementation program (Tablet Tambah Darah/TTD); however, the effectiveness of this strategy depends on adherence, nutritional behavior, and supportive school environments [5,6,22]. Therefore, identifying local nutritional characteristics remains important to develop effective anemia prevention strategies.

This study demonstrated that hemoglobin concentration differed significantly between anemia and non-anemia groups ($p=0.002$), which is consistent with the classification criteria used to define anemia. However, nutrient intake variables, including energy, protein, fat, carbohydrate, vitamin C, and iron intake, did not show statistically significant differences between the two groups. Similar findings have been reported in previous studies indicating that anemia is a multifactorial condition and cannot be explained solely by dietary intake. Nutritional anemia may be influenced by several factors, including iron absorption efficiency, menstrual blood loss, inflammation, infection, genetic susceptibility, and compliance with iron supplementation [23–26].

Although iron intake is an important component of anemia prevention, this study found that the mean iron intake was not significantly different between groups. The anemia group had a slightly lower mean iron intake compared with the non-anemia group; however, the difference was not statistically significant. This finding suggests that the amount of iron consumed may not fully represent iron availability in the body. Dietary iron absorption is strongly influenced by the type of iron source consumed. Heme iron from animal-source foods generally has higher bioavailability compared with non-heme iron from plant-based foods, while inhibitors such as phytate and polyphenols may reduce iron absorption. Conversely, vitamin C improves the absorption of non-heme iron by enhancing its conversion into a more absorbable form[27–29].

The food consumption pattern analysis (Table 5) showed that dietary patterns among adolescent girls were relatively similar between anemia and non-anemia groups. The main carbohydrate source in both groups was white rice, indicating that staple foods remained dominant in daily dietary patterns. Similar dietary patterns have been reported among adolescents in Indonesia, where rice-based diets remain common and contribute substantially to energy intake. However, dependence on staple foods with limited dietary diversity may increase the risk of insufficient micronutrient intake, particularly iron and vitamin-related nutrients[27,28,30]. Protein sources consumed by participants were mainly fried chicken, eggs, and tempeh. The non-anemia group showed a higher reported consumption frequency of fried tempeh and tempeh compared with the anemia group. Tempeh is an important traditional Indonesian food that contributes plant-based protein and micronutrients, including iron. However, iron from plant-based sources is predominantly non-heme iron, which has lower absorption compared with heme iron from animal-source foods. Therefore, improving dietary quality should focus not only on increasing iron-containing foods but also on improving dietary combinations that enhance iron absorption [31,32].

The consumption of vitamin C sources among participants was relatively limited. Based on Table 5, vitamin C intake sources were mainly derived from vegetables, such as sayur asem, spinach soup, vegetable soup, and kangkung, while fruit consumption was less frequently reported. Low consumption of fruits and vegetables may reduce vitamin C availability, which plays an important role in improving non-heme iron absorption. Previous studies have emphasized that dietary diversity, particularly the combination of iron-rich foods and vitamin C sources, is an important component of anemia prevention strategies [33–35]. This study also found that nutritional status based on BMI did not differ significantly between anemia and non-anemia groups. Interestingly, anemia was observed among participants with normal nutritional status. This finding highlights that normal anthropometric indicators do not necessarily indicate adequate micronutrient status. Adolescents may have adequate energy intake to maintain body weight while experiencing micronutrient deficiencies, particularly iron deficiency, which is often described as hidden hunger. Therefore, anemia screening should not rely solely on anthropometric assessment but should include direct assessment of hemoglobin status [36,37].

Nutritional knowledge, attitudes, and anemia-prevention practices were also not significantly different between groups. This finding suggests that knowledge alone may not always translate into optimal dietary practices. Adolescent food choices are influenced by various contextual factors, including family dietary patterns, food availability, peer influence, economic conditions, and school environments. Therefore, nutrition education programs should be integrated with supportive environments that facilitate healthy food choices and sustainable behavior change.

The findings of this study have important implications for school-based anemia prevention programs. Comprehensive strategies should combine regular hemoglobin screening, strengthening adherence to iron supplementation programs, increasing dietary diversity, promoting consumption of iron-rich foods, and encouraging vitamin C-rich food combinations. Interventions should also consider local dietary habits and culturally acceptable food choices to improve long-term effectiveness.

This study has several limitations that should be considered when interpreting the findings. First, the cross-sectional design limits the ability to determine causal relationships between nutritional characteristics and anemia status. The findings describe differences between groups but cannot establish whether nutritional characteristics directly influence anemia development. Second, this study was conducted in only one junior high school in Madiun Regency; therefore, the findings may not be generalized to all adolescent girls in Indonesia with different dietary, socioeconomic, and environmental characteristics. Third, although dietary intake was assessed using SQ-FFQ and 3×24-hour dietary recall methods, these approaches may be affected by recall bias and estimation errors in portion size reporting. Fourth, biochemical indicators of iron status, such as serum ferritin, transferrin saturation, and inflammatory markers, were not measured. Therefore, the specific biological causes of anemia could not be identified. Fifth, factors potentially related to anemia among adolescent girls, including menstrual characteristics, adherence to iron supplementation (Tablet Tambah Darah), infection status, and socioeconomic conditions, were not evaluated in this study. Future research using longitudinal designs and incorporating biochemical indicators is recommended to provide a more comprehensive understanding of anemia determinants among adolescent girls.

CONCLUSION

Anemia remains a nutritional concern among adolescent girls at SMP Negeri 2 Balerejo, Madiun Regency, with a prevalence of 21.1%. Adolescents with anemia had significantly lower hemoglobin concentrations compared with those with normal hemoglobin status. However, no significant differences were observed in dietary intake, nutritional status, nutritional knowledge, attitudes, or anemia-prevention practices between groups. The findings suggest that anemia status among adolescent girls cannot be explained solely by quantitative nutrient intake or anthropometric indicators. A comprehensive school-based prevention approach is needed, including routine anemia screening, promotion of dietary diversity, increased consumption of iron-rich and vitamin C-rich foods, and strengthening nutrition education and anemia prevention programs.

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