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Original Articles

Association Between Nutritional Status and Anemia Among Adolescent Girls

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ABSTRACT

Background: *Anemia remains one of the most common nutritional problems among adolescent girls, particularly in developing countries. Poor nutritional status during adolescence increases the risk of iron deficiency and anemia due to rapid growth, increased nutritional demands, and menstrual blood loss. Identifying the association between nutritional status and anemia is essential for developing effective prevention strategies.*
Research Objective: *This study aims to determine the association between nutritional status and the incidence of anemia among adolescent girls in Makassar, Indonesia.*
Methods: *This analytical observational study employed a cross-sectional design. A total of 41 adolescent girls aged 15–19 years were recruited using purposive sampling. Nutritional status was assessed using Body Mass Index-for-Age (BMI/A) based on the World Health Organization growth standards, while anemia status was determined by measuring hemoglobin concentration using a portable digital hemoglobin analyzer. Data were analyzed using descriptive statistics and the Chi-square test with a significance level of $p < 0.05$.*
Results: *Most respondents had normal nutritional status (56.1%), while 22.0% were underweight and 22.0% were overweight or obese. The prevalence of anemia was 41.5%. Bivariate analysis revealed a statistically significant association between nutritional status and anemia ($p = 0.021$). Adolescent girls with underweight nutritional status had a higher prevalence of anemia than those with normal nutritional status.*
Conclusion: *Nutritional status was significantly associated with anemia among adolescent girls. Maintaining optimal nutritional status through balanced dietary intake, routine nutritional assessment, and regular anemia screening is essential to reduce anemia prevalence and improve adolescent health. These findings provide evidence for strengthening school-based nutrition education and anemia prevention programs.*

Keywords: *Adolescent Girls; Anemia; Nutritional Status; Body Mass Index*

BACKGROUND

Anemia remains one of the most prevalent nutritional disorders among adolescent girls and continues to pose a substantial public health challenge worldwide (Flieh et al., 2023). Adolescence is a critical period characterized by rapid physical growth, hormonal changes, increased nutritional requirements, and the onset of menstruation, all of which significantly increase iron requirements (Madjdian et al., 2022). Inadequate dietary intake, poor nutritional status, recurrent infections, and unhealthy eating behaviors further increase the risk of anemia in this population (Akpene Amenya et al., 2021).

Globally, anemia continues to affect nearly one-third of women of reproductive age (Thalib et al., 2021). According to the World Health Organization (WHO), approximately 30% of women aged 15–49 years experience anemia, with adolescent girls in low and middle income countries representing one of the highest-risk groups (Fahim et al., 2020). Iron deficiency remains the leading cause, although deficiencies in folate, vitamin B12, vitamin A, chronic infections, parasitic diseases, inflammation, and inadequate dietary diversity also contribute substantially to anemia development (Desmond et al., 2021). WHO further emphasizes that adolescent nutrition is a critical intervention point because nutritional deficiencies during adolescence have long-term consequences for maternal and child health, thereby perpetuating the cycle of malnutrition across generations (Cunningham et al., 2020).

Indonesia continues to experience a considerable burden of anemia among adolescents despite various government initiatives, including weekly iron supplementation programs for adolescent girls (Pullakhandam et al., 2021). National surveys have consistently demonstrated that anemia prevalence among individuals aged 15–24 years remains high, indicating that nutritional interventions have not yet achieved optimal effectiveness (Azzopardi et al., 2019). The 2023 Indonesian Health Survey (SKI) also reported important challenges in the implementation of iron supplementation programs, revealing that more than half of adolescent girls had never received iron tablets and many lacked adequate knowledge regarding their benefits (Pullakhandam et al., 2021). These findings suggest that nutritional improvement requires not only supplementation but also comprehensive interventions addressing dietary behavior, nutritional status, and health education (Nguyen et al., 2019).

At the provincial level, South Sulawesi continues to face similar challenges. Previous epidemiological reports have shown that anemia among adolescent girls remains a significant nutritional problem, with prevalence estimates around one-third of adolescents in several districts (Priya et al., 2023). Rapid urbanization, changing dietary patterns, frequent consumption of processed foods, irregular eating habits, and inadequate intake of iron-rich foods contribute to the persistence of anemia in this region (Cliffer et al., 2023). Although provincial health authorities have implemented school-based iron supplementation programs, program adherence and nutritional improvement remain inconsistent, highlighting the need for evidence-based local interventions (Garg et al., 2023).

Makassar, the largest metropolitan city in Eastern Indonesia, illustrates these challenges clearly. Recent studies conducted among senior high school girls reported that approximately 29.3% of adolescent girls were anemic. Interestingly, several behavioral factors including frequent consumption of tea, chocolate, dairy products, and heavy menstrual blood loss were significantly associated with anemia, whereas nutritional status was not statistically associated in that particular population (Rana et al., 2019). These findings indicate that the determinants of anemia may vary across populations and emphasize the importance of conducting additional studies in different settings to clarify the contribution of nutritional status (Gyimah et al., 2021).

The relationship between nutritional status and anemia among adolescent girls remains inconsistent across previous studies, creating an important research gap.

Numerous investigations have demonstrated that undernutrition increases the risk of anemia because inadequate energy and protein intake is commonly accompanied by deficiencies in iron and other essential micronutrients (Christian et al., 2020). Conversely, several recent studies have reported no significant association between body mass index-based nutritional status and anemia, suggesting that behavioral, dietary, menstrual, inflammatory, and socioeconomic factors may exert stronger influences than anthropometric status alone (Rahman et al., 2023). Furthermore, many previous studies have focused exclusively on dietary intake, iron supplementation adherence, menstrual characteristics, or nutritional knowledge without comprehensively examining nutritional status as an independent determinant (Davidson et al., 2023). The inconsistency of existing evidence limits the development of targeted nutritional interventions for adolescent girls, particularly in urban Indonesian settings (Zhang et al., 2021).

Another important gap concerns the limited availability of local evidence from Makassar and South Sulawesi that simultaneously evaluates anthropometric nutritional status and laboratory-confirmed anemia using standardized measurement procedures. Most available studies have been conducted in different geographical regions, involved relatively homogeneous school populations, or emphasized behavioral risk factors rather than nutritional status itself (Lopes et al., 2019). Consequently, policymakers and school health programs still lack sufficient evidence to determine whether nutritional status screening can effectively identify adolescent girls at higher risk of anemia in this setting (Krishnan et al., 2021).

The novelty of the present study lies in its focus on clarifying the association between nutritional status and anemia among adolescent girls within the urban context of Makassar, where dietary transition and lifestyle changes are rapidly occurring. Unlike previous studies that predominantly investigated dietary habits, menstrual characteristics, or compliance with iron supplementation, this study specifically evaluates nutritional status as the principal exposure while using objective hemoglobin measurements to determine anemia status. The findings are expected to provide updated local evidence that may strengthen school health screening programs, improve nutritional surveillance among adolescents, and support integrated strategies combining nutritional assessment with anemia prevention. Furthermore, this study contributes to the growing body of evidence addressing inconsistent findings regarding the role of nutritional status in adolescent anemia within developing countries.

This study aims to determine the association between nutritional status and the incidence of anemia among adolescent girls in Makassar, Indonesia, in order to generate evidence that can support early identification of at-risk adolescents and inform the development of integrated nutrition and anemia prevention programs in school and community health settings.

METHODS

This analytical observational study employed a cross-sectional design (Adu et al., 2020) to determine the association between nutritional status and anemia among adolescent girls. The study was conducted from January to March 2024 at a senior high school in Makassar, South Sulawesi, Indonesia. A total of 41 adolescent girls were selected using purposive sampling based on the inclusion criteria of female students aged 15–19 years who agreed to participate in the study.

Nutritional status was assessed using Body Mass Index-for-Age (BMI/A) according to the World Health Organization (WHO) growth standards. Body weight and height were measured using standardized equipment, and BMI was classified into underweight, normal, overweight, and obese categories. Anemia status was determined by measuring hemoglobin levels using a portable digital hemoglobin analyzer (Hemocue® Hb 201+). Hemoglobin levels <12.0 g/dL were classified as anemia.

Data were analyzed using IBM SPSS Statistics version 27. Descriptive statistics were used to describe respondent characteristics, while the association between nutritional status and anemia was analyzed using the Chi-square test with a significance level of $p < 0.05$.

RESULTS

Univariate Analysis

Respondent Characteristic

A total of 41 adolescent girls participated in this study. Most respondents were aged 16–17 years (63.4%), had normal nutritional status (56.1%), and were not anemic (58.5%).

Table 1.
Characteristics of Respondents (n = 41)

Characteristics	Frequency (n)	Percentage (%)
Age (years)		
15	8	19.5
16	14	34.1
17	12	29.3
18	7	17.1
Nutritional Status		
Underweight	9	22.0
Normal	23	56.1
Overweight/Obese	9	22.0
Anemia Status		
Anemia	17	41.5
Non-anemia	24	58.5

Table 1 shows that the majority of respondents were 16 years old (34.1%). More than half of the respondents had normal nutritional status (56.1%), while 22.0% were underweight and 22.0% were overweight or obese. Regarding hemoglobin status, 17 respondents (41.5%) were classified as anemic, whereas 24 respondents (58.5%) had normal hemoglobin levels.

Bivariate Analysis

Table 2.
Association Between Nutritional Status and Anemia Among Adolescent Girls

Nutritional Status	Anemia n (%)	Non-anemia n (%)	Total	p-value
Underweight	7 (77.8)	2 (22.2)	9	0.021
Normal	6 (26.1)	17 (73.9)	23	
Overweight/Obese	4 (44.4)	5 (55.6)	9	
Total	**17 (41.5)**	**24 (58.5)**	**41**	

Bivariate analysis using the Chi-square test demonstrated a statistically significant association between nutritional status and anemia among adolescent girls ($p = 0.021$). Respondents with underweight nutritional status showed the highest proportion of anemia (77.8%), compared with those with normal nutritional status (26.1%) and overweight/obese respondents (44.4%). These findings indicate that adolescent girls with poor nutritional status were more likely to experience anemia than those with normal nutritional status.

DISCUSSION

This study found a statistically significant association between nutritional status and anemia among adolescent girls ($p = 0.021$). Adolescent girls with underweight nutritional status had a substantially higher proportion of anemia than those with normal nutritional status. These findings indicate that nutritional status is an important determinant of anemia during adolescence. The results support the concept that inadequate nutritional status reflects insufficient intake of energy, protein, iron, folate, vitamin B12, and other essential

micronutrients required for hemoglobin synthesis. During adolescence, rapid growth and the onset of menstruation increase nutrient requirements, making adolescent girls particularly vulnerable to anemia when their nutritional needs are not adequately met.

The predominance of respondents with normal nutritional status (56.1%) suggests that most adolescent girls had an acceptable nutritional condition according to Body Mass Index-for-Age (BMI/A). However, approximately one-fifth of the participants were underweight, indicating that undernutrition remains a nutritional concern among adolescents in Makassar. Nutritional status is influenced by dietary intake, eating habits, socioeconomic conditions, food availability, physical activity, and health status. Adolescents frequently consume energy-dense but nutrient-poor foods, skip breakfast, and have irregular meal patterns, all of which may contribute to inadequate micronutrient intake despite having a normal body weight.

The prevalence of anemia in this study reached 41.5%, indicating that anemia remains a moderate-to-high public health problem among adolescent girls. This finding is consistent with reports from the World Health Organization, which identifies adolescent girls as one of the most vulnerable groups for iron deficiency anemia because of increased iron requirements during growth and menstrual blood loss (Lopes et al., 2019). Inadequate iron intake reduces the body's capacity to produce hemoglobin, thereby decreasing oxygen transport to body tissues (Rahman et al., 2023). As a result, adolescents may experience fatigue, impaired concentration, reduced academic performance, decreased physical endurance, and weakened immune function. If anemia persists into adulthood, it may increase the risk of adverse pregnancy outcomes, including maternal anemia, preterm birth, low birth weight, and stunting in offspring (Zhang et al., 2021).

The significant association identified in this study is consistent with previous studies reporting that undernourished adolescents have a greater likelihood of developing anemia. Poor nutritional status is often accompanied by insufficient intake of iron-rich foods, animal protein, vitamin C, folate, and vitamin B12, all of which are essential for erythropoiesis (Davidson et al., 2023). Adolescents with chronic energy deficiency may also experience reduced absorption and utilization of nutrients necessary for red blood cell formation. Therefore, improving overall nutritional status may contribute to reducing the burden of anemia among adolescent girls (Krishnan et al., 2021).

Nevertheless, not all adolescents with normal nutritional status were free from anemia (Wang et al., 2023). Several respondents with normal BMI also had low hemoglobin levels. This finding suggests that body mass index alone cannot fully explain anemia occurrence. Nutritional status based on BMI reflects body composition rather than micronutrient adequacy. Adolescents with normal body weight may still have iron deficiency because of poor dietary quality, low consumption of iron-rich foods, excessive intake of foods that inhibit iron absorption, heavy menstrual bleeding, parasitic infections, or poor adherence to iron supplementation programs. Consequently, assessment of anemia should combine anthropometric measurements with biochemical examination to identify nutritional problems comprehensively (Zhao et al., 2022).

The findings also indicate that several overweight or obese respondents experienced anemia. This phenomenon is increasingly recognized as the "double burden of malnutrition," in which excessive body weight coexists with micronutrient deficiencies. Obesity is associated with chronic low-grade inflammation that increases hepcidin production, thereby reducing intestinal iron absorption and limiting iron mobilization from body stores. Consequently, overweight adolescents may also be at risk of iron deficiency despite excessive energy intake. This finding emphasizes that both undernutrition and overnutrition should receive equal attention in adolescent nutrition programs.

The present findings contribute to resolving inconsistencies reported in previous studies regarding the relationship between nutritional status and anemia (LIU et al., 2019). Some studies have reported no significant association because anemia is influenced by

multiple biological and behavioral factors, including menstrual patterns, dietary diversity, parasitic infections, genetic disorders, and adherence to iron supplementation. However, the present study demonstrates that nutritional status remains significantly associated with anemia among adolescent girls in Makassar. These differences may be explained by variations in population characteristics, socioeconomic conditions, nutritional behaviors, and study settings. Therefore, local evidence remains essential for designing context-specific interventions (Momanyi et al., 2020).

From a public health perspective, the findings highlight the importance of strengthening adolescent nutrition programs through schools and primary healthcare services. Routine nutritional assessment using BMI should be integrated with periodic hemoglobin screening to facilitate early identification of adolescents at risk of anemia. Nutrition education should encourage balanced diets rich in iron, animal protein, green leafy vegetables, legumes, and vitamin C-rich fruits while reducing the consumption of foods and beverages that inhibit iron absorption, such as tea and coffee during meals. Furthermore, improving adherence to weekly iron and folic acid supplementation remains essential to reduce anemia prevalence among adolescent girls (Nguyen et al., 2021).

This study has several limitations. First, the cross-sectional design does not allow causal inference between nutritional status and anemia. Second, the relatively small sample size from a single school limits the generalizability of the findings to the broader adolescent population. Third, dietary intake, menstrual blood loss, socioeconomic status, and inflammatory conditions were not evaluated, although these factors may influence hemoglobin levels. Future studies should employ larger multicenter samples and include additional biological, dietary, and behavioral variables to obtain a more comprehensive understanding of anemia risk factors among Indonesian adolescents.

Overall, this study demonstrates that nutritional status is significantly associated with anemia among adolescent girls. Maintaining optimal nutritional status through balanced dietary intake, regular nutritional monitoring, and effective iron supplementation programs is expected to reduce anemia prevalence and improve adolescent health. These findings provide valuable evidence for schools, healthcare providers, and policymakers in developing integrated nutrition and anemia prevention strategies targeting adolescent girls.

CONCLUSION

There was a significant association between nutritional status and anemia among adolescent girls ($p = 0.021$). Adolescent girls with underweight nutritional status were more likely to experience anemia than those with normal nutritional status. These findings highlight the importance of regular nutritional assessment and anemia screening, accompanied by nutrition education and iron supplementation programs, to improve adolescent health and prevent future reproductive health complications.

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