Journal of Indonesian Specialized Nutrition | e-ISSN: 3032-3878
Vol. 03 No. 03, 2025

CORRELATION OF BODY MASS INDEX WITH ANEMIA IN ADOLESCENT GIRLS AT SECONDARY SCHOOL PGRI 2 JAMBI CITY

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Abstract

Background: Anemia remains a major public health problem affecting adolescents worldwide, particularly girls who are vulnerable due to rapid growth and menstrual blood loss. In Indonesia, the prevalence of anemia remains high (25–40%), driven by poor dietary habits, low adherence to iron supplementation, and overall nutritional status. While Body Mass Index (BMI)-for-age is a recognized determinant of anemia risk, local evidence, particularly from Jambi City, remains scarce. **Methods**: This cross-sectional study involved 30 female students aged 15–18 years. The data utilized were collected during a Community Service Program (PKM). BMI for age z-scores were calculated using the WHO 2007 Growth Reference. Hemoglobin levels were measured using a portable hemoglobinometer (HemoCue Hb 301). The relationship between BMI-for-age categories (underweight, normal, overweight) and anemia status was analyzed using the Chi-square test. **Results:** The overall anemia prevalence was 40%. Based on BMI for age, participants were categorized as underweight (n=8), normal (n=18), and overweight (n=4). Anemia prevalence varied significantly across categories: underweight (75.0%) showed the highest rate, followed by normal (33.3%), and overweight (25.0%). Statistical analysis revealed a significant association between BMI-for-age and anemia (p = 0.041). **Conclusions:** Anemia was present across all BMI categories, with the highest prevalence among underweight adolescents. These findings indicate that nutritional status strongly influences anemia risk and should be prioritized in adolescent health programs. Integrating school-based strategies such as routine growth and hemoglobin monitoring, iron–folic acid supplementation, and engaging nutrition education.

Keywords: Body Mass Index, Anemia, Adolescent Girls, Nutritional Status.

Introduction

Anemia is a widespread public health problem that affects populations in both developing and developed countries. Globally, it is estimated that more than 30% of the world's population is anemic, with adolescent girls representing one of the most vulnerable groups due to their rapid physical growth, menstrual blood loss, and increased nutritional needs.[1] Adolescent anemia is considered a critical concern because it impairs physical growth, cognitive performance, school achievement, and future maternal health outcomes.[2]

In Indonesia, anemia among adolescent girls remains a significant challenge. National surveys and regional studies have consistently reported anemia prevalence rates ranging from 25% to over 40%, indicating a moderate to severe public health problem.[3] Several factors contribute to this high burden, including inadequate intake of iron-rich foods, consumption of iron absorption inhibitors such as tea and coffee, parasitic infections, poor sanitation, and low adherence to iron–folic acid supplementation programs.[4] These challenges are often compounded by socio-economic conditions and limited health literacy among adolescents and their families.[5]

Nutritional status, as measured by body mass index (BMI)-for-age, plays an important role in anemia risk. Adolescents with low BMI, reflecting undernutrition or thinness, are more likely to experience inadequate intake of macro- and micronutrients such as iron,

folate, and vitamin B12, which are essential for erythropoiesis.[6] Conversely, overweight and obesity, which are increasingly observed among adolescents in urban areas, may also be associated with anemia through mechanisms involving inflammation and impaired iron metabolism.[7] This dual burden of malnutrition/undernutrition and overweight/obesity, highlights the complexity of adolescent nutritional problems in Indonesia.

Despite the importance of this issue, local data from Jambi City remain limited. Most existing studies focus on large urban centers or provincial level surveys, leaving a gap in school based data that could better inform targeted interventions. Schools are a strategic setting for adolescent health research because they provide access to a large proportion of adolescents in a structured environment where both anthropometric measurements and hemoglobin assessments can be feasibly conducted.

Given these considerations, this study was conducted to investigate the correlation between BMI-for-age and anemia among adolescent girls at vocational secondary school or SMK PGRI (*Persatuan Guru Republik Indonesia*) 2 Jambi City. Understanding this relationship at the local level is expected to provide evidence that can guide school-based interventions and strengthen adolescent health programs aimed at preventing anemia and improving overall nutritional status.

Method

This study employed a cross-sectional design and was conducted on February 12, 2024, at SMK PGRI 2 Jambi City. The study population comprised a total of 30 female students aged 15 to 18 years. The data utilized in this research were secondary data collected from a

prior Lecturer Community Service Program (PKM) focused on assessing the nutritional status and health of the female students. Due to the data's origin in a non-research service activity intended for direct community benefit, formal ethical approval (ethical clearance) was not required. The sample was selected using purposive sampling, primarily due to accessibility and consent granted for participation in the original program. The small sample size is acknowledged as a limitation of this study. Anthropometric measurements were conducted by trained research assistants and supervising lecturers, and blood sampling for Hb measurement were conducted by Nursing lecturers. All measurement are taken in the School Health Unit (Unit Kesehatan Sekolah) clinic room.

Nutritional status was assessed using Body Mass Indec (BMI), calculated as body weight (kg) divided by height squared (m^2). The BMI-for-age z-scores were classified according to the World Health Organization (WHO) Growth Reference for 5–19 years, categorizes adolescents into underweight (z-score < -2 SD), normal (-2 SD to +1 SD), and overweight (> +1 SD). In this study, only these three categories were used to simplify interpretation and ensure adequate group sizes for statistical analysis, given the limited sample of 30 participants. The "obese" category was combined with "overweight" due to the small number of cases, allowing for a more meaningful comparison between groups. 8 Anemia status was determined based on hemoglobin (Hb) concentration. Hemoglobin concentration was measured using the HemoCue Hb 301 system, a widely utilized Point of Care Testing (POCT) device for field surveys. Anemia was defined according to WHO criteria, with Hb levels below 12.0 g/dL considered indicative of anemia in adolescent girls.9

Data analysis was performed using SPSS version 29, The chi-square test was used to examine the association between BMI categories and anemia prevalence. A significance level of $p < 0.05$ was set to determine statistical significance.

Results

Table 1. Distribution of Participants by Age, BMI-for-age and Anemia Status

Variables	Frequency (n)	Percentage (%)
Age (years)		
15	8	26.7
16	10	33.3
17	7	23.3
18	5	16.7
BMI-for-age Category		
Underweight	8	26.67
Normal	18	60.4
Overweight	4	13.33
Anemia Status		
Anemia	12	40
Non- Anemia	18	60
Total	**30**	100

The characteristics of respondents are presented in Table 1. Based on age distribution, most participants were 16 years old (33.3%), followed by those aged 15 years (26.7%), 17 years (23.3%), and 18 years (16.7%). In terms of nutritional status measured by BMI-for-age, the majority of respondents were in the normal category (60.4%), while 26.7% were classified as underweight and 13.3% as overweight. The prevalence of anemia among participants was 40.0 % (12 out of 30).

Tabel 2. The association of BMI Categories and Anemia Status among Adolescent Girls

BMI Category	Total (n)	Anemia (n, %)	Non-Anemia (n, %)	p-value
Underweight	10	7 (70.0%)	3 (30.0%)	
Normal	15	5 (33.3%)	10 (66.7%)	0.041
Overweight	5	0 (0.0%)	5 (100.0%)	
Total	**30**	**12 (40.0%)**	**18 (60.0%)**	

The relationship between BMI-for-age and anemia status among adolescent girls is shown in Table 2. Out of 30 respondents, 12 (40.0%) were identified as having anemia, while 18 (60.0%) were non-anemic. Among the 10 respondents categorized as underweight, 7 (70.0%) experienced anemia, indicating the highest proportion of anemia in this group. In contrast, among those with normal BMI (n = 15), only 5 (33.3%) were anemic and the majority (66.7%) were non-anemic. Interestingly, none of the respondents in the overweight group (n = 5) were found to have anemia, with 100% classified as non-anemic. Statistical analysis using the Chi-square test revealed a significant association between BMI-for-age and anemia status (p = 0.041). These findings suggest that underweight adolescents are more vulnerable to anemia compared to those with normal or higher BMI.

Discussion

This study demonstrated a significant association between body mass index (BMI)-for-age and anemia among adolescent girls at Secondary School (SMK) PGRI 2 Jambi City. The findings showed that underweight adolescents were approximately 4.5 times more likely to experience anemia compared to those with normal BMI. This indicates that low BMI is an important predictor of anemia risk in this population. The result aligns with the

biological mechanism that undernutrition leads to inadequate intake of energy, protein, and micronutrients such as iron, folate, and vitamin B12, which are critical for hemoglobin synthesis.[10]

The present study found a significant association between underweight status and anemia among adolescent girls. This finding aligns with national data showing that anemia remains a major nutritional problem among young women in Indonesia, with prevalence reaching 32–39%.[11] Similar associations have been observed in other regions of Indonesia. A study in Central Java reported that female adolescents with low BMI had almost twice the risk of anemia compared to those with normal nutritional status.[11] In West Java, Putri et al. (2020) found comparable findings, while Lestari and Dwihestie (2018) in East Nusa Tenggara also identified higher anemia prevalence among underweight adolescents.[12,13] These studies reinforce that nutritional inadequacy remains a key determinant of anemia in Indonesian adolescent girls.

At the regional level, research from Malaysia and the Philippines similarly reported that adolescents with low BMI were significantly more likely to develop anemia.[14,15] This cross-country consistency supports the robustness of the current finding that underweight status reflects a strong and biologically plausible risk factor for anemia in adolescent girls.

Interestingly, no cases of anemia were found among overweight participants in this study. While this might suggest a potential protective trend, the small sample size in the overweight group (n = 4) limits any firm conclusion. Previous studies have suggested that overweight and obese adolescents may also face anemia risk due to chronic inflammation

and impaired iron metabolism.[16] Therefore, further research with larger and more balanced samples is needed to explore this dual burden of malnutrition.

The results underscore the importance of addressing both undernutrition and anemia as interconnected health challenges in adolescence. Underweight adolescents are particularly vulnerable, as inadequate calorie intake is often accompanied by insufficient micronutrient intake.[17] At the same time, interventions must also consider that overweight adolescents may still face risks of anemia, though through different mechanisms. This "double burden of malnutrition" is increasingly recognized in Indonesia, where rapid dietary and lifestyle transitions have led to the coexistence of undernutrition and overweight in the same communities, and sometimes within the same households.[18]

Preventive efforts should begin early, as iron deficiency anemia has long-term impacts across life stages. A life course approach highlights the importance of integrating nutritional education and supplementation starting from adolescence.[19] From a programmatic perspective, schools represent an ideal platform to deliver nutrition interventions. The Indonesian government has already implemented the '*Tablet Tambah Darah'* (iron–folic acid supplementation) program for adolescent girls; however, compliance remains suboptimal due to limited awareness, misconceptions, and side effects.[20,21] This condition is concerning because iron, as an essential mineral, plays a crucial role in the formation of hemoglobin and myoglobin, which are key components in the transportation of oxygen and carbon dioxide in the body. Without adequate iron intake and adherence to supplementation, the risk of anemia and its associated health consequences among adolescents remains high.[22]

Efforts to prevent anemia should focus not only on improving dietary iron intake but also on achieving and maintaining a healthy BMI to support optimal growth and reproductive health in young women. Our findings suggest that supplementation programs should be combined with efforts to improve dietary diversity, promote balanced school meals, and discourage excessive consumption of iron absorption inhibitors like tea and coffee.[23] Inadequate iron intake not only increases the risk of anemia but also affects cognitive development in children. Children with iron deficiency face reduced cognitive function compared to their peers who have sufficient iron levels, as reflected in lower scores on cognitive tests that measure memory, attention, and learning ability.[24] This indicates that iron deficiency does not merely pose a nutritional problem but also hinders children's academic performance and overall intellectual growth.

Education-based interventions are also essential. A recent study by Heryanda et al. (2025) demonstrated that anemia education using animated videos significantly improved knowledge and attitudes among adolescent girls compared to traditional leaflet-based media[26]. This suggests that integrating engaging nutrition education into school curricula may help improve dietary behavior, compliance with supplementation, and overall nutritional status.

These efforts align with Indonesia's *Aksi Bergizi* initiative, a national school-based program that combines iron–folic acid supplementation with nutrition and physical activity education, which has shown positive effects in improving adolescent awareness and compliance.[27] Strengthening such integrated programs could provide a sustainable approach to addressing the dual burden of undernutrition and anemia in Indonesian adolescents.

Conclusion

This study demonstrated a significant association between body mass index (BMI)-for-age and anemia among adolescent girls, with underweight individuals showing a higher prevalence of anemia. Comprehensive, school-based strategies integrating routine growth and hemoglobin monitoring, iron–folic acid supplementation, and engaging nutrition education are strongly recommended. Implementing such programs can help identify at-risk adolescents early, improve dietary behavior, and prevent both undernutrition and anemia.

Acknowledgment

The authors would like to thank the research and community service institution of Adiwangsa University Jambi for the funding support provided through the Community Service Program (PKM), which facilitated the data collection. We also express our sincere gratitude to the Principal, teachers, and students of SMK PGRI 2 Jambi City for their cooperation and participation in the study.

Conflict of Interest

There are no conflict interest of this publication.

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