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Relationship Between Body Mass Index and The Incidence of Anemia in Adolescent Girls

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Abstract

Anemia is a condition in which the hemoglobin level in the blood is less than 12 g/dl. Anemia in adolescents will result in decreased concentration, decreased physical fitness, and growth disorders, so that height and weight do not reach normal levels. The purpose of this study was to determine the relationship between Body Mass Index (BMI) and the incidence of anemia in adolescent girls.

This study employed a quantitative analytical method with a cross-sectional approach. It was conducted at SMAN 12 Padang from January to July 2025 with a sample size of 54 female adolescents, using proportional random sampling. The research instruments used were digital scales, microtoise, and a digital hemoglobinometer, which were analyzed using the Chi-square test.

The results of the study showed that a low BMI was more prevalent in the anemia group (57.4%) than in the non-anemia group (42.6%). The statistical test results showed a significant relationship between BMI and the incidence of anemia in adolescent girls (p-Value (p = 0.000).

Conclusion: There is a significant association between BMI and the occurrence of anemia in adolescent girls. It is hoped that adolescents will gain a better understanding of anemia and nutritional status.

Keywords: Anemia, BMI, Adolescent girls

Introduction

Anemia is a condition in which the hemoglobin (Hb) level in the blood is less than the normal level of 12 g/dl. Anemia is characterized by fatigue, pale skin, frequent tremors, 51 (tiredness, exhaustion, lethargy, weakness), frequent dizziness and blurred vision. Further symptoms include pale eyelids, lips, tongue, and palms. Iron deficiency anemia in adolescent girls is at higher risk because it causes a decrease in immunity, making them more susceptible to health problems. Anemia in adolescents will result in decreased concentration in learning, decreased physical fitness, and growth disorders so that height and weight do not reach normal levels. In the long term, this condition can continue into pregnancy and childbirth, negatively impacting the health of the mother and baby and potentially increasing the risk of maternal mortality, premature birth, perinatal mortality, and low birth weight. (1–3)

The World Health Organization (WHO) in 2023 stated that the prevalence of anemia worldwide has increased, according to global anemia trends. Anemia is commonly experienced by women aged 15 years and above at a rate of 30,7%, with the highest prevalence of 42% found in Southeast Asia. Overall, anemia affects 40-88% of the total population worldwide. The prevalence of anemia in pregnant women in Indonesia reached 27.1% (4). According to a 2023 report from the Padang City Health Office, the prevalence of anemia among adolescent girls was 34.12% (5)

Indicators of inadequate nutritional status are one of the causes of anemia. Adolescent girls, who tend to be more concerned about their appearance, often restrict their diets too severely because they do not want to become overweight, which can lead to nutritional deficiencies. Very often, diets that violate nutritional guidelines cause the body to not meet its nutritional needs (6)

One factor that can cause anemia is an imbalance between food consumption and the body's nutritional needs. Decreased hemoglobin levels in the blood can occur due to inadequate nutritional intake. Abnormal nutritional status in adolescent girls due to deficiencies in macronutrients (carbohydrates, protein, and fat) and micronutrients (vitamins and minerals) leads to wasting and drastic weight loss. An unbalanced diet is a risk factor. *Body Mass Index* (BMI) can be used to determine the nutritional status of adolescent girls (7)

Adolescent girls are the population group with the greatest potential to

contribute to a nation's progress, as they are the next generation and determine its future. Furthermore, adolescent girls are also potential mothers who will give birth to children who will contribute to the nation's progress. If a woman suffers from anemia from adolescence, it can result in impaired growth and development, weakness due to frequent infections, inactivity, laziness, fatigue, difficulty concentrating in school, and drowsiness. Further consequences of this anemia can affect intelligence and comprehension, given that they are still growing and developing. Therefore, early detection of the nutritional status of adolescent girls is crucial to prevent further nutritional problems that could impact the quality of future human resources (7)

In adolescents, being underweight is associated with macronutrient and micronutrient deficiencies. Obesity is also associated with anemia due to fat accumulation in adipose tissue. Fat can reduce iron absorption, as fatty tissue in obesity causes chronic inflammation. High levels of hepcidin inhibit hepcidin from the liver and adipose tissue, inhibiting the functional activity of ferroportin, thus inhibiting iron absorption in enterocytes and reticuloendothelial iron release in macrophages. This results in hypoferremia and impaired iron metabolism. If iron metabolism is impaired, anemia occurs (8).

Pasalina (2019) found no relationship between BMI and anemia in women of childbearing age. (8). The results of Kaban's (2021) research analysis using the chi-square test showed that there was a significant relationship between BMI and the incidence of anemia (p=0.015) (9). Yulianti's (2024) research also found a similar relationship between nutritional status and anemia in adolescent girls (3). The gaps found in several previous research results made researchers interested in examining the relationship between BMI and MUAC with the incidence of anemia. The purpose of this study was to determine the relationship between BMI and the incidence of anemia in adolescent girls at SMAN 12 Padang.

Method

1. Research design

This type of research uses quantitative analytical methods with data collection based on a cross-sectional approach. The sampling technique used in this study is proportional random sampling. Data analysis techniques are used to test the hypothesis of the

relationship between independent variables and dependent variables using the Chi-square test with a significance level of 95%.

2. Setting and samples

The population in this study consisted of all 115 female students in grade XI at SMAN 12 Padang. Sampling in this study used the Slovin formula to determine the sample size. The number of samples in this study was 54. The sampling technique used in this study was Proportional Random Sampling. The exclusion criteria in this study were not menstruating, not having menstrual disorders/abnormal bleeding, and not being sick.

3. Measurement and data collection

This study uses primary data, namely data obtained from direct measurements of BMI and Hb examination. BMI is calculated by dividing body weight (in kilograms) by the square of height (in meters). BMI is classified as underweight, normal, and overweight. Hemoglobin is measured using a digital hemoglobinometer. The results of the Hb measurement consist of anemia (< 12 g/dl) and non-anemia (≥ 12 g/dl).

4. Data analysis;

Data was analyzed using univariate and bivariate methods. Univariate analysis is used to see the frequency distribution for each variable studied, in this case, BMI. The bivariate analysis conducted was to find the relationship between BMI and the incidence of anemia in female adolescents using the chi-square test.

Results

Tabel 1

Frequency Distribution of Body Mass Index of Adolescent Girls

Body Mass Index	***f***	**Percentage**
Underweigh	31	57.4%
Normal	23	42.6%
Overweight	0	0.0%
Total	54	100%

Table 1 shows that more than half (57.4%) of respondents were classified as underweight based on their Body Mass Index.

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Tabel 2
Frequency Distribution of Anemia Incidence in Adolescent Girls

Anemia Incidence	***F***	**Percentage**
Anemia	32	59.3 %
Non Anemia	22	40.7 %
Total	54	100%

Table 2 shows that more than half (59.3%) of respondents experienced anemia.

Tabel 3
The Relationship between Body Mass Index and Anemia in Adolescent Girls

BMI	**Anemia**		**Non Anemia**		**Total**		**p-Value**
	f	***%***	**f**	***%***	**n**	***%***	
Underweight	27	87.1%	4	12.9%	31	100%	0.000
Normal	5	21.7%	18	78.3%	23	100%	
Total	32	59.3%	22	40.7%	54	100%	

Table 3 shows that underweight was found more frequently in the anemia group (87.1%) than in the non-anemia group (12.9%). The results of the analysis using the Chi-Square Test obtained a p-value of 0.000 ($p < 0.05$), so it can be stated that there is a relationship between BMI and the incidence of anemia in adolescent girls.

Discussion

The results showed that underweight Body Mass Index (BMI) was more common in the anemic group (87.1%) compared to the non-anemic group (12.9%). Furthermore, the statistical test yielded a p-value of 0.000 ($p < 0.05$), indicating a significant relationship between BMI and the incidence of anemia in adolescent girls. This finding indicates that nutritional status, particularly low BMI, is an important factor contributing to adolescent girls' susceptibility to anemia.

This aligns with previous research showing that poor nutritional status, especially low BMI, is strongly associated with an increased risk of anemia among adolescent girls. For example, a national study using the Indonesia Family Life Survey (IFLS-5) reported that underweight adolescents had a significantly higher risk of anemia ($p = 0.034$). This suggests that inadequate nutritional intake, particularly energy, protein, and iron, reduces the body's nutritional reserves and hemoglobin production, increasing the likelihood of anemia (10). Another study conducted in a pesantren environment in

Gresik also found that nutritional status measured by BMI was significantly associated with anemia among adolescent girls (11).

Research by Febriayanti S (2025) on adolescent girls in Sulawesi also found that the majority of young women with BMI were thin at 56.2%, and there was a relationship between BMI and hemoglobin (12). Research by Pasalina (2019) found no relationship between BMI and anemia in women of childbearing age. (8). This finding reinforces the fact that nutritional status plays a crucial role in adolescent hematological health.

This study found that anemia was more common in underweight teenage girls. Underweight adolescents are deficient in both macronutrients and micronutrients. Protein is the primary macronutrient involved in iron absorption and metabolism, so a protein deficiency will disrupt iron transport and increase the risk of infection. Micronutrients play a role in iron absorption and metabolism, including iron, folic acid, vitamin C, vitamin B12, vitamin A, zinc, and copper. If any of these micronutrients or macronutrients are deficient, iron absorption and metabolism will be impaired, leading to impaired hemoglobin synthesis. (8).

Anemia is a condition in which the body's hemoglobin (Hb) level falls below the normal range. Hemoglobin, a key component of erythrocytes (red blood cells), functions as an oxygen carrier that transports oxygen to all body tissues, enabling cells to perform their physiological roles effectively. The normal Hb thresholds are 11.5 g/dL for children aged 5–11 years, 12.0 g/dL for those aged 12–14 years, and 12.0 g/dL for adult females (10).

Iron plays a crucial role in hemoglobin synthesis. Various foods rich in iron include beef, eggs, chicken liver, tuna, green beans, soybeans, spinach, shellfish, and many others. Therefore, it is essential—particularly for adolescent girls—to consume iron-rich foods regularly as a preventive measure against anemia. An individual's nutritional adequacy can also be assessed through Body Mass Index (BMI) measurements, which serve as an indicator of overall nutritional status (10).

Until recently, the evidence published in support of the association between BMI and anemia is controversial. Several studies have reported a direct association, suggesting that a higher BMI increases the likelihood of anemia, while others have found the opposite trend. Additionally, some studies have concluded that no significant

relationship exists between the two variables. These inconsistencies may be partly attributed to variations in the anemia biomarkers used across studies.The present findings indicate that overweight and obese women are less likely to experience anemia compared with those who are normal weight or underweight, and this pattern remained consistent across various statistical analyses (13).

Fat accumulation in adipose tissue can contribute to anemia by reducing iron absorption. In obesity, adipose tissue triggers chronic inflammation associated with increased expression of pro-inflammatory cytokines, such as Interleukin-6 (IL-6) and Tumor Necrosis Factor-α (TNF-α). This systemic inflammation is linked to the development of various metabolic and degenerative diseases. Pro-inflammatory cytokines then stimulate the release of hepcidin from the liver and adipose tissue. High hepcidin levels suppress ferroportin function, inhibiting iron absorption in enterocytes and iron release from reticuloendothelial macrophages. This condition leads to hypoferremia and impaired iron metabolism, which can ultimately lead to anemia. Fat accumulation in the liver can also trigger the formation of lipid peroxides, which in turn impact iron metabolism and generate free radicals. As a result, hemoglobin synthesis is suboptimal. In the final stages, hemoglobin levels decrease and red blood cells shrink, resulting in anemia (8)

Conclusion

Based on the results of research on the relationship between Body Mass Index and with the Incidence of Anemia in Adolescent Girls at SMAN 12 Padang. It was concluded that underweight is more commonly found in the anemia group. In addition, it was also found that more than half of adolescent girls were underweight, and more than half of adolescent girls suffer from anemia.

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Author contribution

The main author contributed to finding the research idea, writing the proposal, coordinating the research implementation, and writing the research article. The author members contributed to the research implementation, data analysis, scientific literature search, and assisted in writing the final research report.

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