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Nutritional Status as a Determinant of Anemia Among Adolescents: A Cross-Sectional Study

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ABSTRACT

Adolescence is a period of physical growth that requires optimal nutritional intake. Nutritional imbalances can increase the risk of anemia in adolescents. Nutritional status, measured using Body Mass Index (BMI), is thought to be associated with hemoglobin levels, an indicator of anemia. This study aimed to determine the relationship between nutritional status based on BMI and the incidence of anemia in junior high school adolescents. This analytical study, using a cross-sectional design, was conducted in November 2024. A sample size of 95 was selected using a purposive sampling technique with inclusion and exclusion criteria. The research instruments, including a weight scale, microtoise, and a Point of Care Test (POCT), were conducted quickly, practically, and directly at the study site without requiring a laboratory. Data were analyzed using univariate tests and Spearman's correlation test due to non-normal distribution. Respondents were 53.7% male and 46.3% female. The average BMI was 18.86 ± 4.07 and the hemoglobin level was 12.84 ± 1.409 mg/dL. Spearman's test results showed a ρ value of 0.713 with a correlation coefficient of 0.038, indicating a very weak and insignificant relationship. There is no significant relationship between nutritional status based on BMI and the incidence of anemia in junior high school adolescents. Anemia in adolescents is a health problem influenced by various factors, including nutritional status, micronutrient intake, and reproductive health.

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Introduction

Adolescence is a crucial transitional phase in the human life cycle, characterized by rapid biological, psychological, emotional, and social changes (Heslin & McNutly, 2023; Sahiner & Yesilkaya, 2021). Rapid physical growth and cognitive development in this period, the intensity of which is only inferior to infancy corresponds, according to optimal nutritional intake to support development and prevent health problems such as anemia (Adegboyega et al., 2025; Heselin & McNulty, 2023; Parks et al., 2020). During adolescence, individuals can experience an increase in body weight of up to 50%, height of more than 20% and bone mass of 50% of total adult mass, which significantly increases daily energy and nutrient requirements (Adegboyega et al., 2025).

Anthropometry, as a science that studies the human body and is used to assess nutritional status. However, this assessment needs to be reinforced with an understanding of specific health conditions such as anemia. Anemia is defined as a condition of low than normal hemoglobin levels, which can be caused by inadequate red blood cell production or iron deficiency, as well as being affected by other nutritional deficiencies, non-nutritional conditions, and genetic factors.

In Indonesia, anemia in adolescence is still a health problem in the community that needs attention. Data shows that the prevalence of anemia in adolescents, especially adolescent girls, in Indonesia varies, with a figure of 21.7% in the age group of 5-14 years, 18.4% in the age group of 10-19 years, and 18.4% in 15-24 years in 2029 (Christiana et al., 2024), In fact, in 2022, around 32% of adolescent girls aged 15-24 years in Indonesia suffer from anemia, which means that 3-4 out of every 10 adolescents experience this condition (Christiana et al., 2024). The tendency to increase the prevalence of anemia in adolescents can have a serious impact on work productivity, study concentration, reproductive health, and inhibit growth, motor development, and brain intelligence (Mulianingsih, 2021, Mulianingsih et al., 2024).

The factors that contribute to the high incidence of anemia in adolescence are complex. Adolescent girls, in particular, are at higher risk due to monthly menstrual cycles and improper eating habits, including diets for the appearance of fiski (Melani et al., 2024; Yulianingsih & Porouw, 2020). Lack of knowledge about anemia, its symptoms, effects, and prevention often causes adolescents to consume foods that are low in iron (Dewayanti et al., 2021; Fauni et al 2025). In addition, unhealthy eating behaviors, such as preferences for fast food and soft drinks that lack complete nutrition and rarely consume traditional foods rich in iron, and even low vitamin D levels can also affect hemoglobin levels (Fauni, et al., 2025; Lasmawanti et al.,

2022). To meet daily iron needs, adolescent girls are advised to consume about 26 mg of iron per day (Fauni et al., 2025).

The age of 13 to 15 years is an important phase in which adolescents' identities begin to take shape and they are particularly vulnerable to the influence of the surrounding environment. Concerns about physical appearance often encourage adolescents to restrict eating or choose certain foods, which can lead to insufficient nutritional intake and risk of anemia (Yulianingsih & Porouw, 2020). Given this background, researchers were interested in investigating the relationship between nutritional status and the incidence of anemia in adolescents aged 13 to 15 years. This research was carried out at Muhammadiyah Rawalo Junior High School, a location that has never been the focus of similar research, so that it can be the basis for further studies on anemia in adolescent population..

Method

This study uses analytical research with *a cross sectional design* to determine the relationship between nutritional status and the incidence of anemia in adolescents at Muhammadiyah Rawalo Junior High School. The population in this study is all students of Muahammadiyah Rawalo Junior High School which is 95 people. The sampling technique in this study is *purposive sampling*, where the sample size in this study is taken in November 2024 in accordance with the inclusion and exclusion criteria. Inclusion criteria: 1) Adolescents aged 13-15 years, 2) A student of Muhammadiyah Rawalo Junior High School, 3) Male students who have been circumcised, 4) Students who have menstruated. Exclusion criteria: 1) Students who have a history of reproductive disorders. The instruments in this study were using a weight scale, height measure, tension meter, HB level examination, questionnaire containing demographic data (name, age, gender, BB, TB, and disease history), BMI calculation sheet. The analysis method uses univariate and bivariate methods. A univariate method was used to describe adolescent characteristics. Meanwhile, the bivariate method uses the Pearson test with the aim of finding out the correlation between adolescent nutritional status as seen from BMI and the results of HB levels with the incidence of anemia.

Research Results

Characteristics of respondents Based on Weight, Height, Systolic Blood Pressure and Diastolic Blood Pressure

Table 1 Characteristics of Respondents by Weight, Height, Systolic Blood Pressure and Diastolic Blood Pressure (n 95)

Variable	Mean (SD)	in -max	Median
Body Weight (kg)	45,18 (12,25)	27,55-96,35	42,25
Height (cm)	153,80 (9,222)	134-181	153
Systole	114,36 (16,413)	62-164	110
Diastole	71.55 (15,96)	21-116	70

Based on table 1, it is known that the average weight of the respondents is 45.18 with a standard deviation of 12.25. The average height of the respondents in the study was 153.80 with a standard deviation of 9.222. The average systolic blood pressure in the respondents was obtained at an average of 114.36 with a standard deviation of 16.413. The systolic blood pressure in the respondents was obtained on average 71.55 with a standard deviation of 15.96.

Table 2 Characteristics of Rsponden by Gender

Variable	F	%
Gender		
Women	44	46,3
Male	51	53,7
Total	95	100,0

Based on table 2, it is known that the gender characteristics of the respondents are mostly male as many as 51 respondents (53.7%) while women in this study amounted to 44 respondents (46.3%)

Table 3 Univariate Analysis Results of Each Variable (n 95)

Variabel	Mean (SD)	Min -max	Median
Body Time Index (BMI)	18,86 (4,07)	12,3-32	17,6
Hemoglobin	12,84 (1,409)	9,5-18,8	12,8

From table 3, it can be seen that the body mass index in the respondents has an average of 18.86 with a standard deviation of 4.0, while the hemoglobin variable has an average of 12.84 with a standard deviation of 1.409.

Table 4 Normality Test of BMI and Hemoglobin variables

Variable	F	value	Remarks
Body Time Index	95	0,000	Abnormal
Hemoglobin	95	0,79	normal

*Description: Significant at ρ-value 0.05, n=95

From table 4, it can be concluded that the results of the normality test on the Body Time Index variable are abnormally distributed and the Hemoglobin variable is normally distributed. So it can be concluded that the test used is an alternative test using the spearman test.

Table 5 Relationship between BMI and Hemoglobin (n 95)

Variable	Median	Min-max	Correlation Coefficient	P-value
Body Time Index	17,6	12,3-32	0,038	0,713
Hemoglobin	12,8	9,5-18,8		

* Description: Significant at ρ-value 0.05, n=95

Based on table 5 above, it can be seen that based on the Spearmon test, ρ-value = 0.713 was obtained, which means that there is no significant relationship between adolescent nutrition and the incidence of anemia in adolescents. The correlation coefficient result was obtained with a value of 0.038 which means that the strength level is low. Therefore, it can be concluded that adolescent nutrition is not significantly related to anemia in adolescents with low relationship strength.

Discussion

This study aims to determine the relationship between nutritional status based on Body Mass Index (BMI) and the incidence of anemia in adolescents aged 13-15 years at Muhammadiyah Rawalo Junior High School. The study was conducted using *a cross-sectional* design of 95 respondents with BMI and hemoglobin levels measured using *the Point of Care Test* (POCT). The results of the analysis showed that there was no significant relationship between nutritional status and the incidence of anaemia ($\rho = 0.713$; $r = 0.038$). Thus, the research hypothesis that states the relationship between nutritional status based on BMI and the incidence of anemia is not statistically proven.

The results of the study show that nutritional status based on BMI is not the main predictor of the incidence of anemia in adolescents. A correlation coefficient value of 0.038 indicates a very weak relationship, while a significance value of 0.713 indicates that variation in hemoglobin levels cannot be explained by BMI variation. These findings indicate that adolescents with normal BMI do not necessarily have normal hemoglobin levels, nor do adolescents with low BMI necessarily have anemia. This condition shows that the macronutrient status measured using BMI has not been able to describe the sufficiency status of micronutrients, especially iron, vitamin B12, and folic acid which play a direct role in the erythropoiesis process.

In addition, the average hemoglobin level of the respondents of 12.84 ± 1.409 g/dL was above the limit of anemia, so most of the respondents did not experience anemia. This condition causes the variation in hemoglobin data to be relatively small, so the ability of statistical tests to detect relationships is also limited. Theoretically, anemia occurs when hemoglobin production is insufficient due to lack of iron, vitamin B12, folic acid, chronic diseases, infections, and genetic disorders. Therefore, nutritional status based on BMI is not the only factor that determines hemoglobin levels.

The results of this study are in line with the theory that anemia is a multifactorial disease. BMI only describes the balance between weight and height, while the formation of hemoglobin is influenced by the adequacy of micronutrients as well as various other biological factors. The findings of this study are also consistent with several previous studies that reported no meaningful association between BMI and the incidence of anemia, such as the research of Permatasari et al. (2020). In contrast, several other studies, such as Husnah et al. (2023) and Nurjannah & Putri (2021), found a significant association between nutritional status and anemia. The difference in results is likely influenced by sample characteristics, proportion of adolescent girls, nutritional status assessment methods, and prevalence of anemia in each study population.

This study offers several important contributions. First, it involved junior high school adolescents of both sexes, providing a broader representation of anemia conditions within the adolescent population. Second, hemoglobin levels were assessed using the Point-of-Care Testing (POCT) method, enabling rapid measurement that is practical for implementation in school-based health screening programs. Third, the findings reinforce the evidence that body mass index (BMI) should not be used as a single indicator for identifying anemia risk among adolescents. Instead, a more comprehensive screening approach is warranted, integrating anthropometric measurements with dietary iron intake, menstrual status, and biochemical biomarkers such as ferritin and transferrin to improve the identification of adolescents at risk of anemia.

Another scientific contribution is to expand the evidence that anemia in adolescents is a multifactorial condition so that prevention programs should not only focus on improving nutritional status based on weight, but should also include nutrition education, iron supplementation, and health behavior changes.

The study initially hypothesized that better nutritional status would be associated with higher hemoglobin levels; however, the findings indicated no statistically significant relationship between the two variables. This result may be explained by the relatively limited variation in the data, as most respondents had normal nutritional status and hemoglobin levels. Furthermore, BMI primarily reflects macronutrient status and does not adequately represent iron or other micronutrient deficiencies that are essential for hemoglobin synthesis. The study also did not assess several potential confounding factors, including dietary iron intake, adherence to iron supplementation, menstrual duration, helminth infections, chronic diseases, inflammatory

conditions, and genetic factors. In addition, the inclusion of male respondents, who constituted 53.7% of the sample, may have contributed to the relatively lower prevalence of anemia compared with studies focusing exclusively on adolescent girls. Finally, the cross-sectional design captures nutritional status and hemoglobin levels at a single point in time and therefore cannot adequately reflect the long-term development of anemia resulting from nutritional deficiencies.

The results of the study imply that the anemia screening program in schools should not only use BMI as a risk indicator, but needs to be combined with regular hemoglobin level checks, assessment of diet and iron consumption, balanced nutrition education, adherence to the consumption of blood-boosting tablets, especially in adolescent girls, and screening of other risk factors such as menstrual patterns, infections, and chronic diseases. For community nurses and UKS officers, the results of this study are the basis that anemia prevention education needs to be directed at increasing the consumption of foods rich in iron, vitamin C, vitamin B12, and folic acid as well as changes in healthy living behaviors.

Theoretically, this study supports the concept that anemia is a multifactorial disease that is influenced by the interaction between biological, nutritional, reproductive, behavioral, environmental, and social factors. Therefore, the research model on anemia in adolescents should use a multivariate approach rather than only assessing a simple relationship between BMI and hemoglobin levels. The limitation of this study is that using *a cross-sectional design* does not allow researchers to determine the cause-and-effect relationship between nutritional status and the incidence of anemia. Nutritional status was only assessed using BMI without biomarker examination such as serum ferritin, transferrin, vitamin B12, or folate levels that more specifically describe iron status. The study did not evaluate other important factors that can affect anemia, such as diet, consumption of blood-boosting tablets, length of menstruation, worm infections, physical activity, socioeconomic status, or knowledge about anemia. The research was conducted in only one school with a sample of 95 respondents so the generalization of the research results is still limited.

Conclusion

The findings demonstrate that nutritional status based on Body Mass Index (BMI) was not significantly associated with anemia among adolescents aged 13–15 years at Muhammadiyah Rawalo Junior High School ($\rho = 0.713$; $r = 0.038$). Although most participants had normal BMI

and hemoglobin levels, these findings suggest that BMI alone is insufficient to identify adolescents at risk of anemia. Anemia is a multifactorial condition influenced by dietary iron and micronutrient intake, adherence to iron supplementation, menstrual characteristics, infectious diseases, and other biological and environmental factors. Therefore, adolescent anemia prevention and early detection should adopt a comprehensive approach that integrates anthropometric assessment with hemoglobin measurement, dietary evaluation, and assessment of relevant clinical and behavioral risk factors to support more targeted and effective interventions.

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