# The Relationship Between Body Mass Index and Incidence of Anemia among Adolescent Girls in East Lombok, Indonesia

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**Abstract.** Anemia in adolescent girls could bring several health consequences and its prevalence was high, thus, remains a public health significance. Nutritional status is one of important factor in anemia development. This study aims to observe a correlation between age and nutritional status with incidence of anemia among adolescent girls. This study used cross-sectional design with total sample of purposively selected 30 adolescent girls aged 15-18 years. Nutritional status data was collected using direct measurement height and weight then calculate Body-Mass-Index (BMI) – Age Z-score (BAZ), while anemia defined by Hemoglobin (Hb) value. Normality test using Kolmogorov-Smirnov was done before inferential analysis. To assess relationship between variables, Pearson correlation analysis was performed. Our study found mean of BMI among adolescents' group was 20.5 kg/m$^2$ $\pm$ 2.8, mean BAZ -0.17 $\pm$ 0.95, while mean of Hb was 14.5 $\pm$ 1.1. Mean of BMI, BAZ and Hb level were considered in normal range. Based on BAZ category, mean of Hb in normal nutritional status was 14.53 while mean of Hb in overweight girls was 14.55. Statistical analysis could not find any significant correlation between age and anemia ($p$ = 1.000), also between BAZ and anemia ($p$ = 0.370). Although there was no correlation, we found a tendency of slightly higher Hb in overweight adolescents. An optimal effort from related stakeholders is needed to increase adolescent girls' nutrition knowledge and practice in optimizing their nutritional status to prevent anaemia by utilizing various media and technology considering the massive use of technology by adolescents.

**Keywords:** anemia, adolescent girls, nutritional status

## 1 Introduction

The World Health Organization (WHO) in the world health topics on adolescent health explains that adolescence is one phase of life between childhood and adulthood, ranging in age from 10 to 19 years; where at this stage, they experience physical, cognitive, and


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psychosocial growth that will affect the way they think, feel, make decisions, and interact with the world around them [1]. This stage is the right time to pay attention to essential health and good nutrition to optimize growth and development. Nutrients that are not correctly fulfilled will cause problems such as stunting, Chronic Energy Deficiency (SEF), overweight or obesity, and iron deficiency or anemia [2]. One of the most common nutritional problems experienced by adolescents in Indonesia, especially adolescent girls, is iron deficiency or anemia [3].

The incidence of anemia based on the results of Riskesdas 2018, the prevalence of anemia in adolescents is 32%, meaning that 3-4 out of 10 adolescents suffer from anemia. This is influenced by non-optimal nutritional intake habits and lack of physical activity [4]. World Health Organization (WHO) (2023) mentions anemia as a condition where the number of red blood cells or hemoglobin concentration in it is lower than the normal value [5]. The use of threshold values in anemia recommended by WHO is in children aged 5-11 years <11.5 g/dl, children aged 12-14 years, and women of childbearing age <12 g/dl [6]. The clinical symptoms of anemia are characterized by weakness, fatigue, lack of enthusiasm, dizziness, foggy eyes, and a pale face. The adverse effects of anemia in adolescents are decreased immunity, concentration, learning achievement, fitness, and productivity [7].

However, if not treated immediately, anemia experienced by adolescent girls can have a more severe impact, considering that they are prospective mothers who will carry and give birth to babies. Because anemia in pregnant women will be very risky for fetal growth, which can result in babies born with low birth weight (LBW) to the death of mothers and babies during the delivery process [8], factors causing anemia include iron deficiency, vitamin B12 deficiency, folic acid deficiency, infectious diseases, congenital factors and bleeding [9]. In addition, the widespread perception of shaping body image to display self-confidence in adolescent girls also makes them have a poor diet and low nutrients. This poor diet is one of the causes of abnormal nutritional status or Body Mass Index (BMI).

Body Mass Index (BMI) is an anthropometric index or an assessment of a person's nutritional status based on the comparison formula of Body Weight (kg)/Height $(cm)^2$ [10]. Calculation of Body Mass Index can be an essential indicator to evaluate and identify problems related to adolescent nutritional status. Body Mass Index is divided into three categories: BMI <18.5 kg/m2 is the Skinny category, BMI 18.5-25 kg/m2 is the Normal category, and BMI >25 kg/m2 is the Fat category [11]. Adolescents with low BMI values below regular or thin may risk health problems, namely anemia [12]. In contrast, adolescents with high BMI values above normal may attempt obesity-related diseases such as diabetes, cholesterol, heart disease, or high blood pressure [13]. With the use and monitoring of this Body Mass Index, preventive or early treatment measures can be taken immediately. Some factors that can affect Body Mass Index include genetic factors, environmental factors based on poor or excessive diet, and lack of physical activity patterns that will cause fat accumulation in the body. The use of certain drugs can also affect body weight and BMI [14].

Based on several previous studies, it was found that weight and height are also factors affecting anemia [15], where women who are overweight or obese have been shown to have a lower chance of experiencing anemia, while underweight women are more likely to experience anemia [16]. It is also known that the nutritional status of adolescents in rural areas is much higher than in urban areas [17]. Although there have been many research studies analyzing the relationship between Body Mass Index or nutritional status with the incidence of anemia, it is known that there has been no research on similar studies, especially in the Sembalun area. So this study was conducted to investigate whether there is a relationship between Body Mass Index (BMI) and the incidence of anemia in adolescent girls in the Sembalun area, East Lombok, Indonesia.

## 2 Methods

This study was a quantitative study using a cross-sectional design. The sample was purposively selected from SMAN 1 Sembalun, East Lombok, Indonesia. A total of 30 adolescent girls were enrolled in the study. Data collection was performed by direct measurement and interview. Direct measurement of weight and weight was used to calculate Body Mass Index (BMI). Weight was measured using a digital weight scale with a precision of 0.1 kg, while height was measured using a portable microtoise with an accuracy of 0.1 cm. All measurement was performed by a trained nutritionist. After weight and height data were collected, BMI was calculated. To define nutritional status in the adolescent group, BMI for age z-score was also calculated using WHO Anthropometry Plus software. BMI for age z-score was then categorized into three categories, i.e., thinness (z-score - 3 SD to <- 2 SD), normal (z-score -2 SD to +1 SD), and overweight (z-score + 1 SD sd +2 SD) [18]. Anemia was categorized based on the WHO definition if the level was less than 12mg/dl [19]. A normality test using Kolmogorov-Smirnov was done before inferential analysis. Univariate analysis was presented as mean $\pm$ standard deviation (SD). To assess the relationship between variables, Pearson correlation analysis was performed.

## 3 Result

A total of 30 adolescent girls completed the study, and the final data analysis was performed. Results of normality analysis using Kolmogorov-Smirnov resulted in a normal distribution for age, BMI for age z-score (BAZ), and hemoglobin ($p > 0.05$), but not a normal distribution for BMI data ($p < 0.05$). Therefore, log10 was done for IMT, and a re-analysis of normality showed a normal distribution (data not presented).

**Table 1. Univariate analysis.**

| Variable | Mean $\pm$ SD | Min-Max |
|---|---|---|
| Age (years) | 15.97 $\pm$ 1.2 | 13 – 18 |
| BMI | 20.47 $\pm$ 2.8 | 17.0 – 27.0 |
| BMI-Age z-score | -0.17 $\pm$ 0.9 | -0.199 – 1.41 |
| Hb (mg/dl) | 14.53 $\pm$ 1.1 | 11.9 – 16.3 |

Table 1 shows the result of the univariate analysis. The mean age was 15.97 ± 1.2, the mean BMI among adolescent girls was 20.5 kg/m2 ± 2.8, the mean BAZ was -0.17 ± 0.95, and the mean of Hb was 14.5 ± 1.1. The mean BMI, BAZ, and Hb level were considered in a normal range. Using ordinal data, the prevalence of anemia (Hb <12 mg/dl) in this population was only 3.3%. In addition, nutritional status based on the BAZ WHO category, 86.7% were in normal nutritional status and, 13.3% were overweight, none were underweight/thin.

Based on BAZ calculation, the mean of Hb in normal nutritional status was 14.53 mg/dl, while the mean of Hb in overweight girls was 14.55 mg/dl. Statistical analysis could not find any significant correlation between age and anemia ($p$ = 1.000), also between BAZ and anemia ($p$ = 0.370) (Table 2). We found a significant correlation between BMI and Hb level ($p < 0.001$; $r = 0.676$). However, the use of BMI in adolescents was not a good indicator for assessing nutritional status.

**Table 2. Relationship between age and nutritional status with anemia (Hb level)**

| Variable | Hb level* |
|---|---|
| Age (years) | 1.000 |
| BMI | <0.001* |
| BMI-Age z-score | 0.370 |

*) *Pvalue* calculated using *Pearson correlation,* significant at $\alpha < 0.05$

## 4 Discussion

The results of univariate analysis of 30 data samples used in this study found that only one respondent (3.3%) experienced anemia, and 29 (96.7%) adolescent girls did not experience anemia. Compared to the results of research in 2016, the results of univariate analysis of 61 adolescent girl respondents, more than half of the sample, namely 35 respondents (57%), experienced anemia, and 26 respondents (43%) did not experience anemia [20]. The results of anemia status in another study showed that out of 70 samples, 41 (58.6%) adolescent girls experienced anemia, and 29 (41.4%) adolescent girls did not experience anemia [21].

The direct impact of anemia that can occur in adolescent girls is often feeling dizzy, weak, lethargic, foggy eyes, pale eyelids, lips, tongue, skin, and palms, which can have a long-term impact and get worse if not treated immediately. Adolescent girls who experience anemia during pregnancy will be very risky for the mother's health condition and the growth of her baby [21]. Adolescent girls have a higher risk of anemia because they experience menstruation every month, making them more deficient in hemoglobin in the blood. In addition, the widespread perception of maintaining body condition

makes them have a poor diet. This is shown by research conducted in 2019. The proportion of adolescent girls with an irregular diet who experienced anemia was 63.6% [7] .

In this study, the nutritional status of adolescent girls (BZA WHO) showed that 86.7% of adolescent girls had normal nutritional status and 13.3% of adolescents with overweight status, and no adolescents had underweight status. Similarly, the results of the univariate analysis in the 2020 research, the frequency of adolescent girls with normal nutritional status was 79.63%, then 20.37% were overweight, and no adolescent girls had a nutritional status of less [22]. The average age of the sample in this study was 16 years or late adolescence. Similar to research conducted in 2020, out of 98 respondents, the frequency of adolescent age was dominated by late adolescence (16-19 years) as much as 60.2% or 59 respondents [23].

In Table 2, the results of bivariate analysis between adolescent age and anemia in this study have a p-value of 1,000 ($p>0.05$), so it can be interpreted that there is no significant relationship between adolescent age and anemia. In line with the results of research in 2020, the statistical test results obtained a value of $p=0.224$ ($p>0.05$) which means that there is no significant relationship between adolescent age and anemia status [23]. However, this is not in line with research conducted in the city of X, where the statistical test results obtained a value of $p=0.047$, meaning there is a relationship between age and hemoglobin levels [24]. The results of other studies with the Chi-square statistical test results obtained p value = 0.018 ($p <0.05$) which shows there is a relationship between age and the incidence of anemia in pregnant women with age at risk (<20 years), and it is known that pregnant women with age at risk experience more anemia than pregnant women with age not at risk (20-35 years). This is because the biological and psychological conditions of adolescents <20 years tend to be unstable, which results in a lack of awareness to meet and balance good nutrition [23] [25].

The results of the analysis of nutritional status variables with anemia in this study have a p-value <0.001, so it can be interpreted that there is a significant relationship between nutritional status or Body Mass Index (BMI) with anemia in adolescent girls in Sembalun village. This is in line with the results of research in 2019, where the results of data analysis with statistical tests between nutritional status and the incidence of anemia obtained a value of $p = 0.008$ (p-value <0.05) which means that there is a significant relationship between nutritional status and anemia in adolescent girls at SMAN 97 Jakarta [23]. In addition, from the sample data of this study, it was found that adolescent girls who experienced anemia had normal nutritional status, which shows that adolescent girls with normal nutritional status can experience anemia if they have unbalanced eating habits, consume less iron-containing foods or have abnormal menstrual patterns [7] [22] [26] [27].

From the results of this study, it can be seen that anemia is not only influenced by nutritional status or Body Mass Index (BMI) and age. However, many factors can affect anemia in adolescents, such as poor diet and abnormal menstrual patterns. In addition,

educational factors are also one of the influences on anemia rates in adolescents. According to research conducted in 2019, the analysis of the relationship between education and anemia status obtained a value of $p = 0.000$ ($p < 0.05$), which means a significant relationship exists between adolescent education and anemia status. The lower the level of education, the lower a person's knowledge of maintaining nutritional status [23]. Another factor found is the presence of regional morphological factors, such as differences in hemoglobin levels in lowlands and highlands. This is supported by research in region A, which found that hemoglobin parameters in the highlands have a higher average value (14.69 g/dL) than in the lowlands (13.14 g/dL) [28].

This study has limitations that can be used as consideration for future researchers. The limitations of this study are:

1) Limitations of the sample used in the study
2) Sampling technique using purposive sampling
3) Limitations of the variables included in the study

## 5 Conclusion

This study revealed that nutritional status among adolescents measured using BMI-Age z-score was not associated with Hb level (anemia), but it does associate with Body Mass Index (BMI). The use of BMI in adolescents was not considered at gold standard in measuring nutritional status; however, this study could be a good pilot study for further research or early anemia intervention in adolescent girls. Increasing adolescent girls' knowledge related to nutritional status and anemia is one of the crucial aspects of reducing the risk of anemia. Optimal efforts are needed from relevant stakeholders to improve adolescent girls' nutritional knowledge and practices in optimizing their nutritional status to prevent anemia by utilizing various media and technology, given adolescents' massive use of technology. Future studies could duplicate the studies using a much higher sample size and variables that play roles in developing anemia among adolescent girls.

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