Correlation of Hemoglobin Levels with Nutritional Status in Adolescent Girls: A Health Promotion Perspective

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ABSTRACT

Background: *Women during pregnancy, childbearing years, and adolescence are susceptible to anemia. The prevalence of anemia in adolescents in Indonesia reached 32 percent in 2018. The aim of this study was to determine the correlation between nutritional status and the incidence of anemia in adolescent girls.*
Method: *This study is an analytical survey with a cross-sectional design. The population in this study was female students in Padang City. The instrument used to measure hemoglobin was a digital hemoglobin measurement device. The nutritional status in this study used the measurement of the nutritional status of adolescents with the indicator of BMI according to age. Correlative analytical test with ordinal scale data used Kendall's tau testing.*
Results: *Based on the results of this study, it was known that most of the adolescents (71.9%) had normal nutritional status Most of the adolescent girls (87.5%) had normal hemoglobin levels, and as many as 12.5 percent adolescent girls had anemia and were not menstruating. There was no correlation between nutritional status (BMI/age) and hemoglobin levels. Nutritional status is not a cause of anemia in adolescent girls. It is necessary to investigate the prevalence of anemia in adolescent girls during menstruation as a comparison.*

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INTRODUCTION

Women during pregnancy, childbearing years, and adolescence are susceptible to anemia. Global data on women aged 15-49 years show that anemia affects 29% of non-pregnant women and 38% of pregnant women.[1] Anemia in adolescents is one of the most common health problems in several countries, particularly in developing countries.[2–4] A systematic review showed that 23.0% of adolescents in Ethiopia were anemic.[5] In Indonesia, the prevalence of anemia among adolescents reached 32%. The government has tried to address the problem with a policy of providing iron supplements to at-risk groups, but still focuses on pregnant women.[6] A study on adolescent girls in Bali found a prevalence of anemia of 45%.[7]

Anemia in adolescents is a condition in which the hemoglobin level is less than 12 g%.[8,9] Anemia causes insufficient hemoglobin to bind and carry oxygen from the lungs to the rest of the body. Not getting enough oxygen needed can cause problems with concentration, physical endurance, and physical activity.[10] Anemia in adolescent girls can impact their physical growth and physical fitness.[11] Ir can cause fatigue and decreased concentration and learning memory, which can affect academic performance.[1] Anemia in the age of adolescence can persist into the time when the pregnancy phase is reached. The prevalence of anemia during pregnancy carries risks for both mother and baby. The risks are complications of pregnancy and childbirth that can lead to mortality, low birth weight and impaired growth and development in the early years of life for infants.[12,13]

Menstrual patterns, unhealthy eating habits, worm infections, routines of drinking tea or coffee after meals, lack of vitamin C intake, and other factors can contribute to anemia.[14] Other factors are influenced by several variables, including caloric protein intake, iron intake, knowledge, education, type of occupation of parents, family income, and menstrual cycle.[10] Adolescent girls are more likely to develop anemia because of their higher than average iron requirements (due to monthly menstruation).[15]

In addition, adolescent girls often diet and restrict food intake to maintain their appearance, which can result in a deficiency of minerals, particularly iron, that the body needs. A diet that does not match the body's needs results in a lack of vital nutrients such as iron or healthy macronutrients.[15] Nutritional status is one of the factors associated with the incidence of anemia. People with a higher or lower level of nutritional status are at risk

of experiencing anemia compared to people with a normal level of nutritional status.[13] Thin girls are at an increased risk for anemia.[10,] Neglecting proper meal timings, eating while on the move, and skipping breakfast are the habits of some teenagers.[15] Reducing food intake or restricting food to maintain their appearance to maintain body weight can result in a deficiency of minerals, particularly iron, that the body needs. Moreover, habits such as fast food consumption also contribute to nutritional inadequacy in adolescents. An inadequate understanding of how to diet to achieve the ideal body weight is also a contributing factor, as the choice of the amount and type of food consumed is not based on nutritional needs. The prevalence of anemia may also be increased by the habit of consuming fast food and drinking tea after meals.[16,17] Some women with anemia have poor nutritional status.[18] Insufficient energy intake is one of the factors associated with anemia.[7]

Adolescent girls tend to be more at risk of developing anemia. Nutritional status is one of the factors related to the incidence of anemia. People with more or less nutritional status are at risk of experiencing anemia compared to people with normal nutritional status.[16] An increase in the risk of anemia in a thin girl.[11,17] One factor is the high need for nutrients, including high iron and regular blood loss during the menstrual cycle. Negligence in eating schedules, eating habits while on the move, and skipping breakfast are the habits of some teenagers.[18] Restrictions on eating to maintain body weight and habits like consuming fast food also contribute to the nutritional adequacy of adolescents. An inappropriate understanding of dieting to get the ideal body weight also contributes. The selection of the amount and type of food consumed is not following nutritional needs. The prevalence of anemia also can be increased by the habit of consuming fast food and drinking tea after eating.[19,20] Some women with anemia have poor nutritional status.[21] Lack of energy intake is one of the factors associated with anemia.[7]

A study in a school in the city of Padang showed that the prevalence of anemia among adolescents was 49.1%.[22] Based on data from the 2018 Basic Health Survey in Padang City, West Sumatra, 11.29% of adolescents were undernourished and 14.86% of adolescents were overnourished.[23] In Indonesia, a vocational school is usually a school with many female students. SMK 06 is a vocational school that has a fashion and beauty department with all female students.[24] Based on the initial survey, there was no measurement of the hemoglobin levels and nutritional status of the students of the school.

Based on the above description, the researchers are interested in analyzing the association of nutritional status with the incidence of anemia in adolescent girls in the city of Padang. The objectives of this study were: to determine the prevalence of anemia, to know the nutritional status of adolescent girls, and to know the correlation between nutritional status with the incidence of anemia in adolescent girls.

METHOD

This study is an analytical survey with a cross-sectional design. It measured nutritional status as the independent variable and the incidence of anemia as the dependent variable. The study was conducted at SMK N 06 Padang in July 2022.

Considering the characteristics of the respondents who were expected to be homogeneous, the sample consisted of the 10th-grade female students of the Cosmetology Vocational Program and Fashion Design Vocational Program at Public Vocational School (SMKN) 6, Padang City, whose 144 students are all female, in the school year 2022. The sample was selected using a purposive sampling technique, which included young women who met the inclusion criteria. The sample to be studied must meet the following eligibility criteria: young women who have reached menarche, are not menstruating, are in good general health, do not have blood disorders such as thalassemia and sickle cell anemia, and do not suffer from chronic diseases such as kidney disease, malaria or intestinal worm infection. In addition, respondents should not use drugs that affect hemoglobin levels (chemotherapy drugs or ARV) and was willing to be a respondent, as stated in the interview.

The data used in this study were primary data. The instrument used to measure hemoglobin was a digital hemoglobin measurement device. The nutritional status in this study was measured using the measurement of the nutritional status of adolescents with the indicator of BMI according to age.[25] The data needed were anthropometric measurements of weight (using digital scales), height (using a height meter), and age, which were then recorded on the observation sheet and converted into a z-score (BMI/age).

Data processing stages included editing, coding, entry, cleaning, and data analysis. The data in this study were analyzed using the SPSS computer program. Data analysis consisted of descriptive tests and correlative analytical tests. Categorical data (anemia status and nutritional status) are presented as frequencies and percentages. Adolescents are categorized as normal if their hemoglobin level is higher than 12 gr% and as anemic if it is less than 12 gr%.[26] Nutritional status was categorized as normal if BMI/age was -3 SD to +1 SD, as undernourished if BMI/age was -2 SD to +1 SD, as over nourished if BMI/age was +1 SD to +2 SD, and as obese if BMI/age was >+2 SD.[25] In addition, numerical data on

hemoglobin levels are presented in the form of means, standard deviations, and maximum and minimum values. Kendall's tau test was used for correlational analysis of ordinal scale data. The study has passed the ethical review conducted by the Health Research Ethics Committee of the Universitas Perintis Indonesia under No.125/KEPK.F1/ETIK/2022.

RESULTS AND DISCUSSION

The study was conducted at SMK N 06 Padang, with the number of respondents as many as 96 female students. Respondents ranged in age from 14 to 17 years, with a mean of 15 years and a standard deviation of 0.67. Based on age, all respondents were adolescents. The distribution of data in a numerical scale is loaded as in Table 1.

The average weight of the female students was 48.29 kg and their average height was 154 cm. Their average BMI/age was -3.175. This means they were in the good or normal nutritional status category (-2 SD to 1 SD).25 However, based on the minimum and maximum values, it can be seen that there were still adolescents with under- or over-nutrition (overweight).

The mean hemoglobin level of the respondents was 14.57 g/dL. Table 2 shows mean of adolescents have normal hemoglobin levels or non-anemia. The lowest hemoglobin level was 10.30 g/dL, which was still in the range of mild anemia. The distribution of hemoglobin levels was normal, while the distribution of nutritional status (BMI/age) was not normal.

Therefore, Kendall's tau test was used for the correlation test. The distribution of the data is also presented in the form of a categorical scale as follows in Table 2.

There were 12 girls (12.5%) who had anemia. A total of 84 people (87.5%) had normal hemoglobin levels. Anemia in adolescents is a condition where the hemoglobin level is less than 12 g%.[8,9] Based on nutritional status (BMI/age), as many as 69 girls (71.9%) had normal nutritional status. There were two adolescent girls in the "malnourished" category, six girls were underweight, 18 girls were overweight, and one girl was obese. Many factors contribute to overweight and obesity, such as higher consumption of energy-dense snacks and low physical activity. Individually, some adolescents prefer snacks that look good and are high calories or are energy-dense and savory. In addition, snacks are packaged foods that have fewer nutrients and are high in sodium, sugar, and fat.[27] Based on the 2021 Youth Profile, 4% of adolescent girls are at risk for being underweight, 13% are at risk for being overweight, and 8% are at risk for being obese.[28] Adolescents who are overweight may be affected by excess caloric intake, but the typed of food they eat are less varied.[29] This indicates that the daily intake does not meet the criteria for a balanced diet.

Table 1. Distribution of numerical data

Variable	Mean	SD	Min	Max	P-value
Hemoglobin level	14.57	1.921	10.30	18.20	0.200
Nutritional status	-0.317	1.27	-3.24	2.35	0.022
Weight	48.29	10.64	29.70	80.70	0.001
Height	154.32	6.49	141	171	0.200
Age	15.23	0.67	14	17	0.000

Table 2. Distribution of categorical data

Variable	Categorical Scale	f	%
Anemia status	Anemic (≥12)	12	12.5
	Normal (<12)	84	87.5
Nutritional status	Malnourished (<-3 SD)	2	2.1
	Underweight (- 3 SD to <-2 SD)	6	6.3
	Normal (-2 SD to + 1 SD)	69	71.9
	Overweight (+1 SD to +2 SD)	18	18.8
	Obese (> 2 SD)	1	1.0

One study found that half of adolescents were dissatisfied with their body shape. The respondents' reflection of weight was largely ideal and most perceived they are fat and overweight are usually want to reduce their weight. However, because they lacked knowledge and understanding, they tried instant and unhealthy diets.[30] Based on the Global School-Based Student Health Survey in 2015, more than 75% of adolescent girls in Indonesia ate less than five servings of fruits and vegetables (categorized as bad), consumed fast food once or more times in a single day (56.17%), and drank carbonated beverages almost every day (57.44%). Adolescents are in the developmental phase and are more interested in appetizing foods that are high in fat and glucose.[31]

The poor nutritional status of adolescent girls has significant implications for physical work capacity, reproductive outcomes, pregnancy outcomes, and birth weight.[10] Adolescent girls who are still in school need adequate nutrition because they do a lot of physical activity at school. They need to have an adequate breakfast before the start of the school day in order to meet their nutritional needs and as an energy reserve. Low routine and adequate intake needs nutrition has a less significant effect on the nutritional status of adolescents.[32]

Many factors contribute to overweight and obesity. It can be associated with variables such as excessive intake of macronutrients, increased consumption of fast food, sedentary lifestyle, lack of physical activity, genetic and psychological factors, allowance, exposure to advertising, socioeconomic status, skipping breakfast, age and gender, and a lifestyle that causes an energy imbalance that increases the risk of obesity.[33] The nutritional status associated with a higher quality of life and has several intergenerational benefits that affect the next generation. Adolescent girls with poor nutritional status are more likely to give birth to children who are underweight. Women deserve special attention because nutrition and physical health before and during pregnancy affect fetal development and infant well-being. Low birth weight, preterm birth, stillbirth, and increased risk of neonatal death Preterm birth, stillbirth, and increased risk of neonatal death are unfavorable prenatal outcomes that greatly influence stillbirth health. and, adequate nutrition is especially important.[34]

In this study, 87.5% of the young women had normal hemoglobin levels. Only 12.5% of the young women were anemic. This result is quite different from data from the Indonesian Basic Health Survey, which showed that the prevalence of anemia in adolescents in Indonesia reached 32 percent in 2018.[6] However, another study showed a higher prevalence of anemia at 45.2%.[35] Iron-deficiency anemia is a more severe condition in which low levels of iron are associated with anemia and the presence of microcytic hypochromic red cells in the circulation, the relative number of which reflects the severity of the iron deficiency.[27,36] Furthermore, anemia in adolescent girls can cause weakness, fatigue, difficulty in concentrating, and poor work productivity, all of which are nonspecific symptoms attributed to low oxygen delivery to body tissues and decreased activity of iron-containing enzymes.[27] Anemia can impact physical growth and physical fitness.[11] All respondents were not menstruating. During menstruation, anemia is more likely to occur. Unlike other studies, there did not appear to be a difference between respondents who were menstruating and those who were not.

Based on the Kolmogorov-Smirnov test, the nutritional status was not normally distributed. Therefore, Kendall's tau test was used for the correlation test. The results of the correlation test are presented in Table 3. Based on the Kendall's tau test shown in Table 3, the p-value was 0.55. It means that nutritional status did not contribute significantly to hemoglobin level. The value of r was 0.05, and the strength of the relationship was weak. A positive r-value means a unidirectional value between the nutritional status variable and anemia status. In this study, most of the respondents' nutritional status was in the "normal" category. Therefore, not much variation can be seen based on statistical tests.

Table 3. Relationship between nutritional status and hemoglobin level

		Hemoglobin level
Nutritional status	R	0.05
	P-value	0.55
	N	96

A study conducted on adolescents aged 12-14 years old in Manado showed no relationship between nutritional status and hemoglobin levels based on Pearson correlation coefficient.[37] Nutritional status with BMI/age indicators is more influenced by the intake of macronutrients, namely carbohydrates, fats, and proteins, as the major energy suppliers for the body. If energy intake is less than required over a long period time, it will cause a decrease in nutritional status. On the other hand, balanced energy intake helps maintain normal nutritional status, whereas excessive energy intake and reduced energy expenditure have the potential to cause obesity. Intake of micronutrients does not directly correlate with nutritional status based on BMI/age because they contain little energy, and if there is a deficiency, it may have been going on for a long time. [38] Another study in India also showed that BMI was not an influential factor in the incidence [39]of anemia in adolescents. This study also showed that there was no significant difference between

the incidence of anemia in the vegetarian and non-vegetarian groups.[40] Another study of adolescent girls in Jatinangor, using the Chi-square test, also found no significant difference between the distribution of nutritional status and the incidence of anemia.[35] A study using the BMI indicator also found no significant relationship between BMI and the prevalence of anemia in adolescents.[41] A study in children with anemia did not show any relationship with nutritional status.[29]

Nutritional status was related to the body's caloric intake and other nutrition need, such as iron. Adolescents with normal nutritional status need different amounts of iron than do overweight or underweight adolescents. Calories consumed daily do not always contain high levels of nutrients. Fast food, which is more likely to be consumed by teenagers, is high in calories but low in nutrient. Therefore, adolescents with normal nutritional status or obesity are still at risk for anemia if they do not meet their dietary needs for iron. This showed that anemia was not related to nutritional status.[42]

Nutritional status was not correlated with micronutrient intake.[29] People with good nutritional status may develop anemia due to an unbalanced diet, for example, consuming fewer vegetables. The BMI/age indicator in assessing nutritional status is more influenced by macronutrients, which are the largest source of energy for the body, such as carbohydrates, fats, and proteins, but does not represent the intake of micronutrients such as vitamins and minerals, which play a role in the formation of hemoglobin levels.[43,44] The source of micronutrients is fruits and vegetables. However, the average consumption of fruits and vegetables in Indonesia does not meet the standard requirements. The consumption of vegetables and fruits and their preparations has not adequately affected the supply of vitamins and minerals needed by individuals. [45,46]

Iron is essential for the production of hemoglobin. Depletion of iron stores can result from blood loss, decreased intake, impaired absorption, or increased demand.[36] Iron absorption is determined by two factors: the absorption of heme iron and non heme iron, which indicates the presence of two types of iron in the diet. Dietary sources of heme iron include meat, fish and poultry, while sources of non-heme iron are vegetables, grains and nuts. Therefore, the low quality of food consumption is also suspected as a cause of low iron absorption.[47] In addition, vitamin C also increases non-heme iron absorption. To benefit from the enhancing effect of meat or vitamin C, they must be consumed at the same time as food rich in non-heme iron.[48]

A study of women of childbearing age in Saudi Arabia found quite different results. Nutritional status is one of the preventive factors for anemia. The risk of anemia is lower in women with high BMI.[49–51] This may be due to differences in sampling criteria; the study did not limit the participants who were menstruating to those who were not.

CONCLUSION

Based on the results of the present study, it was known that most of adolescent girls (71.9%) had normal nutritional status. Most of the adolescent girls (87.5%) had normal hemoglobin levels, and as many as 12.5% of the adolescent girls, who were not menstruating when the study was conducted, had anemia. There was no correlation between nutritional status and hemoglobin levels. Nutritional status is not a factor in causing anemia in adolescent girls. It is necessary to investigate the prevalence of anemia in adolescent girls during menstruation as a comparison. Further studies are also needed to assess the macro- and micronutrient levels of adolescents. With detailed identification of the factors that contribute to anemia, it is hoped that prevention efforts can be made through health promotion.

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