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CORRELATION BETWEEN HEIGHT, BMI, MUAC WITH ANEMIA STATUS IN ADOLESCENT GIRLS

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Abstract

Background: Anemia in adolescents is a health problem that needs immediate intervention in Indonesia. Anemia can caused by malnutrition. protein and iron deficiency will cause nutritional problems including stunted, thinness, and Mid Upper Arm Circumference (MUAC) < 23,5 cm. Protein and iron deficiency can interfere with the formation of hemoglobin resulting in anemia. This study aims to analyze the relationship between status based on height, Body Mass Index (BMI) and MUAC with anemia status at Mambaus Sholihin Islamic Boarding School in Gresik Regency. **Method:** This research is a quantitative observational analytic with the cross sectional method. The population was adolescent girls in Mambaus Sholihin Islamic Boarding School in Gresik Regency. The sample was 11th and 12th grade senior high school girls with a total of 141 respondents using the total sampling technique. The variables used in this research consisted of height, BMI, MUAC, and anemia. Height data was obtained by using microtoise, BMI using microtoise and scales, MUAC using tape measure plastic, and hemoglobin using the digital tool of Point of Care Testing (POCT) method. The research data were analyzed by chi square test with a contingency coefficient of 95%. **Result:** The results showed that out of 141 adolescent girls, 66.7% had normal height status, 23.4% were stunted, and 9.9% were severely stunted. In BMI status, 55.3% normal, 14.9% thinness, 15.6% overweight, and 14.2% obese. MUAC status was 79.4% with MUAC ≥ 23.5 cm and 20.6% with MUAC < 23.5 cm. Anemia status was 51.8% frail and 48.2% not anemic. After the chi square test, the significance value was obtained (p=0.006), which means that statistically there was a significant relationship between height and anemia, (p=0.003) there was a significant relationship between BMI and anemia, and (p=0.01) there was a significant relationship between MUAC and anemia. **Conclusion:** There is a relationship between nutritional status based on height, BMI, and MUAC with anemia status in adolescent girls at Mambaus Sholihin Islamic Boarding School in Gresik Regency.

keyword : Anemia, Adolescent Girls, Height, BMI, MUAC

INTRODUCTION

Anemia is common condition in middle- to low-income countries. This condition is characterized by hemoglobin levels below 12-16 g/dL (Taufiqa, 2020). Anemia often occurs in adolescence (15-24 years) due to rapid physical and mental development. Anemia in adolescents is still a big challenge in Indonesia (Kemenkes, 2021). Anemia is more prone to occur in adolescent girls due to the

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menstrual cycle that occurs every month (Kemenkes, 2018). If not intervened, anemia in adolescent girls will develop into pregnancy anemia. Anemia in pregnancy has a negative impact on fetal growth, increases the risk of complications of pregnancy and childbirth, and risks causing maternal and child death (Riskesdas, 2019).

One of the causes of anemia is malnutrition. Malnutrition that occurred over many years results in a MUAC < 23.5 cm (Muthmainnah et al, 2021). Chronic malnutrition can cause stunting in adolescents characterized by stunted or severely stunted (Tarini et al, 2020). MUAC < 23.5 cm and stunted in adolescents are caused by a lack of protein intake. Protein deficiency will interfere with hemoglobin formation and iron transport, causing anemia (Eniwati et al, 2019). In addition, MUAC < 23.5 cm and stunted in adolescents can also be caused by micronutrient deficiencies, namely iron. Iron is a mineral needed to form hemoglobin (Susiloningtyas, 2023). Iron deficiency will cause the body to be unable to form hemoglobin, resulting in anemia.

According to research by Enggardany et al (2021) there is a relationship between BMI and anemia. This is similar to the results of research by Imelda et al (2022) which states that adolescents with underweight status are more likely to suffer from anemia 1.4 times compared to other BMI status. There is also a relationship between height and anemia, according to research by Zhu et al (2021) there is a relationship between height and anemia. The taller a person's body indicates high hemoglobin levels in the body. This is in line with research by Shaka and Wondimagegne (2018) which resulted in a relationship between height and anemia in adolescents. In addition, there is also a relationship between MUAC and anemia. Based on research by Ina et al (2018) at the Tribhuwana Tunggadewi University Dormitory for Girls Malang, the smaller the MUAC, the lower the hemoglobin levels in the body. This is also similar to the results of research by Vaira et al (2022) showed there is a relationship between MUAC and anemia status The purpose of this study was to analyze the relationship between height, BMI, and MUAC with anemia status in adolescent girls.

METHOD

This type of research was quantitative research with a cross-sectional design, sampling using the total sampling method. The population was adolescent girls in Mambaus Sholihin Islamic Boarding School in Gresik Regency. Using the total sampling technique, the number of samples was 141 adolescent girls in grades 11 and 12 of Mambaus Sholihin Islamic Boarding School in Gresik Regency. The variables used in this research consisted of height, BMI, MUAC, and anemia. Height data was obtained by using microtoise, BMI using microtoise and scales, MUAC using tape measure plastic, and hemoglobin using the digital tool of Point of Care Testing (POCT) method. The research was conducted at Mambaus Sholihin Islamic Boarding School, Gresik Regency from October 2022 to November 2023. Data were taken from direct measurements of respondents. The ethical eligibility number for this study was 231/EC/KEPK/FKUA/2023. Collected data were recorded for entry and processed using Microsoft Excel and SPSS 2.5. Data were analyzed univariate and bivariate in SPSS 2.5 using a chi square test with a 95% confidence level.

RESULT AND DISCUSSION

Research Result

Data and research analysis are explained in the form of tables and narratives. This aims to find out information about the characteristic of respondents.

Table 1 The characteristic of respondents

Characteristic Respondents	f	Percentage (%)
Age		
15 years old	16	11,3
16 years old	96	68,1
17 years old	27	19,1
18 years old	2	1,4
Stay at boarding school		
Stay at boarding school	141	100
Length of stay at boarding school		
< 3 years	55	39
≥ 3 years	86	61
Frequency of meals in a day		
1x a day	12	8,5
2x a day	103	73,0
3x a day	26	18,4
Eating at the boarding school canteen		

Always	117	83,0
Sometimes	9	6,4
Rarely	4	2,8
No	11	7,8
Meal menu		
Rice and side dishes	67	47,5
Rice and vegetables	13	9,2
Rice, vegetables, and side dishes	61	43,3
Side dishes consumed yesterday		
Chicken	23	16,3
Meat	13	9,2
Fish	20	14,2
Tofu/tempeh	45	31,9
Egg	27	19,1
Without side dishes	13	9,2
Tea consumption		
No	92	65,2
Yes	49	34,8

Below is the frequency distribution data of height, BMI, MUAC, and anemia status of respondents at Mambaus Sholihin Islamic Boarding School in Gresik Regency.

Table 2 The Frequency Distribution of Height, BMI, MUAC, and Anemia Status of Respondents

Variable	f	Percentage (%)
Height		
Normal	94	66,7
Stunted	33	23,4
Severely stunted	14	9,9
BMI		
Normal	78	55,3
Thinness	21	14,9
Overweight	22	15,6
Obese	20	14,2
MUAC		
MUAC ≥ 23,5	112	79,4
MUAC < 23,5	29	20,6
Anem Status		
Anemia	73	51,8
Non anemia	68	48,2

Tabel 3 Relationship between height with anemia status in adolescent girls at Mambaus Sholihin Islamic Boarding School in Gresik Regency

Height	Anemia Status				Total	P *value*	CC
	Non Anemia		Anemia				
	f	%	f	%			
Normal	53	56,4	41	43,6	94	0,006	0,26
Stunted	8	24,2	25	75,8	33		
Severely Stunted	7	50	7	50	14		
Total	68	48,2	73	51,8	141		

Based on the results there was relationship between height and anemia status at Mambaus Sholihin Islamic Boarding School in Gresik Regency is weak.

Table 4 Relationship between BMI with anemia status in adolescent girls at Mambaus Sholihin Islamic Boarding School in Gresik Regency

BMI	Anemia Status				Total	P *value*	CC
	Non Anemia		Anemia				
	f	%	f	%			
Normal	31	40,3	46	39,9	77	0,03	0,24
Thinness	9	40,9	13	59,1	22		
Overweight	16	72,7	6	27,3	22		
Obesse	12	60	8	40	20		
Total	68	48,2	73	51,8	141		

Based on the results there was the relationship between BMI and anemia status at Mambaus Sholihin Islamic Boarding School in Gresik Regency is weak.

Table 5 Relationship between MUAC with anemia status in adolescent girls at Mambaus Sholihin Islamic Boarding School in Gresik Regency

MUAC	Anemia Status				Total	P *value*	CC
	Non Anemia		Anemia				
	f	%	f	%			
MUAC ≥ 23,5 cm	60	53,6	52	46,4	112	0,013	0,21
MUAC < 23,5 cm	8	27,6	21	72,4	29		
Total	68	48,2	73	51,8	141		

Based on the results there was the relationship between MUAC and anemia status at Mambaus Sholihin Islamic Boarding School in Gresik Regency is weak.

Discussion

Relationship between Height with Anemia Status in Adolescent Girls at Mambaus Sholihin Islamic Boarding School in Gresik Regency

The results of this study are by research by Shaka and Wondimagegne (2018) in southern Ethiopia which states that there is a relationship between height per age and anemia status in adolescents. The results of this study are similar to research by Zhu et al (2021) in western China which states that height status is related to hemoglobin levels in the blood. Research by Soliman et al (2014) showed that chronic anemia can inhibit growth and development. Anemia that occurs in childhood and then is not intervened will continue to become chronic anemia during adolescence. Research by Soliman et al (2017) also shows a similar thing, namely chronic anemia has a negative impact, especially because it inhibits physical growth. This is because chronic anemia can occur as a result of nutritional deficiency conditions, namely micronutrients (iron) on a chronic basis. Nutritional deficiencies cause impaired growth and psychomotor development.

Other studies have shown that stunting causes anemia. Research by Tarini et al (2020) states that stunting or shortness is one of the factors causing anemia. This is related to protein consumption. Children who consume protein is not optimal tend to experience growth failure so that their height becomes short. Protein plays a role in the formation of hemoglobin. Protein deficiency will disrupt hemoglobin formation resulting in anemia. According to research by Flora et al (2019), children who are stunted or short have a 2.7 times greater risk of anemia.

The results of this study showed that more respondents with normal status did not experience anemia while more respondents with stunted status experienced anemia. Adolescents with stunted and severely stunted status are 6 times more at risk of anemia (Shaka and Wondimanegne, 2018). Normal or above normal height status is associated with high levels of hemoglobin in the blood (Zhu et al, 2021)

A person's height growth is influenced by protein consumption (Millward, 2021; Alwi et al, 2022). Someone whose protein needs are not met will have a shorter height than someone whose protein needs are met. If the body's protein needs are not met, it will cause protein deficiency so that hemoglobin formation

and iron transport will be disrupted and anemia will occur (Eniwati et al, 2019). Conversely, if protein needs are met, the height status will be normal or above normal and there will be no disruption of hemoglobin formation so that anemia does not occur.

Frequent consumption of eggs and meat and frequent meal frequency (≥ 3 times a day) can reduce the chance of anemia in adolescents (Zhu et al, 2021). The above statement relates to the fulfillment of protein and body nutrients for adolescent growth. Based on the results of filling out the questionnaire, 19.1% of respondents consumed eggs, 9.2% of respondents consumed meat and 18.4% of respondents ate 3 times a day. This figure shows that quite a lot of respondents consume eggs, meat and eat 3 times a day so that protein needs are met. This causes the results of the study to show more respondents with normal height status and not anemic.

In this study, the respondents were adolescents aged 16-18 years. At this age, height growth in adolescent girls has stopped. The cessation of height growth is caused by the epiphyseal plates (Fauziyah et al, 2017). This makes it impossible to provide interventions for short or very short adolescents to become tall. The solution that can be provided is an intervention to reduce the anemia status of the respondents.

Relationship between BMI with Anemia Status in Adolescent Girls at Mambaus Sholihin Islamic Boarding School in Gresik Regency

The results of statistical tests in this study showed a relationship between BMI and anemia status in adolescent girls. This is following research by Wiworomukti and Santik (2023) at SMKN 2 Salatiga which resulted in p (0.009) <0.05 with the chi square test which means there is a relationship between BMI and anemia status. The results of this study are also in line with research conducted by Enggardany et al (2021) which resulted in p (0.034) <0.05 with the odd ratio test, which means that there is a relationship between BMI and anemia status.

This study shows the results of undernourished with BMI tend to experience anemia compared to overnourished and obese status. This is similar to the results of research by Imelda et al (2022) which states that adolescents with undernutrition

status are more at risk of 1.4 times suffering from anemia compared to other BMI statuses (Imelda et al, 2022).

Anemia in adolescent girls is influenced by several factors, one of which is poor nutrition (Handayani and Rumiati, 2020). The majority of adolescent girls have poor nutritional status due to an unhealthy diet. An unhealthy diet such as an unbalanced diet can cause protein and iron deficiencies resulting in anemia. Anemia in adolescent girls is exacerbated by iron loss through menstruation every month (Rai et al, 2023). This causes the iron intake of adolescent girls to be more than that of adolescent boys.

According to the results of filling out the questionnaire, respondents consumed more unbalanced menus, namely rice with side dishes without vegetables. According to Regulation of The Minister of Health Republic Indonesia no. 41.2014 on Balanced Nutrition Guidelines, a balanced diet helps maintain body weight and avoid nutritional problems such as undernutrition or overnutrition. This could be the cause of some respondents having under- and over-nutrition and obesity.

An unbalanced diet, such as eating ≤ 2 meals a day and consuming plant-based foods can be the cause of undernutrition and anemia. The recommended meal frequency is 3 large meals a day (BPOM, 2013). A meal frequency of ≤ 2 times a day is not an ideal meal frequency for adolescents because it can cause the fulfillment of micro or macronutrient needs to be not optimal. This leads to undernutrition in adolescents. Suboptimal fulfillment of iron (micronutrients) and protein (macronutrients) nutrition can cause anemia.

Based on the results of filling out the questionnaire, the majority of respondents consumed vegetable side dishes, namely tofu and tempeh. Vegetable side dishes contain non-heme iron and are lower in fat than animal side dishes (Arima et al, 2019; Blongkod and Arpin, 2022). Non-heme iron has ingredients that can inhibit its absorption. If iron absorption is inhibited, iron needs are not met so the hemoglobin formation process will be inhibited and anemia occurs. The low fat content in plant-based foods causes no increase in body weight. Therefore, more respondents with thinness experienced anemia.

Examination of nutritional status by measuring BMI in this study, the results showed that most respondents had normal nutritional status, but many experienced anemia. This can be caused by the lack of consumption of animal protein and animal iron. Based on the results of filling out the questionnaire, the majority of respondents consumed more tofu and tempeh compared to meat, chicken, and fish. Animal iron such as red meat, chicken, and fish is more easily absorbed by the body compared to vegetable iron such as tofu and tempeh (Skolmowska and Glabska, 2019)/ The slow absorption of plant-based iron by the body can cause high iron requirements in adolescent girls to not be met optimally.

Relationship between MUAC with Anemia Status in Adolescent Girls at Mambaus Sholihin Islamic Boarding School in Gresik Regency

The results of this study indicate that there is a relationship between MUAC and anemia status in adolescent girls. In this study, it was found that the majority of adolescent girls with MUAC ≥ 23.5 cm did not experience anemia (53.6%) while adolescent girls with MUAC < 23.5 cm experienced more anemia (72.4%). This is similar to research conducted by Ina et al (2018) at the Women's Dormitory of Tribhuwana Tunggadewi University Malang which states that the smaller a person's MUAC size, the lower the hemoglobin level in that person's body. This is also similar to the results of research by Vaira et al (2022) showing there is a relationship between MUAC and anemia status.

MUAC in women of childbearing age shows the availability of nutrients in bone, muscle, and subcutaneous fat. Subcutaneous fat describes energy stores while muscle and bone can describe protein stores in the body (Seliawati et al, 2023). Fat is needed by the body as a source of energy [30]. A lack of fat will cause the body to experience a lack of energy so the energy that must be met is taken from protein reserves (Marwah, 2019). The use of protein reserves for energy will cause the body to lack protein to transport iron in hemoglobin formation so hemoglobin formation is not optimal. This will lead to anemia.

Fat also helps the absorption of vitamins such as vitamin E. Vitamin E acts as an antioxidant that influences erythrocytes. If the body lacks energy, the absorption of vitamin E will be disrupted. Low vitamin E levels will cause

erythrocytes to split to form hemolysis which then disrupts hemoglobin formation (Marwah, 2019).

Fulfillment of fat reserves is not only obtained from foods that contain fat, but also from foods that contain carbohydrates. Excess carbohydrate intake in the body will be converted into subcutaneous fat (Puddick, 2023). Then the fat will be converted into energy in the metabolic process (Sari, 2019).

The smaller the result of a person's MUAC measurement, it shows that the fulfillment of nutritional needs in the body is not optimal, such as protein deficiency. Protein deficiency will disrupt iron transport in the formation of hemoglobin so that hemoglobin levels in the body will be low and anemia will occur (Muthmainnah et al, 2021). Based on the explanation above, it is following research by (Tarini et al, 2020), states that anemia can occur due to deficiencies in carbohydrates, fats, proteins, vitamins, and iron.

In this study, adolescent girls with MUAC ≥ 23.5 cm tended not to be anemic. This can occur because the need for protein and fat in the body is sufficient so that the body has sufficient protein and fat stores and then causes the results of MUAC measurements to be ≥ 23.5 cm. Adequate fat needs will not interfere with the absorption of vitamin E so that erythrocytes do not experience hemolysis. In addition, adequate fat needs cause the body to have enough energy so that the body does not use protein reserves as energy. Adequate body protein needs cause no disruption of iron transportation in the formation of hemoglobin so that hemoglobin levels in the body will be normal.

The number of adolescent girls with MUAC ≥ 23.5 cm and anemia in this study was 46.4%. This figure is only slightly different from that of adolescent girls with MUAC ≥ 23.5 cm and not anemic (53.6%). In adolescent girls with MUAC ≥ 23.5 cm and anemia can be caused by the needs of protein and fat, but the needs of other micronutrients are not met such as iron.

Based on the results of filling out the questionnaire, the majority of respondents consume a plant-based diet. Plant-based foods contain non-heme iron which is absorbed longer. In addition, the absorption of non-heme iron can be inhibited by egg yolks containing phosvitin (Yilmaz and Ağagündüz, 2020). According to the results of the questionnaire, quite a several respondents consumed

eggs as side dishes. This can cause inhibition of the absorption of non-heme iron that respondents get from plant foods. Iron is needed by the body for the formation of hemoglobin in the (Riawan et al, 2023). If iron needs are not met, then the hemoglobin levels in the body will be low, causing anemia.

Based on the results of filling out the questionnaire, the majority of respondents ate rice and side dishes without vegetables. This can cause respondents to lack vitamin E intake from vegetables, causing erythrocyte hemolysis and disrupting hemoglobin formation.

CONCLUSION AND SUGGESTION

This study concluded that most of the adolescent girls in Mambaus Sholihin Islamic boarding school in Gresik Regency had normal height, normal BMI, and normal MUAC In addition, most of the adolescent girls were anemic. Based on the results of statistical tests, it was found that there was a relationship between height, BMI, and MUAC with anemia status in adolescent girls at Mambaus Sholihin Islamic Boarding School.

DECLARATION

Conflict of Interest

Author declare there is no conflict of interest in this research

Authors' Contribution

All author contribute from concept in writing draf article.

Ethical Approval

Research Ethics Committee of Faculty o Medicine, Universitas Airlangga.

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Funding Source

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Data Availability

The data supporting this research are available from the authors on reasonable request.

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