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Relationship between Body Mass Index and Hemoglobin Levels in Adolescents in Medan City, North Sumatra, Indonesia

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Abstract: Introduction: Anemia is one of the health problems in the world, especially developing countries including Indonesia. Anemia is a condition in which the level of hemoglobin in the blood is less than normal. According to the 2013 Basic Health Research (Riskesdas) data, the prevalence of anemia in Indonesia is 21.7%, with a proportion of 20.6% in urban areas and 22.8% in rural areas. Anemia is mostly suffered by adolescents with a prevalence of 30-55%. The morbidity study in the 2001 Household Health Survey (SKRT) found that one of the risk factors for anemia was anthropometric measurements. This study aims to determine body mass index and hemoglobin levels in adolescents in Medan, North Sumatra, Indonesia.
Method: This research is an analytic observational with a cross sectional study design and uses a total sampling method in sampling. To determine body mass index, anthropometric measurements, especially weight and height, are carried out first. Then blood was taken and hemoglobin examination was carried out in the laboratory. Data analysis was processed using the SPSS program.
Result : The Body Mass Index (BMI) <18.5 was below normal, there were 19 subjects (31.67%), while the highest BMI was 2529.9, namely obesity 1 there were 23 subjects (38.33%). Using Pearson's correlation at 95% confidence level, from 60 samples of adolescents, it was found 6 adolescent girls with low hemoglobin levels. This study shows a relationship between hemoglobin levels in adolescents in Medan, North Sumatra, Indonesia.
Conclusion: There is a relationship between body mass index and hemoglobin levels in adolescents in Medan, North Sumatra, Indonesia.
Keywords: Body Mass Index, Hemoglobin Level, Adolescents.

I. INTRODUCTION

Anemia is one of the health problems in the world, especially in developing countries including Indonesia. Based on data from the *World Health Organization* (WHO) in 2008, the world population suffering from anemia was 1.62 billion people with a prevalence of 24.8%. Anemia is mostly suffered by pregnant women with a prevalence of 55.9% and adolescents by 30-55% (1,2). According to the 2013 Basic Health Research (Riskesdas) data, the prevalence of anemia in Indonesia is 21.7%, with a proportion of 20.6% in urban areas and 22.8% in rural areas and 18.4% for men and 23.9% for women. Based on age group, patients with anemia aged 5-14 years were 26.4% and 18.4% were in the 15-24 year age group (3).

Anemia is a hemoglobin level in the blood that is less than normal (4). According to WHO, normal hemoglobin levels in men are 13 g/dl and 12 g/dl in women. Lack of iron and nutrients (including folic acid, vitamin B12 and vitamin A), acute and chronic inflammation, genetic/hereditary factors in the form of impaired hemoglobin synthesis and parasitic infections are the causes of anemia (5). The study of morbidity in the 2001 Household Health Survey (SKRT) found that the risk factors for anemia included smoking habits, alcoholic beverages, breakfast habits, the use of time for physical activity, the results of anthropometric measurements and hemoglobin levels (6).

The adolescent phase is characterized by physiological maturity such as enlargement of tissues to organs. This makes teenagers need adequate nutritional intake. If the intake is not sufficient, it can cause disturbances in the body's metabolic processes(7).

Lack of nutrients, especially iron (Fe) can cause nutritional anemia, which is part of the hemoglobin molecule. Reduced iron can cause reduced hemoglobin synthesis, resulting in decreased hemoglobin levels. Hemoglobin is an important element for the human body because it plays a role in transporting oxygen and carbon dioxide (8-10). The main nutritional problems experienced by adolescents include iron deficiency anemia, overweight/obesity and nutritional deficiencies (8).

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Body Mass Index (BMI) is a simple measuring tool to monitor nutritional status (11). According to Thompson, nutritional status has a positive correlation with hemoglobin concentration, meaning that the worse a person's nutritional status, the lower the hemoglobin level of the person (12). Based on Permaesih's research in 2005, found a significant relationship between BMI and anemia, in which adolescent girls with a BMI below 18.5 are thin and have a 1.4 times risk of suffering from anemia compared to 48 girls with normal BMI (8).

Riskesdas in 2013 explained that the prevalence of adolescents aged 13-15 years who were very thin was 31.7%, thin was 15.5%, obese was 16.5% and obese was 5.1 (13). Malnutrition is still a health problem in Indonesia. Based on Riskesdas 2013, the prevalence of adolescents 13-15 years who have short stature (according to TB/U) is 35.1%, consisting of 13.8% very thin and 21.3% thin. The five lowest case prevalence positions in Indonesia are Bangka Belitung, Riau Islands, DKI Jakarta, and Bali (14).

Based on these problems, the researchers are interested in conducting research on "The Relationship between BMI and Hemoglobin Levels in Adolescents in Medan City, North Sumatra, North Indonesia".

II. RESEARCH METHODS

This research is an analytic observational, with a *cross sectional study design.* The population of this study were all students of SMA Santo Thomas 1 Medan, North Sumatra, Indonesia. Determination of samples taken by *consecutive sampling* with samples that meet the inclusion criteria.

Data from survey results include gender, age, body mass index and laboratory examination of hemoglobin levels. The data obtained were distributed in the form of a frequency distribution and then displayed in the form of percentages and presented in the form of tables and diagrams, then statistical analysis was carried out using the normality of the Kolmogorov-Smirnov data and then the Pearson correlation test was performed.

III. RESEARCH RESULTS

Based on research conducted in Santo Thomas 1 Medan, North Sumatra, North Indonesia, the total number of subjects was 60 samples with the following results:

Based on Table 1, it can be seen that there are 4 male and female subjects aged 15 years (6.67%) and 12 (20%) students, male and female subjects aged 16 years were 6 (10%) and 12 (20%) students, and male and female subjects aged 17 years were 6 (10%) and 20 (33.33%) students.

Table 1. Frequency Distribution by Age and Gender

	Male		Female		Total	
Age (years)	n	%	n	%	n	%
15	4	6.67	12	20.00	16	26.67
16	6	10.00	12	20.00	18	30.00
17	6	10.00	20	33.33	26	43.33
Total	16	26.67	44	73.33	60	100.00

In Table 2, it can be seen, subjects with low hemoglobin levels were only found in 6 women (13.64%) and those with normal hemoglobin levels were found in 16 men (100%) and 38 women (86.36%).

The frequency distribution based on the Body Mass Index (BMI) in Table 3 shows that subjects who had a BMI below normal were found in 19 people (31.67%) namely 4 men and 15 women, normal nutritional status was 9 people (15%) including 2 there are only 3 women at risk of obesity, then the subject who has obesity nutritional status 1 is 23 people (38.33%) consisting of 6 men and 17 women, while obesity 2 is 6 people (10 %) namely 4 men and 2 women.

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Table 2. Frequency distribution by Hemoglobin Level

Gender	Hemoglobin				Total	
	Low	%	Normal	%	n	%
Male	0	0.00	16	100.00	16	26.67
Female	6	13.64	38	86.36	44	73.33
Total	6	10.00	54	90.00	60	100.00

Table 3. Frequency distribution based on Mass Index Body (BMI)

Body Mass Index ($kg/m^{2)}$	Gender				Total	
	Male	%	Female	%	n	%
<18.5	4	25	15	34.09	19	31.67
18.5 - 22.9	2	13	7	15.91	9	15.00
23 - 24 ,9	0	0	3	6.82	3	5.00
25 - 29.9	6	38	17	38.64	23	38.33
>30	4	25	2	4.55	6	10.00
Total	16	100	44	100.00	60	100.00

Table 4. Frequency distribution of Body Mass Index and Hemoglobin Levels by sex

BMI (kg/m^2)	Gender Hemoglobin	(g/dl)				Total	
		Anemia	%	Normal	%	n	%
<18.5	male	0	0	4	6.67	19	31.67
	Female	3	5.00	12	20.00		
18.5-22.9	male	0	0	2	3.33	9	15.00
	female	1	1.67	6	10.00		
23 - 24.9	male	0	0	0	0	3	5.00
	female	0	0	3	5.00		
25 - 29.9	male	0	0	6	10.00	23	38.33
	female	2	3.33	15	25.00		
>30	male -male	0	0	4	6.67	6	10.00
	per empuan	0	0	2	3.33		
Total		6	10.00	54	90.00	60	100.00

Normality of distribution of all numerical research variables was tested by the *Kolmogorov-Smirnov test* because the sample was more than 50. The p value of body mass index p = 0.076 and hemoglobin p = 0.358. The p value of the two variables is > 0.05 which means that all numerical data are normally distributed, as in Table 5.

Table 5. Normality Test of Numerical

Variables Variable	p
Body Mass Index	0.076
Hemoglobin	0.358

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Table 6. Pearson Correlation Test Results Correlation

of variables	p value
Hemoglobin BMI	0.015

From the test results using the Pearson correlation test, it was found that the significant value was p = 0.015, the value was less than 0.05. So Ho is rejected and H1 is accepted because there is a relationship between body mass index and hemoglobin levels.

IV. DISCUSSION

In this study, the authors are interested in taking adolescents as a sample because adolescence is a period of growth and development, where body mass index and nutritional status are still changing. Habits that are often carried out by most teenagers, both male and female, are consuming less nutritious foods such as ice, chocolate, fried foods, sweets and eating irregularly, while most of them carry out learning activities with dense extracurricular activities so that they experience digestive disorders, resulting in the absorption process in thethe body is disturbed, causing nutritional and iron deficiencies which affect body size and nutritional status, as well as adolescent hemoglobin levels. There are 50% of teenagers in Indonesia who suffer from anemia due to getting used tobreakfast but not consuming foods rich in nutrients. In addition, women's iron needs are greater than men's iron needs because women of productive age, including teenagers, experience menstruation every month. Women also tend to reduce their intake of nutritious food in order to lose weight (diet), so that the iron needs in the body cannot be met properly (15).

The results study using the Pearson correlation test showed that there was a significant relationship between body mass index and hemoglobin (Hb) levels (Table 6). This research is the same as that conducted by Wibowo CDT et al in 2013 at Muhammadiyah 3 Junior High School Semarang (15).

As shown in Table 4, there were 60 research subjects, 6 young women had low hemoglobin levels, while 54 other teenagers had normal hemoglobin levels.

Based on the results of this study, it was found that the six subjects with low hemoglobin levels were all women. The low hemoglobin levels of the six teenage girls have different body mass indexes according to Table 4, 2 of them with a BMI of 25-29.9 including obesity 1, while the other 3 teenagers have a BMI <18.5, which is a nutritional status below normal and only 1 teenage girl who has a BMI of 18.5-22.9 with normal nutritional status. This could be because at the time of blood sampling, adolescent girls with low hemoglobin levels were menstruating. Subjects who have good nutrition and do not experience anemia because the food consumed by the subject already contains all the nutrients needed by the subject's body, so there is a balance between the nutrients consumed by the subject and the nutrients needed by the body. This is also the same as the research conducted by Lakshmi in 2015 in North Karnataka, India (16).

Based on research data that has been done, there is 1 subject (1.67%) who has good nutritional status with anemia. This is because the nutritional content in food, especially iron consumed by students is not fulfilled, especially if these students prefer fast food or junk food , not nutritious food so that it affects the lack of absorption of iron and interferes with the formation of hemoglobin and causes oxygen supply. less in the blood, eventually experience anemia. So, adequate food consumption does not guarantee the adequacy of iron in it.

Subjects who have poor nutritional status with anemia as many as 3 students (5%), this is due to lack of nutritional intake in the body so that nutritional needs in the body are not met, for example the need for iron. Iron is one of the most important components in the formation of hemoglobin, with a lack of iron intake in the body will lead to reduced materials, so that red blood cells cannot perform their function in supplying oxygen which will lead to anemia. This is in line with research by Mayulu N in 2013 in Bolaang Mongondow Regency which showed that iron intake had a significant relationship with the incidence of anemia in elementary school students in North Bolaang Mongondow Regency, ie from 31 (68.9%) of 45 respondents experienced anemia due to lack of nutrient intake (17).

There are 2 research subjects (3.33%) who have obesity status with anemia. This is because the accumulation of fat cells in adipose tissue can reduce iron absorption. Similar to the research conducted by Eftekhari et al in 2008 in Iran, it was found that obese adolescent girls often had iron deficiency anemia (18).

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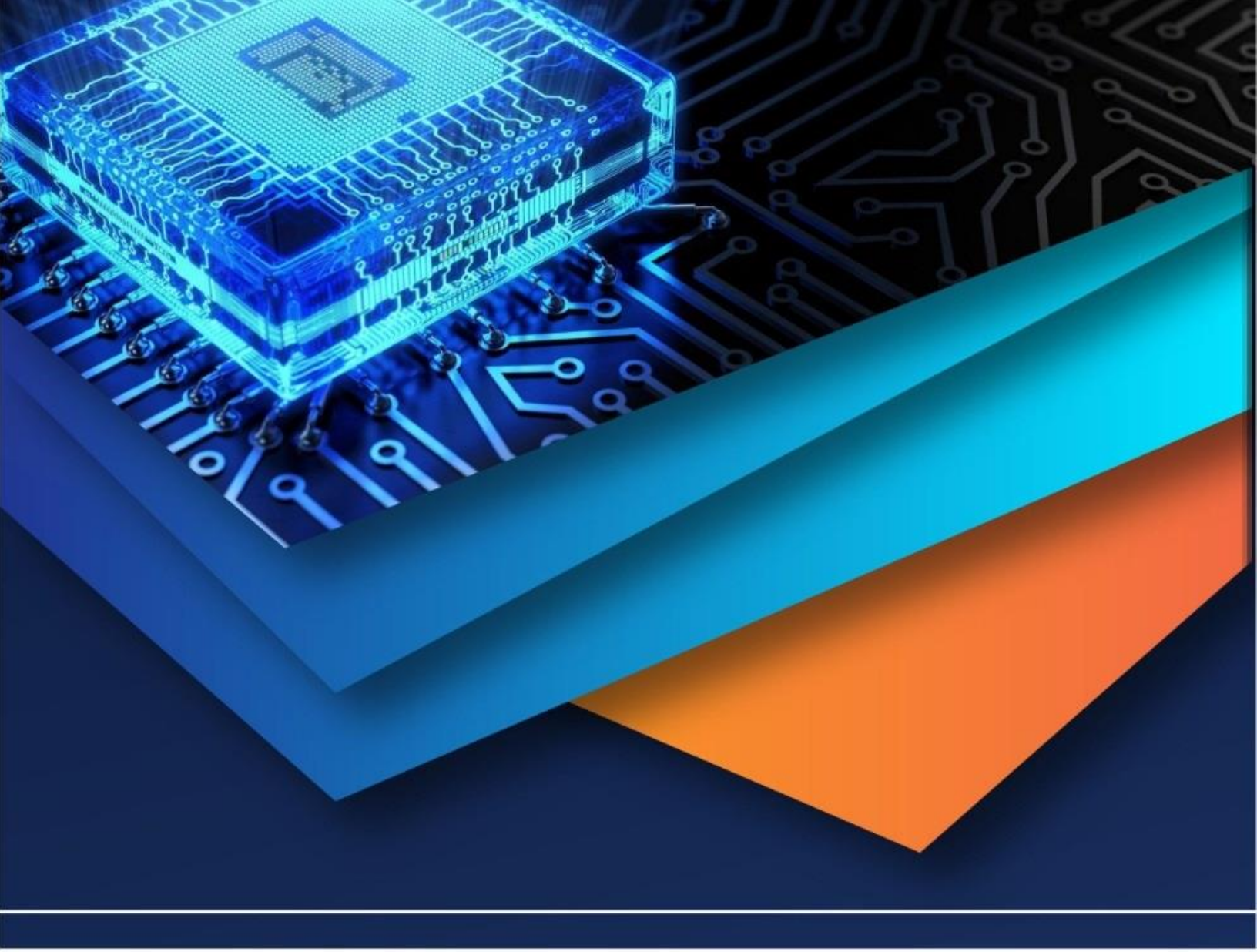
V. CONCLUSION

Based on the results of the study, it was concluded that there was a relationship between body mass index and hemoglobin levels in adolescents in Medan District, North Sumatra, North Indonesia. Ho is rejected and H1 is accepted.

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