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Relationship Between Adequacy of Protein, Iron, Vitamin C, and The Incidence of Anemia in Adolescent Girls Aged 16-18 Years

Dian Ferdi yanto[1], Alifianti Muharramah[2], Dera Elva Junita[3], and Desti Ambar Wati[4]

[1-4] Bachelor of Nutrition Study Program, Aisyah University Pringsewu Lampung ndonesia
Jl. A Yani No. 1A Tambak Rejo, Wonodadi, Pringsewu District, Kab. Pringsewu, Lampung 35372
Tel. 085769856074
[1]E-mail: dianferdi y anto29@gmail.com

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ABSTRACT

Background: *Anemia is a condition with a red blood cell count of less than <12 mg/dl. Factors that cause the high incidence of anemia in adolescents include low intake of animal and vegetable protein, iron, vitamin C, and bleeding due to prolonged menstruation.*

Research Methods: *This study aimed to determine the relationship between adequate protein, iron, and vitamin C levels and the incidence of anemia in young women aged 16-18 years at SMA Negeri 1 Jati Agung. The research design used in this research is quantitative, utilizing a cross-sectional method. The subjects in this research were 66 female respondents from SMA Negeri 1 Jati Agung.*

Research Result: *Base The results of the analysis using the Fisher test showed that there was no relationship between the level of protein adequacy (p = 0.633), the level of iron adequacy (p = 0.769), and the level of vitamin C adequacy (p = 0.128).*

Conclusion: *This research concludes that there is no relationship between adequate levels of protein, iron, and vitamin C and the incidence of anemia in young women aged 16-18 at SMA Negeri 1 Jati Agung.*

BACKGROUND

Adolescents are one of the groups that are vulnerable to nutritional anemia starting from junior high school, high school, and equivalent (Tritanto, 2013). A red blood cell count below 12 mg/dl indicates anemia. It is called anemia when adolescent females' hemoglobin levels are 12 mg/dl or higher (Wahyuningsih, 2021). Anemia affects 31.2% of Indonesian teenage females, according to the World Health Organization (WHO, 2022). The prevalence of anemia among teenage females rose by 37.1% in 2018, as reported by the RISKESDAS (RISKESDAS 2013), to 48.9% between the ages of 15 and 24. In Lampung Province in 2018, there was a prevalence of anemia of 11.57% spread across 16 districts/cities. (Mugiati, 2020). Meanwhile, the prevalence of anemia in adolescents aged 16-18 years at SMA Negeri 1 Jati Agung was 32.3% (Hanifa, 2022).

The impact of anemia on adolescent girls is stunted growth; the body is easily infected, fitness and freshness are reduced, and enthusiasm for learning and achievement is reduced (Apriyanti, 2019). Factors that cause high rates of anemia in adolescents include low intake of animal and vegetable protein, iron, vitamin C, and chronic infectious diseases such as tuberculosis, HIV / AIDS, bleeding due to prolonged menstruation, sufferers of thalassemia (genetic blood disorders), and bleeding in chronic malaria sufferers (Ministry of Health, 2018). Based on the Nutritional Adequacy Rate (AKG 2019), the daily nutritional needs for adolescent girls aged 16-18 years are 65 g of protein, 15 mg of iron, and 75 mg of vitamin C.

The human body uses protein as a store, building block, and regulator, making it an absolutely necessary nutrient. An integral part of the body's iron transport mechanism is protein. Iron insufficiency can

develop due to insufficient protein consumption, which hinders iron transformation (Farahdiba. 2018). Protein also plays a role in the process of transporting nutrients, including iron and the digestive tract in the blood, from the blood to the tissues and through the cell membrane into the cells so that if there is a lack of protein, it will cause interference with absorption and transportation (Andreas. 2021). Hemoglobin and other vital biological connections are formed by protein. Its function in iron absorption and transport is critical. Say there is not enough protein in the diet. If that happens, protein plays an important part in hemoglobin creation and iron transport; thus, hemoglobin levels will decrease if hemoglobin synthesis is not running optimally (Silvia. 2019).

Haemoglobin contains iron. The body absorbs iron in the duodenum, the top portion of the small intestine, with the aid of transferrin, a protein. Depletion of iron reserves and poor dietary iron absorption lead to decreased production of hemoglobin-containing red blood cells, which causes anemia (Tania, 2018).

The white crystal of vitamin C dissolves quickly in water. For the body to absorb iron, vitamin C converts ferric ions (Fe3+) to ferrous ions (Fe2+). Hemoglobin levels drop when vitamin C levels are low because iron interacts less optimally during hemoglobin synthesis (Silvia. 2019).

RESEARCH METHODS

The study was conducted in August - September 2023 at SMA Negeri 1 Jati Agung. Each respondent adjusted the schedule so that respondents could follow the entire data collection process. The research strategy used in this study is known as a cross-sectional approach, and its primary goal is to determine the nature of the link between risk factors and the outcomes of concurrently conducted observations or observations between variables (Notoatmodjo, 2012). The sample selection technique in this study used a simple random sampling technique. The sample of this study was adolescents aged 16-18 years at SMA Negeri 1 Jati Agung, South Lampung Regency, who had the same opportunity to be sampled in this study. This study was conducted after obtaining ethical clearance from the Aisyah Pringsewu University Ethics Commission, issued on August 30, 2023, with letter 039 / UAP.OT / KEP / EC / 2023.

Inclusion criteria include being willing to participate in the research by filling out the Informed Consent, being 16-18 years old and living in SMA Negeri 1 Jati Agung, being in good health, and being able to communicate well. Exclusion criteria are not participating in one of the series of studies and not complying with research procedures, being afraid of blood samples being taken, being in a state of illness, respondents not participating until the study's end, and not being menstruating. The dependent variable to be studied is anemia. At the same time, the independent variables are the level of protein adequacy, iron adequacy, and vitamin C adequacy. Researchers conducted a 3 x 24-hour recall to determine data on food intake from foods consumed (protein intake, iron, vitamin C). To determine the degree of protein, iron, and vitamin C adequacy, they compared it to the AKG (nutritional adequacy rate) based on age.

This analysis data is presented using a frequency distribution table of the variables to be studied. This univariate analysis aims to find the mean distribution of all the evaluated variables, including the correlation between anemia occurrence and protein, iron, and vitamin C adequacy levels. Bivariate analysis determines the relationship between research variables. Data analysts in this study used the Fisher test to determine the existence of independent and dependent variables. Also, it is crucial to investigate whether anemia rates significantly correlate with protein adequacy, iron adequacy, vitamin C adequacy, etc. Finding a cell>62.5% was done using the Fisher test.

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RESULTS

Characteristics Respondents

Distribution of Respondent Characteristics

Table 1. Distribution Respondents Based on Characteristics Respondents

Characteristics	n	Percentage (%)
Age		
16 year	11	16.6
17 year	46	69.6
18 year	9	13.6
	66	100
Class		
X	20	30.3
XI	27	40.9
XII	19	28.7
	66	100

The table shows the distribution of respondent characteristics. Most respondents are 17 years old (69.6%). Female students are in class XI (40.9%) in most classes.

Data Analysis

Univariate Analysis

The frequency distribution of anemia incidents at SMA Negeri 1 Jati Agung is presented in Table 2:

Table 2. Frequency Distribution of Anemia Incidence

Anemia	n	%
Anemia	30	45.4
No anemia	36	54.5
Total	66	100%

Source: Primary Data, 2023

Table 2 shows that out of 66 respondents, 30 (45.4%) had anemia.

The frequency distribution of protein adequacy levels in female students of SMA Negeri 1 Jati Agung is presented in Table 3:

Table 3. Frequency distribution of protein adequacy levels

Protein Adequacy Level	n	%
Not enough	64	97
Enough	2	3
Total	**66**	**100%**

Table 3 shows that the level of protein adequacy in female students at SMA Negeri 1 Jati Agung is 64 respondents in the insufficient category (97%).

The frequency distribution of iron adequacy levels in female students of SMA Negeri 1 Jati Agung is presented in Table 4:

Table 4 Frequency distribution of iron adequacy levels

Iron Adequacy Level	n	%
Not enough	65	98.5
Enough	1	1.5
Total	**66**	**100%**

Table 4 shows that the level of iron adequacy in female students at SMA Negeri 1 Jati Agung is 65 respondents in the insufficient category (98.5%).

The frequency distribution of vitamin C adequacy levels in female students of SMA Negeri 1 Jati Agung is presented in the following table:

Table 5. Frequency distribution of vitamin C adequacy levels

Vitamin C Adequacy Level	n	%
Not enough	59	89.4
Enough	7	10.6
Total	**66**	**100%**

Table 5 shows that the level of vitamin C adequacy in female students at SMA Negeri 1 Jati Agung is 59 respondents in the insufficient category (89.4).

Bivariate Analysis

Relationship between Protein Adequacy Level and Anemia Incidence

The results of this study, presented in Table 6, show the relationship between the variables studied with the Fisher test.

Table 6. Relationship between Protein Adequacy Level and Anemia Incidence

Level AdequacyProtein	Anemia ccurrence								*P Value*
	Heavy		Currently		Light		Normal		
	n	%	n	%	n	%	n	%	
Not enough	2	3.0	10	15.2	18	27.3	34	51.5	0.633
Enough	0	0.0	0	0.0	0	0.0	2	3.0	**(**Fisher's
More	0	0.0	0	0.0	0	0.0	0	0.0	test)
Amount	2	3.0	10	15.2	18	27.3	36	54.5	

Table 6 shows that out of 66 individuals (100%) tested, two (or 3.0%) had severe anemia with a protein adequacy level below the recommended minimum. Ten persons, or 15.2% of the total, had mild anemia with a protein adequacy level below the recommended minimum. The incidence of anemia in the mild category with a protein adequacy level in the category of less was 18 people (27.3%). The incidence of anemia in the normal category with a protein adequacy level in the category of less was 34 people (51.5%). The incidence of anemia in the normal category with a protein adequacy level in the sufficient category was two people (3.0%).

Based on the statistical test analysis results using the Fisher test above, a p-value of 0.633 was obtained, indicating no significant relationship between the level of protein adequacy and the incidence of anemia at SMA Negeri 1 Jati Agung.

Relationship Between Iron Adequacy Levels and Anemia Incidence

The results of this study, presented in Table 4.7, show the relationship between the variables studied with the Fisher test.

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Table 7. Relationship between Iron Adequacy Level and the Incidence of Anemia

Level Iron Adequacy	Anemia Occurrence								*P Value*
	Heavy		Currently		Light		Normal		
	n	%	n	%	n	%	n	%	
Not enough	2	3.0	9	13.6	17	25.8	31	47.0	0.769
Enough	0	0.0	1	1.5	1	1.5	5	7.6	Fisher's test
Amount	2	3.0	10	15.2	18	27.3	36	54.5	

Based on Table 7, it can be seen that out of 66 (100%)., the incidence of anemia in the severe category with a level of iron sufficiency in the category of less was two people (3.0%). The incidence of anemia in the moderate category with a level of iron sufficiency in the category of less was nine people (13.6%). The incidence of anemia in the mild category with a level of iron sufficiency in the category of less was 17 people (25.8%). The incidence of anemia in the normal category with a level of iron sufficiency in the category of less was 31 people (47.0%). The incidence of anemia in the moderate category with a level of iron sufficiency in the sufficient category was one person (1.5%). The incidence of anemia in the mild category with a level of iron sufficiency in the sufficient category was one person (1.5%). The incidence of anemia in the normal category with a level of iron sufficiency in the sufficient category was five people (7.6%).

According to the results of the Fisher test mentioned earlier, there was no statistically significant correlation between iron sufficiency and anemia rates at SMA Negeri 1 Jati Agung (p = 0.769).

The Relationship Between Vitamin C Adequacy Levels and the Incidence of Anemia

The results of this study, presented in Table 8, show the relationship between the variables studied with the Fisher test.

Table 8. Relationship between Vitamin C Adequacy Level and the Incidence of Anemia

Level AdequacyVitamin C	Anemia Occurrence								*P Value*
	Heavy		Currently		Light		Normal		
	n	%	n	%	n	%	n	%	
Less	2	3.0	9	13.6	18	27.3	36	54.5	0.128 Fisher's test
Enough	0	0.0	1	1.5	0	0.0	0	0.0	
Sum	2	3.0	10	15.2	18	27.3	36	54.5	

Based on Table 8, it can be seen that out of 66 (100%)., the incidence of anemia in the severe category with a vitamin C sufficiency level in the category of less was two people (3.0%). The incidence of anemia in the moderate category with a vitamin C sufficiency level in the category of less was nine people (13.6%). The incidence of anemia in the mild category with a vitamin C sufficiency level in the category of less was 18 people (27.3%). The incidence of anemia in the normal category with a vitamin C sufficiency level in the category of less was 36 people (54.5%). The incidence of anemia in the moderate category with a vitamin C sufficiency level in the sufficient category was one person (1.5%).

According to the findings of the aforementioned Fisher test, there was no statistically significant correlation between vitamin C adequacy and anemia incidence at SMA Negeri 1 Jati Agung. The p-value was 0.128.

DISCUSSION

The relationship between protein adequacy levels and the incidence of anemia

The study's results show no significant relationship between protein adequacy and the incidence of anemia, with a p-value of 0.633. This means that the lower the protein intake as an independent variable, the lower the hemoglobin level as a dependent variable.

Lewa's research (2016) concluded that, with a p-value of 1,000, there is no correlation between protein consumption and the prevalence of anemia among female students at MAN 2 Model Palu. This is because many people who took the survey prefer plant-based protein sources like tempeh and tofu to meat, an

iron source. Protein intake is low among responders due to the low protein content of vegetable protein sources. Iron deficiency can develop due to impaired iron transport caused by a diet low in protein.

An integral part of the body's iron transport mechanism is protein. Utilizing specialized protein transporters, absorption primarily occurs in the duodenum, the small intestine's top portion. Two types of protein transporters help iron absorption, namely transferrin and ferritin. Transferrin plays a central role in iron metabolism. This protein element transports iron into circulation and requires iron from the intestines to the bone marrow and other organs to form new hemoglobin (Vinny. 2020). According to Kalsum (2016), protein cannot be an iron transporter. If the intake does not contain food sources of iron, it can cause low iron and hemoglobin levels.

The relationship between iron adequacy levels and the incidence of anemia

The study found no statistically significant correlation (p=0.769) between iron adequacy and anemia occurrence. In this study, iron is a very important substance needed for the function of hemoproteins, such as hemoglobin, which is used in transporting and binding oxygen. Iron can be obtained from the breakdown of red blood cells to meet the body's needs. Iron can also be obtained from animal foods and plant food sources (Ariningrum. 2021).

Wandansari's research (2019) stated no relationship between iron intake and anemia in MAN 2 Model Palu female students, with a p-value of 1,000. This aligns with Ariningrum's research (2021), which found no relationship between nutrient intake and anemia in female adolescents in Sukoharjo Regency. Iron is the most prevalent macromineral in the bodies of humans and other animals, at three to five grams per adult. As an integral component of numerous enzyme activities in bodily tissues, iron is crucial in oxygen delivery from the lungs to the rest of the body (Almatsier, 2011).

The duodenum and upper jejunum are the organs responsible for iron absorption. Iron enters the stomach from the esophagus as ferric iron (ferri), which is transformed into soluble ferro after oxidation. Gastric acid will lower the pH to increase the solubility and absorption of iron. Teenage girls who are menstruating will lose iron, namely 15-28 mg/month. Insufficient iron in food occurs due to food consumption patterns. If iron intake is sufficient, the hemoglobin level of female students is good, and they will not experience anemia. If intake is lacking, anemia can occur because hemoglobin levels are less than usual, resulting in anemia (Tania. 2018).

Relationship between Vitamin C Adequacy Level and Anemia Incidence

With a p-value of only 0.128, the study found no statistically significant correlation between anemia rates and vitamin C sufficiency levels. In this study, vitamin C intake was lacking and had no relationship with hemoglobin levels. This happens because the research sample chose inappropriate foods and consumed less varied foods. One factor that causes suboptimal absorption of vitamin C is an error during processing because vitamin C is easily damaged when exposed to heat (Wandansari. 2019).

Based on research by Utomo (2013), A p-value of 0.198 indicates no correlation between vitamin C consumption and the prevalence of anemia in teenage girls. This is in line with research by Denistikasari (2016), which had a p-value of 0.920, which indicated that there was no correlation between vitamin C consumption and the occurrence of anemia in teenage females attending SMK Penerbangan Bina Dhirgantara Karanganyar. The production of red blood cells requires vitamin C, an important nutrient. Hemosiderin is difficult to mobilize for iron release; however, vitamin C prevents its production. To avoid anemia, vitamin C can aid iron absorption; nevertheless, iron absorption will be impaired with insufficient vitamin C consumption. Iron transport from plasma transferrin to ferritin involves vitamin C (Marfuah, 2021). If vitamin C intake is sufficient, hemoglobin levels are good, and you do not experience anemia. The adequacy of vitamin C according to the category of women aged 16-18 years is 75 mg (AKG, 2019).

CONCLUSIONS

Based on the results of the 3x24-hour food recall, as many as 93% of the research subjects' protein intake levels were included in the insufficient category, while only 3% were included in the sufficient category. Based on the results of the 3x24-hour food recall, 98.5% of the research subjects' iron intake levels were in the insufficient category, while only 1.5% were in the sufficient category. Based on the results of the 3x24-hour food recall, as much as 89.4% of the research subjects' vitamin C intake levels were included in

the insufficient category. In comparison, only 10.6% of the research subjects were included in the sufficient category. As many as 45.5% of respondents had anemia status, and 54.5% had non-anemia status. There is no relationship between protein intake and the incidence of anemia, with a p-value of 0.633. There is no relationship between iron intake and the incidence of anemia, with a p-value of 0.769.

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