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ANEMIA AMONG ADOLESCENT GIRLS: ITS ASSOCIATION WITH PROTEIN AND IRON INTAKE

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ABSTRACT

Adolescence is a time of physical and psychological growth as people transition to adulthood, and proper nutrition is essential for this process. Anemia is characterized by a lack of red blood cells or hemoglobin. The purpose of this study was to investigate the prevalence of anemia among teenage women in a rural area. The study used a cross-sectional design and included 112 middle school female students in Rejang Lebong Regency. The data was collected using survey questionnaire and a semi-quantitative food frequency questionnaire to assess risk factors such as knowledge, the intake of energy, protein, vitamin C, and iron. Correlation analysis was used to analyze the relationship between these variables and anemia status. The correlation analysis showed that knowledge, energy, and vitamin C intake were not significantly correlated with anemia (p value = 0.378, 0.563 and 0.087, respectively). However, there was a significant correlation between iron and protein intake with the occurrence of anemia (p value = 0.000 and 0.030).

Keywords*: knowledge, intake, energy, vitamin c, protein, iron, hemoglobin*

BACKGROUND

Anemia is a common nutritional issue that affects both developing and developed countries. Approximately two billion individuals are affected by anemia, with the highest prevalence observed in Asia and Africa (MacDonald, 2002). Adolescents are at a greater risk of developing anemia due to their requirements for macro and micronutrients (UN Standing Committee on Nutrition, 2004). Optimal nutrition is necessary for adolescents' growth and development. Anemia is a common issue among adolescents, as this stage involves physical, biological, and psychological growth and development. Imbalances between nutrient intake and needs can lead to nutritional problems, including over- and undernutrition (Briawan D, 2014). Adolescent girls are particularly at risk of anemia due to increased iron needs during this growth period. The body requires a lot of nutrients, including iron, which is used by the blood to transport oxygen. A lack of iron can lead to anemia, and this risk is further increased by blood loss during menstruation (Laksmita S *et al*, 2018).

Based on the information obtained from the 2013 Indonesian National Health Survey (Riskesdas), the occurrence of anemia in Indonesia was recorded at 21.7%. The prevalence of anemia was observed to be higher in women (23.9%) compared to men (18.4%). The prevalence of anemia was also higher in the 5-14 age group compared to the 15-21 age group, with 26.4% and 18.4%, respectively (Balitbangkes, 2013). According to Riskesdas data in 2018, the proportion of anemia was higher in women (27.2%) compared to men (20.3%) and particularly high (32%) in the 15-24 age group (Riskesdas, 2018). In 2018, a health examination conducted by the Puskesmas Curup Timur, Rejang Lebong Regency, found that out of 39 adolescent girls tested, 21 (53.8%) had hemoglobin levels below 12 grams/dL.

Hemoglobin is a widely used parameter for determining the prevalence of anemia. Anemia is characterised by a decrease in hemoglobin, red blood cell count, and hematocrit, leading to a reduced number of circulating red blood cells or hemoglobin that cannot provide oxygen to the body's tissues (Lestari IP *et al*, 2018). Low hemoglobin levels are commonly found in adolescent girls, a population group at high risk of nutrient deficiencies, particularly iron. The total amount of iron in the body is approximately 4-5 grams, with 65% of this iron present in the form of hemoglobin (Aulia *et al*, 2017).

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Typically, the elevated occurrence of anemia is attributed to various factors such as insufficient consumption of iron and other essential nutrients, including vitamin A, vitamin C, folate, riboflavin, and B12. To meet daily iron needs, it is essential to consume animal-based sources of iron, which are easily absorbed, as well as plant-based sources, which are high in iron but may be less easily absorbed (Most UMP, 2004)

Iron deficiency anemia in adolescents can have various negative effects, including impaired immunological function and increased disease susceptibility, decreased physical activity and job capacity, and poor academic performance. Additionally, adolescents with anemia have diminished fitness, which can hamper performance and productivity. Micronutrient deficiency throughout adolescence can significantly impact the development and maturity of reproductive organs (Briawan D, 2014).

The most influential micronutrient about anemia is iron. Iron is a vital micronutrient that is required by the body. Iron from plant-based (non-heme) sources such as legumes and vegetables generally has a lower absorption rate than iron from animal-based (heme) sources such as meat, eggs, and fish. According to the World Health Organization (WHO), iron deficiency is one of the ten most serious health problems (WHO, 2012).

According to Arisman (2010), protein intake is a cause of anemia in adolescent girls because protein is a vital nutrient that functions as a building and regulatory substance. Adequate protein intake is essential for maintaining humans' integrity, function, and health by providing essential amino acids as precursors to crucial molecules that are components of all cells in the body. A study by Sintha & Oster (2019) found that 63.4% of adolescent girls had anemia, and knowledge about anemia was a dominant factor among this group. Knowledge about foods high in iron was also low. It is essential to address anemia in adolescent girls to ensure that they have sufficient stores of iron in their bodies in preparation for marriage and pregnancy.

Soekirman (2008) defines nutritional knowledge as what is understood about food in connection to optimal health. Inadequate nutritional knowledge, lack of understanding about healthy eating habits, and lack of understanding about the dietary contributions of different types of food and the imbalance of nutrient needs can result in intelligence issues, decreased work capacity, and adverse effects on the quality of human resources and future generations. SMP N 3 was located in the highlands of Rejang Lebong Regency, where this district was a vegetable supplier for Bengkulu Province. Food consumption was influenced by the geographical conditions. With the abundant availability of vegetables in Rejang Lebong Regency, whether it impacts the high consumption of vegetables. Green vegetables were known high in iron and vitamin C. Anemia can be prevented by consuming green vegetables. This encouraged the researchers to conduct a study in this location. This study aims to determine the prevalence of anemia in adolescent girls at SMPN 3 in Rejang Lebong District.

METHODS

This research has obtained approval from the Research Ethics Committee of Poltekkes Kemenkes Bengkulu with No. KEPK/113/12/2020 and research permit No. 872/1495/SDK. The respondents have provided their consent after receiving a complete explanation according to the informed concern.

This research used a cross-sectional design conducted in the highlands of the Rejang Lebong District of Bengkulu City. The study population is 112 female adolescents in grade 8 in SMP Negeri 3, using a total sampling technique. The inclusion criteria for the subjects of that study were 8th grade female adolescents who were not menstruating during data collection period and willing to participate as research respondents, while the exclusion criteria were respondents who were ill and unable to participate. The independent variables in this study were knowledge, energy intake, vitamin C, iron, and hemoglobin. Anemia status was assessed by measuring Hemoglobin (Hb) levels using *Easytouch.* Knowledge was assessed using a questionnaire that was adopted and modified from several sources (Runkat, 2018; Rahma, 2017; & Lestari DIN, 2018), while consumption patterns were obtained using a semi-quantitative FFQ form (Laksmi W. 2009). The

dependent variable in this study is hemoglobin value. Statistical analysis was done using a correlation test.

RESULTS AND DISCUSSION

Table 1. Frequency distribution of knowledge, energy intake, vitamin C, iron, protein, and hemoglobin in female adolescents

Variable	N	Mean	SD	Min	Max
Knowledge	112	75	14,48	20	93
Energy intake	112	1763	636,80	661	4062
Vitamin C intake	112	110	103,99	17	524
Iron intake	112	10,72	7,00	3	52
Protein intake	112	65,3	34,49	18	203
Hemoglobin	112	13,2	2,04	7	18

Table 1 shows that the respondents' knowledge scores range from 20 to 93, averaging 75. The results of energy intake ranged from 661 to 4062 kcal, with an average intake of 1763 kcal per day. Vitamin C intake ranged from 17 to 525 mg, with an average intake of 110 mg. Iron intake among respondents ranged from 3 to 52 mg, with an average intake of 10.72 mg. Protein intake ranged from 18 to 203 g, with an average intake of 65.3 g. The results of the hemoglobin examination showed that the lowest Hb level was 7 g/dl, and the highest was 18 g/dl.

Table 2. The relationship between knowledge, energy intake, vitamin C, iron, protein, nutritional status, and hemoglobin in female adolescents

Variable	Anemia status		
	N	r	p
Knowledge	112	-0,084	0,378
Energy intake	112	0,055	0,563
Vitamin C intake	112	0,163	0,087
Iron intake	112	0,206	0,030
Protein intake	112	0,362	0,000

The p-value of 0.378 indicates that there is no correlation between knowledge and the hemoglobin value (Table 2). The p-value of 0.563 also shows no connection between calorie intake and the hemoglobin value. The hypothesis test for vitamin C intake results in a p-value of 0.087, indicating no significant association between vitamin C intake and the hemoglobin value. According to the hypothesis test, there is a substantial link between iron intake and the likelihood of developing anemia, as shown by the p-value of 0.030 and a positive correlation coefficient, which means that the more iron consumed, the higher hemoglobin level or, the less likely to develop anemia. With a p-value of 0.000 and a positive correlation coefficient, the hypothesis test also reveals a significant link between protein intake and anemia, which means that the higher the protein intake, the higher the hemoglobin level or, the lower the occurrence of anemia.

Nutrition Knowledge

This study's results showed no relationship between knowledge and the occurrence of anemia, as indicated by the p-value of 0.378. The respondents' lowest and highest knowledge scores were 20 and 93, respectively. The lack of knowledge about anemia among adolescents resulted in their need for more understanding of the condition. Adolescent girls' knowledge can be seen from their ability to correctly answer questions about the definition, symptoms, signs, iron-inhibiting foods, causes, consequences, and prevention of anemia in adolescent girls in a questionnaire. The knowledge that is included in the cognitive domain has six levels: knowing, understanding, applying, analysing, synthesizing, and evaluating. . It has been proven that behaviour based on knowledge is more enduring than behaviour that is not based on knowledge (Notoatmodjo 2010).

Sugiarsih's research indicates that there is no correlation between knowledge and anemia. This is because education is not the only variable that might influence the occurrence of anemia (Sugiarsih U, 2013). Similarly, Chusniaty's report revealed that the incidence of anemia was higher in the group with adequate knowledge (33.3%) than in the group with insufficient information (28.6%). Behaviour is influenced by knowledge level. The greater one's awareness of anemia prevention, the greater their knowledge. Level of knowledge also affects dietary behaviour, which in turn changes eating patterns and ultimately aids in the prevention of anemia (Chusniaty N, 2002).

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Iron (Fe)

The results show a relationship between iron intake and the occurrence of anemia with a p-value of (0.030). According to Sari (2016), one factor that influences anemia is iron. Urban adolescent girls with inadequate iron intake are at higher risk of iron deficiency anemia compared to adolescents with good iron intake.

Iron is a crucial component required for the production of blood, and it is stored in the body as ferritin, which is carried in the bloodstream. A deficiency in iron can lower the level of hemoglobin, resulting in a reduced delivery of oxygen to the tissues in the body. (Suryani D *et al*, 2015). Research by Pibriyanti showed that low iron intake in adolescents increases the risk of anemia 3.09 times higher than in adolescents with sufficient iron intake (Pibriyanti K *et al*, 2020).

Iron reserves in the body, specifically ferritin and hemosiderin, are typically located in the liver, spleen, and bone marrow. If the quantity of stored iron is adequate, the formation of red blood cells in the bone marrow will always be adequately fulfilled. However, suppose the intake of iron in the diet is insufficient over the long term. In that case, iron stores in the body will also decrease, resulting in a decrease in blood hemoglobin levels. This is what causes iron deficiency anemia (Briawan D, 2014)

Iron is a crucial element for the body as it is involved in the production of oxygen-carrying proteins, such as hemoglobin and myoglobin, as well as heme enzymes and other iron-containing enzymes that play a role in electron transfer and oxidation-reduction. The majority of the body's iron, about two-thirds, is found in the form of hemoglobin in red blood cells, while 25% is stored and ready to be mobilized. The remaining 15% is bound to myoglobin in muscle tissue and various enzymes that contribute to oxidative metabolism and other cellular functions (Abbaspour N *et al*, 2014).

Protein

The data indicate a correlation between protein consumption and the incidence of anemia. Some respondents could not achieve their daily protein demands based on the recommended value of 69 grams, as determined by the results of interviews using the FFQ. Protein is among the essential nutrients. It facilitates the delivery of iron to the spine for red blood cell production. Protein consumption, particularly animal protein, reduces iron absorption. Consequently, protein consumption can influence Hb levels and result in anemia (Sholihah N *et al*, 2019).

According to research by Fridayanti (2000), teenagers with inadequate protein consumption are 3.48 times more likely to develop anemia than those with adequate protein intake. Sholihah's research demonstrates a correlation between protein intake and the incidence of anemia in adolescent girls; the lower the protein intake, the lower the hemoglobin level (Sholihah N *et al*, 2019). Protein has a substantial effect on anemia. Anemia can result from insufficient protein intake, which disrupts iron transport for synthesising hemoglobin and red blood cells. Similarly, Pratiwi's research at MTS Ciwandan indicates a correlation between protein consumption and anemia (Pratiwi E, 2016).

Vitamin C

The research findings indicate that there is no significant correlation between the intake of vitamin C and the incidence of anemia, as reflected in the p-value of 0.087. The results of the interviews revealed that the average intake of vitamin C was 110 mg, and the majority of respondents had adequate intake of vitamin C. The respondents consumed fruit sources of vitamin C such as papaya, Ambon banana, sweet orange, salak, watermelon, and guava. Although the statistical test conducted in this research showed no relationship between protein intake and the occurrence of anemia in adolescent girls at SMP N 3 Kabupaten Rejang Lebong, it can be seen that students with sufficient vitamin C intake tend to be at risk of anemia if they consume food or drinks containing tannins at the same time.

Adolescent girls tend to consume foods such as tea and coffee containing tannins, inhibiting iron absorption into the body. Research by Marfuah (2021) shows no relationship between vitamin C intake in adolescent girls at SMP Brebes and hemoglobin levels. Intan (2018) found no relationship between vitamin C intake and Hb levels in teenage girls at SMA Negeri 5 Malang. The analysis results are due to the consumption of vitamin C sources not being balanced with

non-heme iron-rich foods and the consumption of iron-inhibiting foods, and the form of the food being fresh, which has a high fibre content that will inhibit iron absorption (Intan YH *et al*, 2018).

The body needs vitamin C to produce red blood cells, and its presence in the diet can aid in the absorption of iron. Vitamin C can prevent the formation of hemosiderin, which can be difficult to mobilize when the body needs iron. When vitamin C is present in the diet, it can help convert ferric iron into ferrous iron, which is more easily absorbed by the small intestine. The absorption of nonheme iron increases fourfold when vitamin C is present, but if the consumed iron is limited in quantity, the function of vitamin C as an iron enhancer will not work. (Adriani M *et al*, 2012) Vitamin C is a vital factor in enhancing the absorption of iron in the body. Iron is essential in producing hemoglobin, which is responsible for carrying oxygen in red blood cells. Additionally, vitamin C plays a significant role in the production of red blood cells. (Resmi S *et al*, 2017).

The findings of this study were consistent with the research conducted by Sholihah N (2019), which concluded that there is no correlation between vitamin C and anemia. The occurrence of anemia can be influenced by various other factors, such as a history of worm infections and the consumption of iron-enhancing supplements. Furthermore, anemia may result from impaired iron absorption, which can also impact the role of vitamin C in the body. Vitamin C assists in the absorption of iron, but if iron intake is insufficient, the iron absorption process facilitated by vitamin C will not function properly (Sholihah N, 2019).

Energy

According to the study's findings, there is no correlation between calorie intake and the incidence of anemia. The metabolism of carbohydrates, proteins, and lipids produces energy. It serves as a source of energy for metabolism, growth, regulation of body temperature, and physical activity. At age 12, teenage girls require approximately 2,550 kcal per day; by age 18, this reduces to 2,200 kcal per day. This computation is based on the physiological development stage rather than chronological age (Restuti AN *et al*, 2017).

This is consistent with Aramico (2017) that there is no significant correlation between nutritional intake (p=0.25) and the incidence of anemia with nutritional status. Teenagers require a substantial amount of energy for their metabolism. Teenage females' low food intake may contribute to energy nutrient intake deficiencies. Junior high schools had the most significant proportion of students with inadequate energy consumption. According to the SQ-FFQ, the consumption of energy-producing foods varies, and breakfast habit may be a factor in the respondents' inadequate intake of energy nutrients.

Hemoglobin

Based on the research results, the hemoglobin levels in teenage girls at SMPN 3 were the lowest at 7 gr/dl and the highest at 18 gr/dl, with 21 out of 112 teenage girls having a hemoglobin level below 12. SMP N 3 is located in the Rejang Lebong district of Bengkulu city. Hemoglobin is a widely used parameter for determining the prevalence of anemia. Anemia causes the blood not to bind and transport enough oxygen from the lungs to the entire body. If the required oxygen is insufficient, it will result in difficulty concentrating, low physical endurance, easily tiredness, decreased physical activity, and low resistance to illness due to low body resistance (Suryani D *et al*, 2015).

Low levels of hemoglobin, the oxygen-carrying compound found in red blood cells, can result from a lack of essential nutrients, particularly iron deficiency, which happens when the body's iron absorption is insufficient to fulfill its requirements. Factors that contribute to this may include insufficient iron intake, decreased bioavailability of iron in the body, or an increase in the body's iron demands due to physiological changes like pregnancy and growth (Briawan D, 2014).

CONCLUSION

Knowledge, energy intake, and vitamin C do not have a significant relationship with the occurrence of anemia, as shown by the p values (p= 0.378), (p= 0.563), (p 0.087). There is a relationship between iron and protein intake with the occurrence of anemia, as shown by the p values (p 0.030) and (p= 0.000). It is recommended for

teenage girls to have a balanced diet, including the intake of protein (both heme and non-heme) and iron. It is necessary to limit the consumption of coffee and tea to prevent the inhibition of iron absorption. It is required to educate teenagers about anemia and its impact.

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