Nutra: Jurnal Gizi Dan Kesehatan
https://saintifypublish.com/index.php/nutra
Volume 02 | Number 01 | Juli |2024
e-ISSN: 3025-9886

THE RELATIONSHIP OF MACRO AND MICRO NUTRIENTS WITH THE INCIDENCE OF ANEMIA IN ADOLESCENT GIRLS AT SMP PLUS AL MUHSININ CANGKUANG DISTRICT, BANDUNG REGENCY

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Article History
Received 21 Juli 2024
Accepted 30 Juli 2024

Keyword
Adolescents
Anemia
Nutrition

DOI

Abstract
Adolescent girls are a population at risk of iron deficiency due to increased nutrient requirements during growth. The high incidence of anemia among adolescents will continue into adulthood if not handled properly. Problems that will be experienced include pallor, fatigue, dizziness, and reduced concentration on learning. The purpose of the study was to determine the relationship between macronutrients and micronutrients with the incidence of anemia in adolescent girls at SMP Plus Al Muhsinin in Cangkuang District. This study uses a cross-sectional design involving 35 respondents from SMP Plus Al Muhsinin in Cangkuang Distric. Data were collected on nutrient intake using the Semi Quantitative Food Frequency Questionnaire (SFFQ) and the value of hemoglobin levels using the hemoglobin blood test (GCHb). The results of statistical tests using chi-square showed significant relationships between carbohydrate intake (p = 0.009), protein intake (p = 0.001), fat intake (p = 0.004), iron intake (p = 0.004), vitamin C intake (p = 0.016), and folic acid intake (p = 0.016). There was no significant relationship with zinc intake (p = 1.000). It is recommended that schools implement healthy canteens, encourage regular healthy breakfast initiatives twice a week, and establish teams and youth cadres to supervise the consumption of Fe tablets.

Introduction

Anemia in adolescent girls is a condition where the number of red blood cells or the concentration of hemoglobin in the blood is insufficient to meet their physiological needs. Anemia in women of childbearing age is a challenge in the field of reproductive health nutrition, anemia is characterized by a decrease in hemoglobin levels of less than 11.5 g/dl in adult women (1). In 2018, the World Health Organization (WHO) recorded the prevalence of anemia in women of productive age at 32.8%, while in 2021 WHO recorded the prevalence of anemia at 29.9%, resulting in a decrease of 2.9% from 2018, and specifically for the Southeast Asia region was recorded at 45.6% (2). Indonesia is one of the countries in the

Southeast Asia region. The prevalence of anemia in adolescents in the world ranges from 40-88%. According to the World Health Organization (WHO). In iron deficiency cases, the prevalence of children in adolescent age group ranged from 14.1% to 18.4% (3). The incidence of anemia in adolescent girls in developing countries is around 53.7% of all adolescent girls (4).

The causes of anemia include inadequate intake, loss of red blood cells caused by trauma, infection, chronic bleeding, menstruation, and decreased or abnormal cell formation, such as: hemoglobinopathy, thalassemia, and hereditary spherocytosis (5). Iron is an essential element for almost all living organisms as it participates in a wide variety of metabolic processes, including oxygen transport, deoxyribonucleic acid (DNA) synthesis, and electron transport (6). According to research by Kartini ddk (2019) on the relationship between iron intake, vitamin C and menstrual cycle patterns with hemoglobin levels, a study on teenagers at SMK Negeri 10 Semarang, this shows that there is a significant relationship between protein intake, iron, menstrual cycle and length of menstruation with hemoglobin levels. The results of research from Sholicha & Muniroh (2019) iron, protein and vitamin c intake are related to hemoglobin levels. Low intake of iron, protein and vitamin c means that hemoglobin levels are also low, so the incidence of anemia is higher (7). Adolescent girls should be able to increase their intake of iron-source foods and take iron supplements or blood supplement tablets regularly to replace iron in the body that is lost during menstruation (8).

Materials and Methods

This study is an analytical observational study with a cross-sectional approach, where observations or measurements of independent and dependent variables are collected together to determine the relationship between macronutrients and micronutrients with the incidence of anemia in SMP Plus Al-Muhsinin, Cangkuang Sub-district, Bandung District. The sample used was 35 respondents from students of SMP Plus Al Muhsinin in Cangkuang District. The inclusion criteria are as follows: willing to participate as respondents, respondents are not menstruating, respondents are aged 12 – 18 years. The exclusion criteria are as follows: not currently using medications that can increase hemoglobin levels such as gentamicin (antibiotic), respondents with comorbid conditions. The sample was selected using a random sampling method. We collected data on nutritional intake using the Semi Quantitative Food Frequency Questionnaire (SQFFQ), which involved detailed interviews about the frequency and quantity of food consumed by the respondents. Hemoglobin levels were measured using the hemoglobin blood test (GCHb), conducted by taking blood samples and analyzing them for hemoglobin concentration. This study used a chi-square test with a significance limit of 0.05, carried out using SPSS version 22 software.

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Additional procedures included verifying the accuracy of the data and confirming that all assumptions of the chi-square test were met before analysis

Results

Table 1 Frequency Distribution Based on the Incidence of Anemia in SMP Plus Al Muhsinin Cangkuang District

Anemia	Frequency	
	n	(%)
Anemia	6	17.1%
Non Anemia	29	82.9%
Total	35	100%

Based on table 1 shows that of the 35 female respondents who did not experience anemia were 82.9% and those who experienced anemia were 17.1%.

Table 2 Frequency Distribution of Food Intake in Adolescent Girls at SMP Plus Al Muhsinin Cangkuang District

Type of intake	Frekuency	
	n	(%)
Carbohydrates		
Less	7	20.0%
Enough	28	80.0%
Protein		
Less	29	14.3%
Enough	30	85.7%
Fat		
Less	6	17.1%
Enough	29	82.9%
Iron		
Less	6	17.1%
Enough	29	82.9%
Zink		
Less	20	57.1%
Enough	15	42.9%
Vitamin C		
Less	8	22.9%
Enough	27	77.1%
Vitamin B9		
Less	8	22.9%
Enough	27	77.1%

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Total	**35**	**100%**

Table 2 shows that 20% of the adolescent girls had deficient carbohydrate intake, while 80% had adequate carbohydrate intake. In the protein category, 14.3% of the adolescents had deficient intake and 85.7% had adequate intake. For fat, 17.1% of them had deficient intake and 82.9% had sufficient intake. Similar to fat, 17.1% of adolescents had deficient iron intake and 82.9% had sufficient intake. However, in the zinc category, there was a significant number of adolescents who had a deficient intake, at 57.1%, while the remaining 42.9% had sufficient zinc intake. In vitamin C, 22.9% of adolescents had a deficient intake, while 77.1% had an adequate intake. Finally, in the vitamin B9 category, 22.9% of adolescents had a deficient intake and 77.1% had an adequate intake. Table 2 shows that most adolescents had adequate intake in most intake categories, except for zinc where more than half of the adolescents had an insufficient intake.

Tabel 3 Relationship between food intake and the incidence of anemia in adolescent girls at SMP Plus Al Muhsinin Cangkuang District

Type of intake	Incidence of Anemia				Total		*p Value*
	Anemia		NonAnemia				
	n	%	n	%	N	%	
Carbohydrates							
Less	4	11.4%	3	42.9%	7	100%	0.009
Enough	2	7.1%	26	5.7%	28	100%	
Protein							
Less	4	11.4%	1	48.6%	5	100%	0.001
Enough	2	5.7%	28	34.3%	30	100%	
Fat							
Less	4	11.4%	2	48.6%	6	100%	0.004
Enough	2	5.7%	27	34.3%	29	100%	
Iron							
Less	4	11.4%	2	48.6%	6	100%	0.004
Enough	2	5.7%	27	34.3%	29	100%	
Zink							
Less	4	11.4%	17	48.6%	21	100%	1.000
Enough	2	5.7%	12	34.3%	14	100%	
Vitamin C							
Less	4	11.4%	4	11.4%	8	100%	0.016
Enough	2	5.7%	25	71.4%	27	100%	
Vitamin B9							
Less	4	11.4%	4	11.4%	8	100%	0.016
Enough							

	2	5.7%	25	71.4%	27	100%

Table 3 shows the relationship between types of food intake and the incidence of anemia in adolescent girls at SMP Plus Al Muhsinin Cangkuang. Based on the results of the analysis, carbohydrate, protein, fat, iron, vitamin C, and vitamin B9 intake had a significant relationship with the incidence of anemia, as indicated by a p value of less than 0.05 for each type of intake. In contrast, zinc intake showed no significant association with the incidence of anemia, indicated by a p value of 1.000. This indicates that deficiencies in the intake of some essential nutrients such as carbohydrates, protein, fat, iron, vitamin C, and vitamin B9 may increase the risk of anemia in adolescent girls.

DISCUSSION

The results of the carbohydrate intake research showed that almost all of the respondents had sufficient carbohydrate intake, with 28 respondents (80.0%) meeting the required levels. Statistical tests indicated a significant relationship between carbohydrate intake and the occurrence of anemia, with the chi-square test yielding a p-value of 0.009. This relationship is attributed to the adequate carbohydrate intake among the majority of research samples. Based on the SQFFQ interview, respondents consumed carbohydrates 2-4 times a day, as most students ate regularly at breakfast, lunch, and dinner. These findings align with the research by Maesarah et al. (2023), which reported a significant relationship between carbohydrate intake and anemia in students at the Faculty of Public Health, Gorontalo University, with a p-value of 0.000 (9). Carbohydrates are the main source of energy for the needs of cells and body tissues. Some tissues, such as the nervous system and erythrocytes, can only use carbohydrates as a source of energy (10). The implications of this study suggest that ensuring sufficient carbohydrate intake is crucial in preventing anemia among adolescents. Schools and parents should encourage regular meals that include adequate carbohydrate sources to support the energy needs of growing adolescents.

Based on the results of the SQFFQ, most of the respondents who experienced anemia had poor protein intake. This is evident from their habit of consuming low-protein food sources and unhealthy snacks. Protein plays an important role in iron transportation in the body. Therefore, a lack of protein intake inhibits iron transport, leading to iron deficiency and low hemoglobin levels, which results in anemia (11). Animal protein intake can increase iron absorption in the body. Low protein consumption reduces iron absorption, causing the body to lack iron and potentially leading to anemia (12). This study aligns with research conducted by Hendrawanti (2018), which showed a significant relationship between protein intake and anemia, with a p-value of 0.000 (13). These findings imply that improving protein intake among adolescents is crucial for preventing anemia. Schools and parents should promote the consumption of protein-rich foods to enhance iron absorption and maintain healthy hemoglobin levels.

The relationship in this study occurred because the majority of respondents had sufficient fat intake. According to the SQFFQ results, the respondents consumed adequate fat because they frequently ate foods high in fat content, such as fast food and fried snacks. This study aligns with research by Maesarah et al. (2023), which found a significant relationship between fat intake and anemia in students at the Faculty of Public Health, Gorontalo University, with a p-value of 0.000 (14). Fat is a crucial energy source for growth and activity. Low fat intake results in insufficient energy and can negatively affect iron and zinc absorption (15). These findings highlight the importance of ensuring adequate fat intake to support energy needs and nutrient absorption. Schools and parents should encourage balanced diets that include healthy fat sources to prevent anemia and support overall growth in adolescents.

The lack of iron intake in this study, based on the SQFFQ results, was due to the students' less varied diet, particularly lacking in iron-rich foods such as liver, beef, and green vegetables. Some students also consumed tea almost every day. Although tea has various benefits, it contains tannins, which can bind to metals like iron, calcium, and aluminum, forming complex bonds that make these nutrients difficult for the body to absorb. Consequently, regular tea consumption can decrease iron absorption, increasing the risk of anemia. Students who drink tea daily have a two-fold higher risk of anemia compared to those who do not (16). This study is consistent with research by Wiranti (2016), which found a significant relationship between iron intake and anemia incidence in students at SMKN 1 Sukoharjo, with a p-value of 0.001 (17). Similarly, research by Emilia (2019) reported a significant relationship between iron intake and anemia status in female students at Hidayatussalikin Air Itam Islamic Boarding School in Pangkalpinang City, with a p-value of 0.001 (18). These findings highlight the importance of a varied diet that includes iron-rich foods and the potential negative impact of certain dietary habits, like frequent tea consumption, on iron absorption. Efforts should be made to educate students and their parents about the importance of iron intake and to promote dietary practices that support adequate iron levels to prevent anemia.

Based on the SQFFQ results, many students still do not consume zinc-rich foods such as milk, fish, and other animal proteins. Zinc is a micronutrient that affects iron metabolism. It interacts with iron both directly and indirectly, primarily through its role in protein synthesis, including the iron transport protein transferrin. Zinc is crucial in almost all body metabolism, including the formation of red blood cells by assisting the enzyme carbonic anhydrase, which maintains acid and alkaline balance. Additionally, zinc helps carbonic anhydrase stimulate the production of gastric HCL, which can increase hemoglobin levels (19). This study aligns with research by Trisnawati (2014), which found that zinc does not have a significant relationship with the incidence of anemia in school children. These

findings suggest that while zinc plays a vital role in overall metabolism and hemoglobin production, its intake alone may not directly correlate with anemia prevention.

The SQFFQ results show that respondents consume vegetables and fruits less than three times per week. Many respondents prefer certain types of vegetables and fruits, such as guava and mango, due to living in a region where "sosin" (a specific vegetable) is commonly produced. Consequently, their diet lacks variety, leading to insufficient vitamin C intake. Vitamin C is essential for red blood cell formation and can inhibit the formation of hemosiderin, which binds iron. It also aids in transferring iron from transferrin in the plasma to ferritin in the liver. Vitamin C can increase the absorption of non-heme iron up to fourfold (20). This study aligns with Trisnawati (2016), who found a significant relationship between vitamin C intake and anemia incidence, with a p-value of 0.011 and a positive correlation coefficient of 0.305. This indicates that higher vitamin C intake corresponds with higher hemoglobin levels and lower anemia incidence. These findings underscore the importance of adequate vitamin C intake for improving iron absorption and preventing anemia.

Based on the SQFFQ results, the foods most often not consumed by respondents are vegetables, especially green vegetables, fruits, and animal protein. This leads to a deficit in folic acid intake, as these foods are primary sources of folic acid. Poor eating habits and frequent consumption of street food contribute to this deficiency. Long-term folate deficiency can decrease hemoglobin formation, causing anemia (21). Folic acid is essential for the formation and maturation of red and white blood cells in the bone marrow. Red blood cells carry oxygen from the lungs throughout the body and transport carbon dioxide to the lungs for expulsion. Folate also acts as a single carbon carrier in the formation of heme (22). This study aligns with Saptyasih (2016), which found a significant relationship between folic acid intake and hemoglobin levels. The correlation coefficient value of 0.621 indicates a strong, positive relationship between folic acid intake and hemoglobin levels in junior high school students. This positive correlation suggests that higher folic acid intake leads to higher hemoglobin levels and vice versa (23). These findings highlight the importance of a balanced diet that includes green vegetables, fruits, and animal proteins to ensure adequate folic acid intake and prevent anemia.

Conclusion

This study shows that the majority of female students at SMP Plus Al Muhsinin often choose foods that do not meet balanced nutrition requirements and that there is no healthy canteen available at the school. The results indicate that most respondents have sufficient intake of carbohydrates (80%), protein (85.7%), fat (82.9%), iron (82.9%), folic acid (77.1%), and vitamin C (77.1%). However, zinc intake among most respondents is relatively low (57.1%). Despite this, the majority of respondents do not experience anemia (82.9%). The study also found a significant relationship between the intake of macronutrients

(carbohydrates, protein, and fat) and micronutrients (iron, vitamin C, and folic acid) with the incidence of anemia, as indicated by p-values less than 0.05 for each of these nutrients.

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