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The relationship between macronutrient and micronutrient intake with anemia in the Puruk Cahu health center

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ABSTRACT

Adolescents constitute a vulnerable demographic group susceptible to iron deficiency owing to heightened nutritional demands during their growth phase. These requirements persist until the onset of puberty. The considerable prevalence of anemia among adolescents may persist into adulthood if not effectively managed. Within the working area of the Puruk Cahu Puskesmas, 20.68% of junior high school students are afflicted with anemia. This study aims to scrutinize the correlation between protein, iron, vitamin C, folic acid, and vitamin B12 levels and anemia among junior high school students in the aforementioned locale. Employing an analytical observational approach with a cross-sectional design, the study sampled 102 individuals through purposive sampling. Data collection utilized a questionnaire. Independent variables encompassed protein, iron, vitamin C, folic acid, and vitamin B12. Bivariate analysis was conducted utilizing the chi-square method, with multivariate analysis employing multiple logistic regression. Findings unveiled significant associations between protein (p=0.009), iron (p=0.008), and vitamin B12 (p=0.026) levels and anemia, whereas no such correlation was found with vitamin C (p=0.196) and folic acid. Iron emerged as the most influential factor contributing to anemia among junior high school students (Exp(B)=8.747). Consequently, this underscores the imperative of addressing iron deficiency within this demographic to alleviate anemia prevalence.

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INTRODUCTION

The prevalence of anemia worldwide ranges from 40-80% (Reski et al., 2020; Wahyuni et al., 2021). In India, the prevalence of anemia among adolescent girls is 45% (Chandrakumari et al., 2019; Kamble et al., 2021). While in Indonesia, it stands at 32% (Husna & Saputri, 2022). The proportion of anemia in females is 27.2%, higher than males at 20.3%. Anemia among adolescent girls has increased from 37.1% in the Riskesdas 2013 survey to 48.9%. Approximately 12% of adolescent

males and 23% of adolescent females in Indonesia suffer from iron deficiency anemia. According to the 2018 Riskesdas data, the prevalence of anemia in Indonesia is 48.9%, with the majority occurring in the age groups of 15-24 years and 25-34 years (Carolin & Novelia, 2021; Nadiyah et al., 2022).

Children and women of reproductive age (WRA) are the most at risk, with estimated global prevalence rates of 47% in toddlers, 42% in pregnant women, and 30% in non-pregnant women aged 15-49 years (Dewi et al., 2023; Huriah et al., 2023). The 2013 Riskesdas survey found the proportion of anemia among adolescents (15-24 years) to be 18.4%, and the 2018 survey reported that 23.8% of adolescent girls had not received Iron Supplementation Tablets (IST) (National Institute of Health Research and Development, Ministry of Health, 2013, 2018). The World Health Organization aims to reduce the prevalence of anemia in WRA by 50% by 2025 (Thamrin & Masnilawati, 2021). Based on the prevalence of anemia in Central Kalimantan Province in 2018, the prevalence rate was reported at 32% among adolescent girls and WRA (Riskesdas, 2018). Data from monitoring and evaluation of iron supplementation tablets distribution at the junior high school/MTSN level in the Puruk Cahu community health center area showed that 20.68% of the monitored adolescent students were anemic, and at the equivalent level of high school, 13.8% were anemic.

The 2018 Basic Health Research (Riskesdas) results show that 76.2% of adolescent girls who received Iron Supplementation Tablets (IST) in school also received iron-folic acid tablets (IFAT). However, nearly 98.6% consumed less than 52 tablets. According to the Murung Raya District Health Office data in 2022, only 14.86% of adolescent girls received IST, and only 13.27% of them consumed IFAT. The causes of anemia generally include lack of knowledge about anemia, iron deficiency, folate deficiency, vitamin B12 deficiency, and vitamin A deficiency (Budiarti et al., 2021; Fitriany & Saputri, 2018). Other less common causes include acute and chronic inflammation, parasitic infections, congenital abnormalities affecting hemoglobin synthesis, and reduced red blood cell production (Minarfah et al., 2021).

In order to provide novelty value related to this research, the following researchers present several previous studies that have similar themes with this research: Research by Rahmadani et al. (2019) uncovered that within the operational area of the Kabere Community Health Center, Cendana District, Enrekang Regency, 46.7% of toddlers aged 24-59 months experienced stunting, while 53.3% exhibited normal nutritional status. Chi-Square statistical analysis revealed a significant relationship between carbohydrate, protein, fat, iron, and zinc intake with stunting, with a p-value of <0.005. However, no significant association was found between calcium and vitamin D intake with stunting (p> 0.005). Consequently, it is concluded that there is a significant relationship between macro-nutrient intake, iron, and zinc with stunting in toddlers (Rahmadani et al., 2019).

The study conducted by Astuti and Septriana (2018) revealed the mean intake among respondents to be as follows: energy 1149.34±401.09 kcal, carbohydrates 143.55±43.46 g, protein 39.38±16.53 g, and fat 49.01±26.82 g. The average intake of vitamin B1 was 0.38±0.14 mg, vitamin B2 0.49±0.24 mg, vitamin B6 0.64±0.25 mg, folic acid 0.68±0.94 mg, vitamin C 24.08±21.01 mg, and vitamin A 397.31±536.14 µg. Sodium intake averaged 22.45±220.23 mg, potassium 1714.01±1153.91 mg, calcium 301.13±173.23 mg, and phosphorus 544.94±193.08 mg. In conclusion, the energy intake, macro-nutrients, and vitamin intake among hemodialysis patients at the Panembahan Senopati Bantul Regional Public Hospital are still below the recommended levels, while sodium, calcium, and phosphorus intake align with the recommendations of the Indonesian Society of Nephrology (Astuti & Septriana, 2018).

The research conducted by Petry et al. (2010) indicated that the elevated levels of polyphenols and phytic acid in common beans are responsible for their diminished iron bioavailability in young women, which could potentially increase their vulnerability to anemia (Petry et al., 2010). Previous research on the relationship between macronutrient and micronutrient

intake with anemia has identified several gaps that make this study necessary. One of the identified gaps is the lack of focus on specific populations, such as adolescent high school students, who may have unique nutritional needs and are vulnerable to anemia. Additionally, some previous studies may not have addressed specific aspects of nutrient intake, such as vitamin B12 or iron, which may play a critical role in preventing or addressing anemia. This study is expected to make a significant contribution to the field by addressing these gaps. By focusing on the relationship between macronutrient and micronutrient intake with anemia in the adolescent high school student population, this research aims to provide a deeper understanding of the nutritional factors that may influence the risk of anemia in this group. The findings of this study may provide a strong foundation for the development of targeted and effective nutritional interventions to prevent and address anemia, as well as guide further research in this area.

Based on this background, the researchers are interested in studying the relationship between macro and micronutrient intake and anemia among junior high school/MTSN female students in the Puruk Cahu community health center area (focusing on protein intake, iron intake, vitamin C intake, folate intake, and vitamin B12 intake).

RESEARCH METHOD

This research is an analytical observational study with a cross-sectional survey approach, involving a sample of 102 respondents selected through cluster sampling. The study was conducted in the Puruk Cahu community health center area in February 2024 and lasted for one month. Ethical clearance was obtained prior to data collection. Data were collected directly from junior high school/MTSN female students. The independent variables in this study were protein intake, iron intake, vitamin C intake, folate intake, and vitamin B12 intake, while the dependent variable was anemia. Logistic regression analysis was conducted at a 95% confidence level ($\alpha = 0.05$) (Yuniawati, 2020). The total number of samples used in this study was 102 respondents. The instruments used included Sejoy hemoglobin test strips, a 24-hour food recall form, and a semi-quantitative food frequency questionnaire (SQ-FFQ).

RESULTS AND DISCUSSIONS

Univariate Analysis Results

Table 1. Percentage of respondents based on variables in the Puruk Cahu community health center area

Variable	N	%
Anemia		
Anemia	52	51,0
Normal	50	49,0
Protein Intake		
Insufficient	76	74,5
Adequate	26	25,5
Iron Intake		
Insufficient	88	86,3
Adequate	14	13,7
Vitamin C Intake		
Insufficient	92	90,2
Adequate	10	9,8
Folate Intake		
Insufficient	102	100,0
Adequate	0	0,0
Vitamin B12 Intake		
Insufficient	90	88,2
Adequate	12	11,8
Total	102	100,0

Source: Primary data, 2024

Based on Table 1, it can be observed that the most frequent frequency of respondents with anemia is 51.0%. The most frequent frequency of respondents with insufficient protein intake is 74.5%. The most frequent frequency of respondents with insufficient iron intake is 86.3%. The most frequent frequency of respondents with insufficient vitamin C intake is 90.2%. The most frequent frequency of respondents with insufficient folate intake is 100.0%, and the most frequent frequency of respondents with insufficient vitamin B12 intake is 88.2% (Putri, 2018).

Bivariate Analysis Results

Table 2. Results of the analysis of the relationship between protein, iron, vitamin C, and vitamin B12 with anemia among junior high school students in the Puruk Cahu community health center area

	Anemia				Total		P-Value	OR
	Anemia		Normal					
	N	%	N	%	N	%		
Insufficient	45	59,2	31	40,8	76	100,0	0,009	3,940
Adequate	7	26,9	19	73,1	26	100,0		
Total	52	51,0	50	49,0	102	100,0		

Iron Intake	Anemia				Total		P-Value	OR
	Anemia		Normal					
	N	%	N	%	N	%		
Insufficient	50	56,8	38	43,2	88	100.0	0,008	7,895
Adequate	2	14,3	12	85,7	14	100.0		
Total	52	51,0	50	49,0	102	100,0		

Vitamin C Intake	Anemia				Total		P-Value	OR
	Anemia		Normal					
	N	%	N	%	N	%		
Insufficient	49	53,3	43	46,7	92	100,0	0,196	2,659
Adequate	3	30,0	7	70,0	10	100,0		
Total	52	51,0	50	49,0	102	100,0		

Vitamin B12 Intake	Anemia				Total		P-Value	OR
	Anemia		Normal					
	N	%	N	%	N	%		
Insufficient	50	55,6	40	44,4	90	100,0	0,026	6,250
Adequate	2	16,7	10	83,3	12	100,0		
Total	52	51,0	50	49,0	102	100,0		

Source: Primary data, 2024

Multivariate Analysis Results

Table 3. Results of the analysis of the relationship between Protein, Iron, Vitamin C, and Vitamin B12 with anemia among junior high school students in the Puruk Cahu community health center area

No	Variable	B	Wald	Sig	Exp (B)	95% CI
1	Protein Intake	1,770	10,513	0,001	5,873	2,014 – 17,123
2	Iron Intake	2,169	6,742	0,009	8,747	1,702 – 44,958
3	Vitamin C Intake	1,305	2,651	0,103	3,686	0,767 – 17,721
4	Vitamin B12 Intake	2,050	5,808	0,016	7,767	1,466 – 41,143

Source: Primary data, 2024

Based on Table 2, the results of the bivariate analysis show that protein intake has a p-value of 0.009 ($p<0.5$), meaning that H0 is rejected. This suggests that there is a relationship between protein intake and anemia among junior high school students in the Puruk Cahu community health center area. The results of the bivariate analysis also indicate that iron intake has a p-value of 0.008 ($p<0.5$), indicating that H0 is rejected. This implies that there is a relationship between iron intake and anemia among junior high school students in the Puruk Cahu community

health center area. Moreover, the bivariate analysis shows that vitamin C intake has a p-value of 0.196 (p>0.5), meaning that H0 is accepted. This implies that there is no relationship between vitamin C and anemia among junior high school students in the Puruk Cahu community health center area. Lastly, the bivariate analysis reveals that vitamin B12 intake has a p-value of 0.026 (p<0.5), indicating that H0 is rejected. This suggests that there is a relationship between vitamin B12 and anemia among junior high school students in the Puruk Cahu community health center area.

Multivariate Analysis Results

Based on Table 3, the results of the multivariate analysis show that the value of B is positive for the protein intake variable. The strength of the relationship is indicated by the value of Exponent Beta (EXP B). The protein intake variable is 5.873, meaning that anemia among junior high school students in the Puruk Cahu community health center area with insufficient protein intake is 5.873 times more likely to experience anemia compared to those with sufficient protein intake. The value of B is also positive for the iron intake variable. The strength of the relationship is indicated by the value of Exponent Beta (EXP B). The iron intake variable is 8.747, meaning that anemia among junior high school students in the Puruk Cahu community health center area with insufficient iron intake is 8.747 times more likely to experience anemia compared to those with sufficient iron intake (Sholikhah et al., 2023).

Moreover, the value of B is positive for the vitamin C intake variable. The strength of the relationship is indicated by the value of Exponent Beta (EXP B). The vitamin C intake variable is 3.686, meaning that anemia among junior high school students in the Puruk Cahu community health center area with insufficient vitamin C intake is 3.686 times more likely to experience anemia compared to those with sufficient vitamin C intake (Nugraheni et al., 2020).

Discussion

Relationship between Protein Intake and Anemia in Junior High School Students in the Puruk Cahu Community Health Center Area

The research findings indicate a relationship between protein intake and anemia among junior high school students in the Puruk Cahu community health center area. The study revealed that out of the respondents, 45 had insufficient protein intake and experienced anemia. The odds ratio (OR) was calculated as 3.940, suggesting that students with inadequate protein intake were 3.940 times more likely to develop anemia compared to those with sufficient protein intake. This finding is consistent with the research conducted by Mulyani dan Sadrina (2021), which showed a significance value of p 0.000 < 0.05, indicating a relationship between protein intake and the occurrence of anemia among nutrition students at the Health Polytechnic of the Ministry of Health, Aceh (Mulyani & Sadrina, 2021).

The assessment of protein intake was obtained through food recall data. Based on the food recall data, it was observed that respondents with poor protein intake tended to have dietary habits characterized by limited food variety, particularly insufficient intake of diverse protein sources and small food portions. Inadequate protein intake among adolescents is often attributed to skipping breakfast and frequent consumption of snacks, such as fried foods. Adolescent girls are at risk of anemia due to unhealthy eating habits, including skipping breakfast, inadequate water intake, and dietary practices that reduce protein, carbohydrate, vitamin, and mineral intake. Snacking and consumption of fast food also contribute to nutritional deficiencies (Purba, 2018).

The research findings reveal a significant relationship between protein intake and anemia among junior high school students in the Puruk Cahu community health center area. The study shows that students with insufficient protein intake were 3.940 times more likely to develop anemia compared to those with sufficient protein intake, as indicated by an odds ratio (OR) of 3.940. This finding aligns with prior research conducted by Mulyani and Sadrina (2021), which also demonstrated a significant relationship between protein intake and anemia occurrence among

nutrition students. The assessment of protein intake was based on food recall data, highlighting that inadequate protein intake among adolescents may stem from limited food variety, skipping breakfast, and frequent consumption of snacks, particularly fried foods. Unhealthy eating habits, such as skipping breakfast and consuming snacks, contribute to nutritional deficiencies and increase the risk of anemia among adolescent girls.

Relationship between Iron Intake and Anemia in Junior High School Students in the Puruk Cahu Community Health Center Area

The research findings also indicate a relationship between iron intake and anemia among junior high school students in the Puruk Cahu community health center area. The study revealed that out of the respondents, 50 had insufficient iron intake and experienced anemia. The odds ratio (OR) was calculated as 7.895, suggesting that students with inadequate iron intake were 7.895 times more likely to develop anemia compared to those with sufficient iron intake. This finding aligns with the research conducted by Amelia et al., which showed a significance value of p 0.007 < 0.05, indicating a relationship between iron supplement intake and the occurrence of anemia among adolescent girls at the Pakuan Baru Health Center in Jambi City in 2020. Assessment of iron intake was obtained through food recall data. Based on the food recall data, it was found that the majority of respondents chose plant-based protein sources such as tofu and tempeh for iron intake, although it is known that animal protein sources are more effective in iron absorption. Drinking tea after meals can also affect the absorption of iron in the body because tea contains tannins, which act as inhibitors of iron absorption (Mulyani & Sadrina, 2021b).

Adolescents are particularly susceptible to iron deficiency. The menstrual phase in adolescents can affect iron stores in the body. The more blood is lost, the greater the depletion of iron stores in the body. The primary function of iron is to assist in the formation and increase of red blood cells in the body. Iron in the body is divided into two categories: stored iron and functional iron. Stored iron functions to replenish depleted functional iron. If stored iron is depleted and iron intake is low, it results in an imbalance of iron in the body. Insufficient iron intake can lead to a decrease in hemoglobin levels in the blood. Symptoms of iron deficiency include weakness, fatigue, lethargy, fainting, and forgetfulness. Some effects of iron deficiency in the body include disruption and inhibition of growth in body and brain cells, resulting in decreased academic performance, sports performance, and work productivity (Purba et al., 2019).

The research findings reveal a significant relationship between iron intake and anemia among junior high school students in the Puruk Cahu community health center area. The study indicates that students with insufficient iron intake were 7.895 times more likely to develop anemia compared to those with sufficient iron intake, as demonstrated by an odds ratio (OR) of 7.895.

This finding is consistent with prior research conducted by Amelia et al. (2020), which also showed a significant relationship between iron supplement intake and anemia occurrence among adolescent girls. Assessment of iron intake was based on food recall data, highlighting the preference for plant-based protein sources such as tofu and tempeh among respondents despite the known superiority of animal protein sources in iron absorption. Adolescents are particularly vulnerable to iron deficiency due to factors such as menstrual phases, which can deplete iron stores in the body. Iron deficiency can lead to various symptoms and impacts on physical and cognitive functions, including decreased academic and sports performance, emphasizing the importance of addressing iron intake to prevent anemia among adolescents.

Relationship between Vitamin C Intake and Anemia in Junior High School Students in the Puruk Cahu Community Health Center Area

The research findings did not show a relationship between vitamin C intake and anemia among junior high school students in the Puruk Cahu community health center area. The study revealed that there were 49 respondents with insufficient vitamin C intake who experienced anemia. This finding is consistent with the research conducted by Thamrin & Masnilawati (2021),

which showed a significance value of p 0.757 > 0.05, indicating no relationship between vitamin C intake and hemoglobin levels in midwifery students. Assessment of vitamin C intake was obtained through food recall data. Based on the food recall data, it was found that the majority of respondents had low consumption of vitamin C sources. They rarely consumed fruits and vegetables, and some of them even disliked vegetables (Azzahroh & Rozalia, 2018).

This could be attributed to various factors that may affect the occurrence of anemia, such as a history of parasitic infections and habits of consuming iron supplements. Additionally, the insignificant relationship between vitamin C intake and anemia could be due to the presence of inhibitors of iron absorption or inhibitory factors that were not eliminated in this study, although these factors can affect the function of vitamin C. Some examples of iron inhibitors are phytic acid, oxalic acid, and polyphenols such as tannins (Pertiwi et al., 2019).

The research findings indicate no significant relationship between vitamin C intake and anemia among junior high school students in the Puruk Cahu community health center area. Despite 49 respondents having insufficient vitamin C intake and experiencing anemia, the study did not reveal any significant association, consistent with prior research by Thamrin & Masnilawati (2021) showing no relationship between vitamin C intake and hemoglobin levels in midwifery students. Assessment of vitamin C intake revealed low consumption of vitamin C sources among respondents, with limited fruit and vegetable intake, possibly influenced by personal preferences. Various factors such as parasitic infections and habits of consuming iron supplements may contribute to anemia occurrence, while inhibitors of iron absorption like phytic acid and polyphenols such as tannins may affect the function of vitamin C, potentially explaining the lack of significant relationship observed in this study.

Relationship between Folate Intake and Anemia in Junior High School Students in the Puruk Cahu Community Health Center Area

The research findings regarding the relationship between folate intake and anemia among junior high school students in the Puruk Cahu community health center area showed that all 102 (100%) respondents had insufficient folate intake and none had sufficient folate intake. Bivariate analysis of folate intake with anemia could not be conducted due to the constant folate category (single category). Research conducted by Sarfa et al. (2024) showed a significance value of p 0.001 < 0.05, indicating a relationship between folate intake and the occurrence of anemia in adolescent girls at SMPN 8 in South Konawe. Assessment of folate intake was obtained through food recall data. Based on the food recall data, it was found that all respondents had low folate intake. Apart from inadequate intake, respondents were also unaware of the food sources of folate.

Folate is a nutrient needed for hemoglobin formation and nucleus maturation. Folate is abundant in chicken liver, beef liver, and green vegetables. Folate cannot be stored in the body in large amounts; therefore, to meet the needs of adolescent girls, they should be provided with adequate and consistent food intake. Folate deficiency can result in enlarged red blood cell nuclei. While nucleus maturation may be hindered, the process of hemoglobin production remains normal, resulting in the formation of enlarged cell nuclei (Aulya et al., 2022).

The research findings revealed that all 102 (100%) respondents in the study had insufficient folate intake, precluding bivariate analysis of folate intake with anemia due to the constant folate category. This contrasts with research by Sarfa et al. (2024), which found a significant relationship between folate intake and anemia occurrence in adolescent girls. Despite all respondents having low folate intake, they were also unaware of folate-rich food sources. Folate plays a crucial role in hemoglobin formation and nucleus maturation, with sources including chicken liver, beef liver, and green vegetables. Folate deficiency can lead to enlarged red blood cell nuclei, impacting nucleus maturation while hemoglobin production remains normal, resulting in enlarged cell nuclei formation.

Relationship between Vitamin B12 Intake and Anemia in Junior High School Students in the Puruk Cahu Community Health Center Area

From the research results, there is a relationship between vitamin B12 intake and anemia in female students SMP/ The research findings revealed a relationship between vitamin B12 intake and anemia among junior high school students in the Puruk Cahu community health center area. The study showed that there were 50 respondents with insufficient vitamin B12 intake who experienced anemia. The research findings indicated an odds ratio (OR) of 6.250. This means that students with inadequate vitamin B12 intake have a 6.250 times greater risk of experiencing anemia compared to those with sufficient vitamin B12 intake. This finding is consistent with the research conducted by Agesti & Listyani (2023), which showed a significance value of p 0.007 < 0.05, indicating a relationship between vitamin B12 intake and the occurrence of anemia in adolescent girls in Sukoharjo Regency. Assessment of vitamin B12 intake was obtained through food recall data. Based on the food recall data, it was found that the majority of respondents had low consumption of vitamin B12 sources. Respondents were also unaware of the food sources of vitamin B12. Vitamin B12 is a vital nutrient for all cells in the body and the general development of tissue cells. This is because vitamin B12 plays a role in DNA synthesis. Erythropoietic tissues have the fastest growth and proliferation rate, so a deficiency in vitamin B12 will inhibit the rate of red blood cell formation, leading to rapid reproduction and enlargement of cells, resulting in macrocytic cells. Macrocytic erythrocytes have almost the same function as red blood cells but disintegrate at a very young age and have a very short lifespan. Vitamin B12 deficiency leads to failure in red blood cell formation (Sarfa et al., 2024).

The interaction of several minerals with vitamins generally affects nutritional status. Iron and folate can enhance metabolism, as can iron with vitamin B12. The role of folate in the process of nucleoprotein synthesis is key to the formation and production of normal red blood cells in the bone marrow. The function of folate is closely related to the function of vitamin B12 (Hoffbrand et al., 2013). Folate is required in various biochemical reactions in the body involving the transfer of a single carbon unit in amino acid interconversion, such as the conversion of homocysteine to methionine and serine to glycine, or in the synthesis of DNA precursor purines (Hoffbrand et al., 2013).

Folate acts as a coenzyme in the transport of single carbon fragments in amino acid metabolism and nucleic acid synthesis. The coenzyme form is tetrahydrofolate (THF) or tetrahydrofolic acid (THFA). THFA is involved in the synthesis of guanine and adenine purines as well as thymine pyrimidines, compounds used in DNA and RNA formation. THFA is involved in interconverting serine and glycine, oxidizing glycine, methylating homocysteine to methionine with vitamin B12 as a cofactor, and methylating ethanolamine precursor to choline. Folate is needed for the formation of red blood cells and white blood cells in the bone marrow and for their maturation. Folate acts as a carrier of single carbon in hem formation. Vitamin B12 is required to convert folate into its active form and in the normal functioning of metabolism in all cells, especially gastrointestinal tract cells, bone marrow, and nervous tissue (Sholihah et al., 2019).

The research findings revealed a significant relationship between vitamin B12 intake and anemia among junior high school students in the Puruk Cahu community health center area, with 50 respondents experiencing anemia due to insufficient vitamin B12 intake, yielding an odds ratio of 6.250. This aligns with previous research by Agesti & Listyani (2023), indicating a significant association between vitamin B12 intake and anemia occurrence in adolescent girls. Assessment of vitamin B12 intake highlighted low consumption among respondents, who were also unaware of its food sources. Vitamin B12 deficiency inhibits red blood cell formation due to its role in DNA synthesis, leading to macrocytic cells. Moreover, the interaction between minerals and vitamins, particularly iron, folate, and vitamin B12, significantly influences nutritional status and red blood cell formation. Folate, crucial for nucleoprotein synthesis and DNA precursor synthesis, requires

vitamin B12 for activation, highlighting their interdependence in normal metabolism, including red blood cell maturation.

The Relationship between Macro and Micronutrients Intake and Anemia in Junior High School Students in the Puruk Cahu Community Health Center Area

The multivariate test results present logistic regression analysis for three independent variables: protein intake, iron intake, vitamin C intake, and vitamin B12 intake with the dependent variable. These results indicate that protein intake has an Exponent Beta (Exp B) of 5.873, iron intake has an Exponent Beta (Exp B) of 8.747, vitamin C intake has an Exponent Beta (Exp B) of 3.686, and vitamin B12 intake has an Exponent Beta (Exp B) of 7.767. Based on these analysis results, it can be concluded that among all independent variables, the most dominant variable associated with anemia in junior high school students in the Puruk Cahu Community Health Center area is iron intake, with an Exponent Beta (Exp B) value of 8.747, followed by vitamin B12 intake, protein intake, and vitamin C intake. This implies that junior high school students who are affected by anemia are fewer among those with sufficient iron intake in the Puruk Cahu Community Health Center.

Iron intake is the dominant variable compared to protein intake, vitamin C intake, folate intake, and vitamin B12 intake. Iron is an essential element in the body and is needed to form red blood cells (hemoglobin). Iron is one of the components of heme, which is part of hemoglobin. This occurs because adolescent girls experience menstruation every month, leading to a deficiency of iron in the blood. Essentially, nutrient intake in the body, especially in adolescent girls, must be adequate, including iron intake. If the iron stores are depleted, the body will lack red blood cells, and the amount of hemoglobin in them will decrease, resulting in anemia (Pertiwi et al., 2018). Iron intake among adolescent girls in this study was determined using the SQ-FFQ method. Adequate iron intake for adolescent girls aged 13-18 years according to AKG 2019 is 15 mg/day (Sholikhah et al., 2023). The multivariate test results from logistic regression analysis reveal that among the independent variables of protein intake, iron intake, vitamin C intake, and vitamin B12 intake, iron intake emerges as the most dominant variable associated with anemia among junior high school students in the Puruk Cahu Community Health Center area, with an Exponent Beta (Exp B) value of 8.747. Following iron intake, vitamin B12 intake, protein intake, and vitamin C intake also show significant associations with anemia, with Exp B values of 7.767, 5.873, and 3.686 respectively. This underscores the critical role of iron in red blood cell formation, particularly among adolescent girls who experience monthly menstruation, leading to iron deficiency anemia. Adequate iron intake, determined through the SQ-FFQ method, is essential to prevent anemia in this demographic, with recommended daily intake set at 15 mg/day according to AKG 2019 guidelines.

CONCLUSION

The practical implications of the research underscore the importance of promoting adequate protein, iron, and vitamin B12 intake among junior high school students to combat anemia effectively. Health practitioners and policymakers can utilize these findings to design targeted interventions and educational programs aimed at improving dietary habits and addressing nutritional deficiencies among adolescents, ultimately reducing the prevalence of anemia in this demographic. From a theoretical standpoint, the study contributes to our understanding of the multifaceted relationship between dietary factors and anemia, highlighting the significance of specific nutrients in mitigating anemia risk. These insights provide a foundation for future research exploring the complex interplay between diet, micronutrient intake, and health outcomes, further advancing our knowledge in the field of nutrition and public health. However, it's crucial to acknowledge the study's limitations, including its cross-sectional design, which limits the establishment of causality, and reliance on self-reported dietary intake, potentially introducing recall bias. Additionally, the sample size of 102 respondents may restrict the generalizability of

findings. Future research directions should encompass longitudinal investigations to explore causal links, employ more objective measures for dietary assessments, expand sample sizes, and delve into other dietary factors, alongside genetic, socioeconomic, and environmental variables, for a more comprehensive understanding of anemia etiology in junior high school students.

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