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The Correlations of Body Image, Eating Behavior Types, and Energy and Nutrient Adequacy Level with Anemia Status in Adolescent Girls at SMAN 1 Dramaga, Bogor Regency

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ABSTRACT

Anemia is a serious global public health issue with the highest prevalence in adolescent girls. This study aimed to analyze the relationships among body image, eating behaviour, and the adequacy of energy and nutrient intake with anemia status in adolescent girls. This study used a cross-sectional design with 105 participants selected through purposive sampling. Data on subject characteristics were collected using a questionnaire, body image was assessed using the Body Shape Questionnaire (BSQ), eating behaviour using the Dutch Eating Behaviour Questionnaire (DEBQ), nutrient adequacy level using 2 × 24 H food recall, and hemoglobin levels were measured using HemoCue 301. Data were analysed using the Spearman Rank test. The results showed that 28.6% of the subjects had anemia. Based on bivariate analysis, there was no correlation between body image and anemia status (r=-0.108, p =0.271). There was also no correlation between emotional eating, external eating, and restrained eating (p>0.05) and anemia status. Similarly, energy (r= 0.133, p=0.177), vitamin B9 (r=0.169, p=0.085), and vitamin C (r=0.016, p=0.873) were not significantly correlation with anemia status. However, adequacy level of protein (r=0.288, p=0.003), iron (r= 0.194, p=0.048), and vitamin B12 (r= 0.216, p=0.027) were significantly positive correlation with anemia status. This study indicates that the majority of subjects had a negative body image, tended to display external eating behavior, and generally had insufficient nutrient intake. Therefore, nutrition education for adolescents is needed, with a focus on promoting healthy and high-quality eating habits.

Key Messages:

- Adolescent girls are a group vulnerable to anemia, with 28.6% found to be anaemia.
- The majority of adolescent girls were dissatisfied with their appearance (51.4%).
- The adequacy levels of energy and nutrient intake among adolescent girls were mostly categorized as insufficient.

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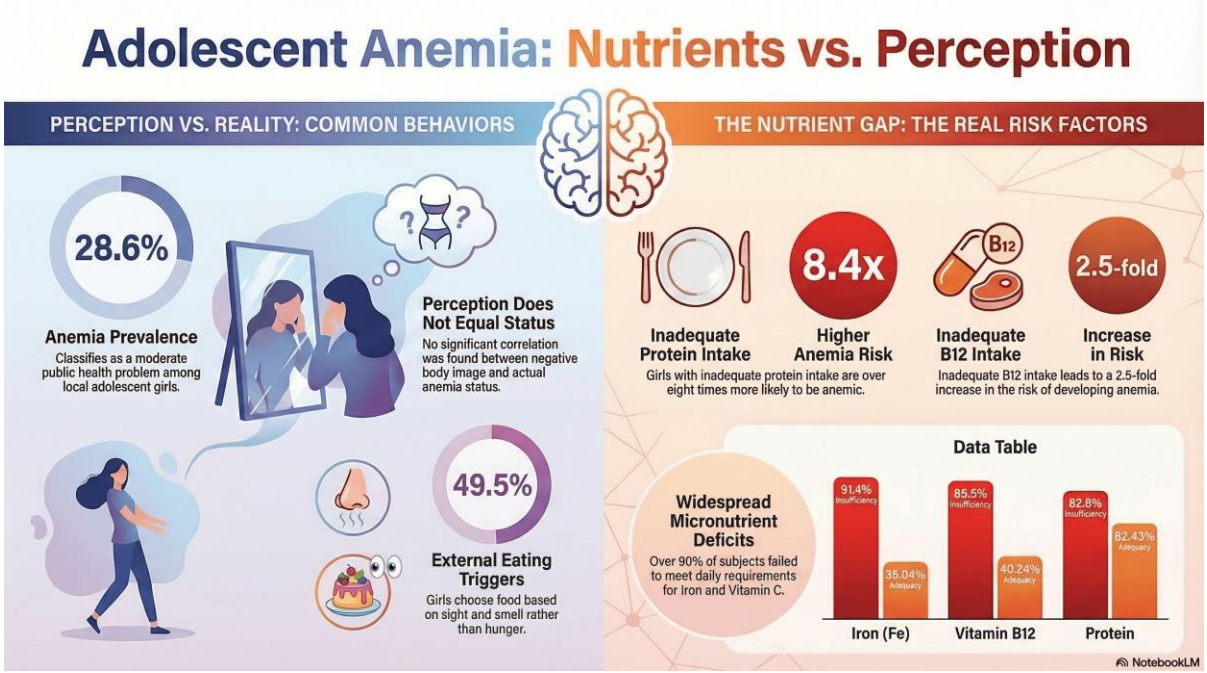
GRAPHICAL ABSTRACT



INTRODUCTION

Anemia is a serious global public health problem that primarily affects children, adolescent girls, women of reproductive age, and pregnant women (1). It remains a major public health challenge, with the highest prevalence observed among females in South and Southeast Asian countries. Indonesia, a developing country in Southeast Asia, continues to face a significant anemia burden (2). According to the 2018 Basic Health Research (RISKESDAS) report, the prevalence of anemia among children aged 5–14 years was 26.8%, and among individuals aged 15–24 years was 32% (3). Data from the West Java Provincial Health Office in 2022 indicated that the prevalence of anemia in West Java Province (41.8%) was higher than the national average. In Bogor City, the prevalence of anemia among adolescent girls was reported at 20.9% (4), which increased by 2.1% in 2024 to reach 23% (5). In Bogor Regency, the prevalence was even higher at 45.6% (6). These figures indicate that anemia has reached the threshold of a severe public health problem, defined as a prevalence rate of > 40% (7). Anaemia can lead to decreased immunity and productivity. Moreover, anemia in adolescent girls poses significant risks during future pregnancies, potentially leading to adverse effects on foetal growth and development, as well as an increased risk of pregnancy and childbirth complications (8).

Adolescence is the final stage of rapid growth and development in humans. According to the World Health Organization (9), adolescents are individuals aged 10 to 19 years, a transitional phase from childhood to adulthood. This period is characterized by rapid physical, behavioural, and psychosocial changes (10). During adolescence, accelerated growth and development result in increased nutritional requirements. Deficiency in essential nutrients can lead to various health problems in adolescents (11). Adolescent girls are particularly susceptible to anemia due to rapid physical growth, menarche, and regular menstruation. These factors contribute to iron loss and increase the risk of developing anemia (11,12).

Adolescents who experience rapid and continuous physical changes may become more aware of and sensitive to their body shapes (13). Adolescent girls often feel dissatisfied with their bodies due to an increase in body fat, whereas adolescent boys tend to feel more satisfied with their bodies as a result of increased muscle mass. A study by Niswah et al. (14) reported that most adolescent girls are highly concerned about their physical appearance and often feel embarrassed and lack self-confidence in their body image. This dissatisfaction with body image is influenced by external factors, including media exposure, peer pressure, and prevailing social trends(15). Adolescent girls who are dissatisfied with their body shape often attempt to modify it according to their desired appearance by engaging in various

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methods, one of which is adopting unhealthy eating behaviours, such as strict dieting, irregular eating patterns, and restricting or avoiding certain foods (16–18). In the study by Yong *et al.* (19) adolescents who exhibit restrained eating behaviours (restricting food intake) tended to have a higher prevalence of body image dissatisfaction. Unhealthy changes in eating behaviors can lead to adverse effects, such as an imbalance in nutrient intake within the body (20). Adolescent girls with a negative body image are at risk of developing iron deficiency (17), as they tend to restrict the consumption of iron-rich foods that are perceived to be high in fat, such as meat and dairy products (21). Based on the explanation above, it is evident that body image perception is highly influential among adolescent girls. Adolescent girls often work to achieve an ideal body shape according to their personal preferences. Certain eating behaviors, such as restricting specific types of food, are commonly observed among adolescent girls. Poor eating patterns may affect nutrient adequacy in the body, which, in turn, can influence anemia status among adolescents. The purpose of this study is to analyze the relationship between body image, types of eating behavior, and the adequacy levels of energy and nutrients with the anemia status of adolescent girls.

METHODS

This study employed a cross-sectional design and an observational research approach that collected data over a specific period. The study was conducted from May to June 2025 at SMAN 1 Dramaga Bogor Regency. The school was selected as the research site based on several considerations, including a sufficient number of female students, ease of obtaining research permission from the school's administration, and accessibility. Adolescent girls were chosen as the study population because they are at a higher risk of developing anemia than adolescent boys.

The study population consisted of adolescent girls who were 11th-grade students at SMAN 1 Dramaga, Bogor Regency, Indonesia. This study only involved grade XI and did not include grades X and XII due to the consideration that grade X students are still in the transition period from junior high school to senior high school, while grade XII students cannot be disturbed as they will be taking their final exams. The subjects were selected using purposive sampling. The inclusion criteria were as follows: 11th-grade female students, not currently following a special diet, and willing to subject in the study with parental or guardian consent by completing an informed consent form. The subjects provided written assent through an informed assent form. The exclusion criteria included students with chronic illnesses and those who did not complete all the stages of the study. The sample size was calculated using the formula proposed by Lameshow and David (22) based on the prevalence of anemia in Bogor Regency in 2023, which was 45.6% (6). The minimum sample was 95 to account for possible dropouts, an additional 10% was added, resulting in a total of 105 subjects.

Data collected included participants' characteristics (age and pocket money), body image, types of eating behaviour, nutrient adequacy levels, and anemia status. Data on subjects' characteristics were obtained through questionnaires filled out by the subjects under the supervision of the researchers. Body image data were collected using the Body Shape Questionnaire (BSQ) developed by Cooper et al. (23) which consists of 34 questions. The BSQ uses a Likert scale (1 = never, 2 = rarely, 3 = sometimes, 4 = often, 5 = very often, 6 = always). The total score is obtained by summing all item scores. Body image categories were determined based on the total BSQ score: positive body image (< 80) and negative body image (≥ 80).

Eating behaviour data were collected using the Dutch Eating Behaviour Questionnaire (DEBQ), which was originally developed by van Strien in 1986. The DEBQ consists of 33 questions that measure three types of eating behaviour: emotional eating, external eating, and restrained eating. Responses were recorded using a Likert scale (1 = never, 2 = rarely, 3 = sometimes, 4 = often, 5 = always).

Dietary intake data, including energy, protein, iron, vitamin B9 (folate), vitamin B12, and vitamin C, were obtained through interviews using 2 × 24 H food recalls (weekday and weekend). Food consumption data was converted into units of energy (kcal), protein (g), and iron (mg) using the NutriSurvey database and the Food Composition Table (DKBM). Dietary intake data are used to calculate the subject's adequacy levels of nutrients. Subject's adequacy levels of energy and protein are calculated by comparing the subject's actual intake to their respective energy and protein requirements. Furthermore, the energy adequacy level is classified into two categories according to WNPG 2018: insufficient (<70%)

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and sufficient (≥70%), and the protein adequacy level into insufficient (<80%) and sufficient (≥80%) (24). Subject's adequacy levels of vitamins and minerals are calculated by comparing the subject's actual intake with the recommended nutrient intake for their age group. Subsequently, the adequacy levels of vitamins and minerals are classified into two categories according to Gibson: insufficient (<77% RDA) and sufficient (≥77% RDA) (25).

Anemia status was determined by measuring Hemoglobin (Hb) levels using a HemoCue Hb 301 device from capillary blood samples, conducted by trained healthcare professionals. Subjects were categorized as anemia if their Hb < 12 g/dL and non anemia if their Hb ≥ 12 g/dL (26).

Data analysis was performed using SPSS Statistics (version 25.0). Univariate analysis was used to describe and tabulate the frequency distribution of each variable, including subjects' characteristics, body image, eating behaviour, nutrient adequacy, and anemia status. Bivariate analysis was conducted using the Spearman's rank correlation test, as the data were not normally distributed. A correlation test was used to examine the relationships between independent variables (body image, eating behaviour, and nutrient adequacy levels) and the dependent variable (anemia status). Multivariate analysis was conducted using binary logistic regression. This analysis was conducted to identify the factors most strongly influencing the occurrence of anemia.

CODE OF HEALTH ETHICS

All procedures were conducted in accordance with ethical principles. The implementation of the study was approved by the Research Ethics Committee of Universitas Airlangga under approval number 0416/HRECC.FODM/III/2025.

RESULTS

The subjects were 105 eleventh-grade female students from SMAN 1 Dramaga, West Java, who agreed to participate in the study, as indicated by the signed informed consent form from their parents or guardians and the informed assent form from the subjects themselves.

Table 1, Characteristic of the Subject

Variable	n (105)	(%)
Age (year)		
15	1	1.0
16	37	35.2
17	64	61.0
18	3	2.9
Mean ± SD	16.66 ± 0.55	
Pocket money (IDR/day)		
10.000-20.000	55	52.4
21.000-30.000	35	33.3
≥ 31.000	15	14.3
Mean ± SD	24.466.67 ± 9852.83	
Body image		
Positive	51	48.6
Negative	54	51.4
Mean ± SD	87.05 ± 36.09	
Eating behaviour		
Emotional eating	31	29.5
Mean ± SD	29.37 ± 10.77	
External eating	52	49.5
Mean ± SD	31.99 ± 7.86	
Restrained eating	22	21.0
Mean ± SD	23.58 ± 9.18	
Anemia status		
Anemia	30	28.6
Non anemia	75	71.4
Mean ± SD	12.62 ± 1.29	

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The subjects in this study were adolescent girls aged 15 to 18 years, with a mean age of 16.66 years (SD = 0.55). Notably, 61% of the participants were 17 years old. The average daily pocket money was Rp24,466.67 (SD = 9852,83), with 52.4% of participants receiving between IDR 10.000 and IDR 20.000 daily, 33.3% receiving between IDR 21.000 and IDR 30.000, and 14.3% receiving IDR 31.000 or more. The average body image score among participants was 87.05 (SD = 36.09), with the majority (51.4%) categorized as having a negative body image. Although the difference in proportions between those with negative and positive body images was relatively small, the findings suggest a tendency towards a predominantly negative body image among adolescent girls.

The results of the study showed that 49.5% of the subjects exhibited external eating behaviour, 29.5% exhibited emotional eating, and 21% exhibited restrained eating. The most prevalent eating behavior among the subjects was external eating. The findings also indicated that 71.4% of the subjects were not anemia, while 28.6% were anemia. The average hemoglobin level among the participants was 12.62 g/dL (SD = 1.29).

Table 2 Frequency distribution of subjects based on the adequacy level of energy and nutrient intake

Adequacy level	n	%
Energy		
Insufficient (<70%)	38	36.2
sufficient (≥70%-110%)	67	63.8
Mean ± SD	74.90±17.87	
Protein		
Insufficient (<80%)	87	82.9
Sufficient (≥70%)	18	17.1
Mean ± SD	62.43±18.09	
Iron (Fe)		
Insufficient (< 77% AKG)	96	91.4
Sufficient (≥ 77 % AKG)	9	8.6
Mean ± SD	38.04±21.13	
Vitamin B_9 (Folate)		
Insufficient (< 77% AKG)	98	93.3
Sufficient (≥ 77 % AKG)	7	6.7
Mean ± SD	42.92±20.48	
Vitamin B_{12}		
Insufficient (< 77% AKG)	94	89.5
Sufficient (≥ 77 % AKG)	11	10.5
Mean± SD	40.24±40.34	
Vitamin C		
Insufficient (< 77% AKG)	101	96.2
Sufficient (≥ 77 % AKG)	4	3.8
Mean ± SD	19.29±20.45	

Data analysis showed that the mean adequacy level of energy was 74.90%, with 36.2% of subjects classified as having an insufficient and 28.6% as sufficient. The mean adequacy level of protein was 62.43%, with 82.9% of subjects exhibiting protein adequacy levels below the recommended dietary allowance (deficit) and only 17% achieving adequate levels. The findings further indicated that 91.4% of subjects had less iron adequacy levels, with an average daily iron intake of 5.7 mg/day and an average adequacy level of 38.04%. Subjects also failed to meet their folate adequacy levels, as 93.3% had less folate intake and only 6.7% had sufficient intake. Similarly, 89.5% of subjects had less vitamin B12 adequacy, while only 10.5% had sufficient levels. Additionally, 96.2% of subjects had less vitamin C adequacy levels, with an average adequacy of 19.29%.

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Table 3 The correlation between body image, eating behaviour types, and nutrient adequacy levels with anemia status

	Anemia status				*r*	*p-value*
	Anemia		Non anemia			
	n	%	n	%		
Body image						
Positve	12	40.0	39	52.0	-0.108	0.271
Negative	18	60.0	36	48.0		
Eating behaviour						
Emotional eating	6	20	25	33.3	0.132	0.179
External eating	19	63.3	33	44	-0.175	0.075
Restraint eating	5	16.7	17	22.7	0.067	0.500
Energy						
Insufficient (<70%)	16	53.3	22	29.3	0.133	0.177
Sufficient (≥70%)	14	46.7	53	70.7		
Protein						
Insufficient (<80%)	30	100	57	76.0	0.288	0.003
Sufficient (≥80%)	0	0.0	18	24.0		
Iron						
Insufficient (< 77% RDA)	30	100	66	88.0	0.194	0.048
Sufficient (≥ 77 % RDA)	0	0.0	9	12.0		
Vitamin B_9 (Folate)						
Insufficient (< 77% RDA)	30	100	68	90.7	0.169	0.085
Sufficient (≥ 77 % RDA)	0	0.0	7	9.3		
Vitamin B_{12}						
Insufficient (< 77% RDA)	30	100	64	85.3	0.216	0.027
Sufficient (≥ 77 % RDA)	0	0.0	11	14.7		
Vitamin C						
Insufficient (< 77% RDA)	29	96.7	72	96.0	0.016	0.873
Sufficient (≥ 77 % RDA)	1	3.3	3	4.0		

The analysis results indicated that body image was not significant correlation with anemia status (p = 0.271), as 34.3% of subjects with a negative body image did not exhibit anemia (Table 3). Similarly, the types of eating behaviour, emotional eating (p = 0.179), external eating (p = 0.075), and restrained eating (p = 0.500) were not significant correlation with anemia. Additionally, adequacy level of energy showed a not significant correlation with anemia (p = 0.177). However, a positive significant correlation was identified between adequacy level of protein and anemia status (p = 0.003), suggesting that subjects with anemia generally lacked adequate protein intake levels. Furthermore, the analysis of adequacy level of iron a positive significant correlation with anemia status (p = 0.048). The adequacy level of vitamin B12 was significant correlation with anemia status (p < 0.05). In contrast, the adequacy level of dietary folate (vitamin B9) (p = 0.085) and vitamin C (p = 0.873) was not significantly correlated with anemia.

Based on the results of the multivariate analysis using binary logistic regression (Table 4), two factors were found to be significantly correlated with the occurrence of anemia in adolescents. Subjects with inadequate protein intake had an 8.4-fold higher risk of anemia than those with adequate protein intake (p = 0.048; OR = 8.405; 95% CI: 1.015–66.987). In addition, subjects with inadequate vitamin B12 intake had a 2.49-fold higher risk of anemia (p = 0.049; OR = 2.490; 95% CI: 1.002–6.186).

Table 4. Multivariate analysis of factors influencing anemia

Variable	p-value	OR	95% CI for Exp	
			Lower	Upper
Protein adequacy level	0.044	8.405	1.015	66.987
Vitamin B_{12} adequacy level	0.049	2.490	1.002	6.186

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DISCUSSION

This study aimed to examine the relationships among body image, various types of eating behaviors (emotional eating, external eating, and restrained eating), and the adequacy of energy and nutrient intake, in relation to anemia status among adolescent girls. The findings indicate that anemia is a significant health concern among this demographic, with a prevalence of 28.6%. Although this rate is below the national prevalence, it is classified by the WHO as a moderate public health issue, as it falls within the 20%-39.9% range (27).

Body Image and Anemia

The research results revealed minimal differences between positive and negative body images among adolescent girls; however, the data suggested a tendency towards a negative body image. This indicates a prevalent dissatisfaction with body shapes among adolescent girls. Influences from family, peers, and media, which often promote thinness, can contribute to the development of negative body image (19). The aspiration to achieve thinness prompts adolescent girls to restrict their food intake (19), resulting in inadequate dietary intake. In this study, it was shown that body image does not have a significant correlated with anemia status ($p=0.271$). This may be because perceptions of body image are not the main factor influencing the occurrence of anemia, although it can serve as an indirect factor in identifying anemia cases. Body image was a psychosocial construct, whereas anemia was a biological–physiological condition primarily influenced by nutrient adequacy, blood loss, and absorption processes. The correlation between body image and anemia was indirect and was mediated by eating behaviors and diet quality. If changes in body perception did not substantially affect nutrient intake, their impact on anemia status became minimal. In this study, micronutrient inadequacy occurred among adolescents with both positive and negative body image. This condition indicated that anemia more strongly reflected generally poor diet quality rather than a direct consequence of negative body image

This research is consistent with the study by Zulfa (28), which stated that there is no significant correlated with anemia problems in adolescents. Adolescents who are concerned about their body shape are not affected by anemia status. This is also supported by results showing that the difference between subjects with negative and positive body image who experience anemia is not very significant. This indicates that body image status does not make a meaningful contribution to changes in anemia status. However, other studies have shown a significant relationship between body image and anemia in adolescent girls(29).

Eating Behaviors and Anemia

Adolescence is characterised by diverse eating behaviors, including meal skipping, emotional eating, and food restriction (30). Among these behaviours in adolescent girls, research has identified external eating as the most prevalent, accounting for 49.5% of the cases. This behavior is characterized by a tendency to select and consume food based on external influences rather than relying on internal signals, such as hunger or the feeling of being full (31). This indicates that taste has a significant influence on food choices (32). Studies conducted in Ireland also demonstrate that adolescents are inclined towards external eating, with their food preferences being influenced by factors such as the aroma, taste, appearance of food, or the presence of peers consuming certain foods (33). The study found no correlation between emotional eating, external eating, and restrained eating with anemia status.

Emotional eating reflects psychological triggers that influence eating behavior, such as eating in response to stress, sadness, or anxiety, rather than the quality and composition of nutrients consumed. Anemia, especially iron deficiency anemia, is more affected by the intake of specific nutrients such as iron, protein, vitamin B12, and folate, as well as factors related to iron absorption and loss. Therefore, the frequency or tendency to eat triggered by emotions does not directly reflect the adequacy of nutrients involved in hemoglobin formation.

External eating behavior is more triggered by external conditions such as seeing food, smelling the aroma of food, or watching others eat, rather than by the quality of the diet itself. As a result, adolescents tend to prefer more visually appealing options, such as energy-dense snacks. The lack of a correlation

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between external eating and the incidence of anemia may be due to the fact that eating stimuli among adolescents are not necessarily followed by food availability. Adolescents also face financial limitations in purchasing food because of their limited pocket money.

The results of the correlation test show that there is no significant correlation between restrained eating and anemia status. Restrained eating behavior was found more frequently in adolescents without anemia compared to those with anemia. This indicates that the tendency to restrict food intake is actually more common among adolescent girls who do not have anemia. Nevertheless, the results regarding nutrient intake show that both groups those with and without anemia mostly have inadequate intake levels. This suggests that adolescent girls, regardless of whether they practice restrained eating or not, generally have low nutrient intake. Therefore, this is what causes restrained eating to have no direct effect on the incidence of anemia.

Nutrient Adequacy Levels and Anemia

Energy adequacy levels were not significant correlation with anemia (p=0.177). However, a significant positive correlation was observed between protein adequacy level with anemia status (p=0.003), with anemia subjects exhibiting inadequate protein intake. These results are consistent with those of Akib and Sumarmi (34), who highlighted the association between protein intake and anemia status in adolescent girls. Proteins are essential for transporting iron to the bone marrow for synthesis of new hemoglobin. In this study, it was found that most adolescents consumed protein sources mainly in the form of chicken meat in relatively small amounts; consequently, 82.9% of adolescents had inadequate protein intake. It was also reported that female adolescents tended to restrict the consumption of meat and dairy products due to concerns about their high fat content, which could lead to weight gain(21). Another study similarly reported that anemia female adolescents consumed lower amounts of animal-source foods, such as meat, chicken, and fish, than those who were not anemia (35).

Based on the results of the logistic regression analysis presented in Table 4, adolescents with inadequate protein intake had an approximately 8.4-fold higher risk of developing anemia than those with adequate or sufficient protein intake. These findings indicated that protein intake was a major factor associated with the occurrence of anemia at SMAN 1 Dramaga. The magnitude of this risk suggested that protein deficiency could interfere with the transport of iron into the bloodstream and result in lower hemoglobin levels, thereby increasing the risk of anemia.

Iron is a critical component in the synthesis of hemoglobin, playing a vital role in the body's processes of oxygen transport, storage, and utilization(36). Analysis of micronutrient adequacy level showed a significant positive correlation between iron adequacy levels with anemia status (p=0.048). This finding aligns with the research conducted by Sholicha and Muniroh (37), who demonstrated a correlation between iron intake and hemoglobin levels. Increased consumption of iron rich foods correlates with elevated hemoglobin levels, reducing the incidence of anemia. Adolescents who frequently consume junk food often ignore nutritious meals prepared at home because of satiety. The habitual consumption of junk food, which is deficient in essential nutrients such as vitamins and minerals, can result in iron deficiency (38). On average, the subjects' iron adequacy was 38.04%, with only 8.6% achieving adequate iron intake. This deficiency may stem from insufficient dietary iron, particularly from animal sources (heme). A lack of iron can impair hemoglobin synthesis, leading to a reduced number of red blood cells (RBCs). This condition impairs the blood's capacity to transport oxygen and increases the risk of anemia. Ensuring sufficient iron intake, especially from animal-based foods or supplements, is crucial for supporting hemoglobin synthesis (39).

The analysis of folate (vitamin B9) adequacy levels indicated no significant correlation with anemia status (p=0.085). The average folate adequacy was 42.92%, with only 6.7% of the subjects achieving sufficient folate intake. Folate deficiency can cause enlargement of erythrocyte nuclei due to disruption of the maturation process of cell nuclei, whereas hemoglobin synthesis remains unaffected. As a result, erythrocytes with enlarged nuclei (megaloblastic) are formed (40).

The results further indicated a significant positive correlation between Vitamin B12 adequacy levels and anemia status (p=0.027). This finding aligns with the study by Siallagan et al. (41) which reported

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a significant correlation between Vitamin B12 intake and hemoglobin (Hb) levels, highlighting the role of Vitamin B12 in the synthesis of Hb and erythrocytes through the metabolism of fats, proteins, and folic acid. Only 10.5% of participants had sufficient Vitamin B12 intake, with an average adequacy of 40.24%. Vitamin B12 deficiency can disrupt erythrocyte formation in the bone marrow, potentially resulting in reduced hemoglobin levels (42). Nevertheless, the body efficiently utilizes Vitamin B12, which can be stored for up to 10 years, allowing the body's needs to be met even with insufficient daily intake through existing reserves (41). Based on the results of the logistic regression analysis presented in Table 4, adolescents with inadequate vitamin B12 intake had approximately a 2.5-fold higher risk of developing anemia compared with those who had adequate or sufficient vitamin B12 intake. These findings indicate that vitamin B12 intake was also a contributing factor to the occurrence of anemia at SMAN 1 Dramaga. The magnitude of this risk suggests that vitamin B12 deficiency may reduce hemoglobin levels in the blood and subsequently increase the risk of anemia.

In contrast, the adequacy level of Vitamin C (p=0.873) was not significantly correlated with anemia status. However, Nasrul et al. (43) reported a significant association between vitamin C intake and the occurrence of anemia. Vitamin C plays an important role in enhancing the absorption of non-heme iron, which is commonly found in plant-based foods frequently consumed by the Indonesian population. Vitamin C facilitates the conversion of non-heme iron from the ferric form (Fe^{3+}) to the ferrous form (Fe^{2+}), thereby improving its bioavailability and absorption (39). The absence of a significant correlation between vitamin C intake and anemia in this study may be explained by the interview findings indicating that female adolescents frequently consumed tea in their daily diets. Tea contains iron absorption inhibitors, which can hinder iron uptake. Furthermore, female adolescents were also found to rarely consume vitamin C rich foods, such as fruits.

Limitations

This study had several limitations that warrant consideration. Nutrient intake was assessed using 2 x 24-hour food recall interviews, which depend on the participants' memory and may introduce recall bias. Additionally, the study did not account for other factors influencing anemia status, such as menstrual patterns, history of infectious diseases, iron supplementation, and bioavailability of nutrients from consumed foods. The study was conducted at a single school, which limits the generalizability of the findings to the broader adolescent female population.

CONCLUSION

This study examined the relationship between body image, eating behaviors (emotional eating, external eating, and restrained eating), and adequacy of energy and nutrient intake in relation to anemia status among adolescent girls. The prevalence of anemia is 28.6%, which is considered a moderate public health problem according to WHO. Adolescencts tend to have negative body images and display external eating behavior. Most adolescent girls are unable to meet theor macro and micronutrient intake requirements. This study found no significant correlation between body image and anemia status, although a tendency toward negative body image was observed among female adolescents. External eating was the most common eating behavior (49.5%); however, no significant correlation was identified between eating behaviors and anemia status. The result demonstrated a positive correlation between protein and iron adequacy level and anemia status, with subjects who had inadequate protein intake being 8.4 times more likely to develop anemia. Vitamin B12 adequacy level was also significantly positive correlation with anemia status, and adolescents with inadequate vitamin B12 intake had a 2.5-fold higher risk of anemia. This study had limitations, including potential recall bias in the nutrient intake assessment and limited generalizability due to the single-school setting.

Based on the findings that the majority of adolescents experienced inadequate intakes of protein, iron, and vitamin B12, which were significantly associated with the occurrence of anemia, it is recommended to implement interventions aimed at increasing the consumption of animal-source protein foods. Foods such as meat, eggs, fish, and milk, which are rich in heme iron and vitamin B12 with high bioavailability, should be prioritized. School-based nutrition education programs should emphasize the

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importance of combining heme and non-heme iron sources and avoiding the consumption of iron absorption inhibitors, such as tea and coffee, during meals. In addition, anemia screening and regular monitoring of micronutrient intake among adolescents should be strengthened to support early detection. Additionally, future research should aim to include a larger sample and a wider geographic area, while also considering other factors such as menstrual patterns, infection history, and the bioavailability of nutrients from both animal and plant sources.

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CONFLICTS OF INTEREST

The authors declare no conflict of interest. This study was conducted independently, without any financial, institutional, or personal influence that could affect the design, analysis, or interpretation of the study.

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