Anemia Incidence in Adolescent Girls

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ABSTRACT

Anemia in adolescent girls is a major public health problem that can persist into adulthood and contribute to increased maternal mortality, prematurity, low birth weight, and perinatal death. Data from the Padang City Health Office reported that the prevalence of anemia among adolescent girls at vocational high schools (SMKN) reached 37.5%. This study aimed to identify risk factors associated with anemia among adolescent girls at SMKN in 2019. A case–control study was conducted from January to March 2019 involving female students in grades X and XI. The sample consisted of 32 anemia cases and 32 non-anemia controls. Hemoglobin levels were measured using the Easy Touch GCHb device. Dietary intake of protein, vitamin C, and iron was assessed using a Semi-Quantitative Food Frequency Questionnaire (SQFFQ), while infectious diseases were identified through questionnaires. Data were analyzed using univariate analysis and bivariate analysis with Chi-square tests and Odds Ratios. The results showed that protein intake (p = 0.00; OR = 7.667), vitamin C intake (p = 0.00; OR = 5.000), and infectious diseases (p = 0.01; OR = 3.571) were significantly associated with anemia. Iron intake was not identified as a significant risk factor (p = 0.64; OR = 1.552). In conclusion, anemia prevalence among adolescent girls at SMK Negeri 03 Padang remains high. Efforts to improve nutritional intake, particularly protein, vitamin C, and iron, are strongly recommended to reduce anemia risk and improve adolescent health outcomes.

Keywords: Protein Intake, Vitamin C Intake, Fe Intake, Infectious Diseases

INTRODUCTION

A disorder known as anemia occurs when the blood's hemoglobin level is below normal. When the amount of hemoglobin is insufficient, either the red blood cells are too deformed or too few, or both. Symptoms include weakness, fatigue, chest tightness, shortness of breath, and others. The most common causes of anemia include nutritional deficiencies, especially iron deficiency. Anemia mostly affects young people and pregnant women and is a global health problem(World Health Organizations, 2022).

According to a 2019 World Health Organization data, 29.9% of women aged 15 to 49 worldwide suffered from anemia. The population grew quickly, causing the total number of anemic women to rise from 492.9 million in 2018 to 570.8 million in 2019. In 2021, the worldwide prevalence of anemia across all age groups was 24.5% (WM Gardner *et al.,* 2023) . Meanwhile, for the ASEAN region itself, the incidence of anemia reached 45.6% (World Health Organizations., 2022) .

According to the Ministry of Health's (Kemenkes) Basic Health Research Data (Riskesdas), the prevalence of anemia in the 15–24 age range increased from 18.4% to 32%, or 14.7 million persons, between 2013 and 2018 (Ministry of Health of the Republic of Indonesia., 2019) . In 2023 the prevalence of anemia in the 15-24 age group was 14.6%(Kementerian Kesehatan RI, 2023). The prevalence of anemia in women of productive age in the world is 29.9%. The anemia population group includes children aged <5 years or 6-50 months (39.8% suffer from anemia, women of childbearing age aged 15-49 years. Married and non-pregnant women aged 15-49 years and pregnant women aged 15-49 years. Anemia is a severe public health issue on a worldwide scale. According to WHO estimates, anemia affects 30% of women aged 15 to 49, 37% of pregnant women, and 40% of children aged 6 to 59 months globally (N. Fauziah *et al.,* 2024).

The prevalence of anemia among teenagers in Southeast Asia ranges from 27% to 55% (Syah, 2022). The Republic of Indonesia's Ministry of Health (2022) reports that the prevalence of anemia in Indonesia is 26.8% in the 5–14 age group and 32% in the 15–24 age group(Kementerian Kesehatan RI, 2018). According to the West Java Provincial Health Office, 32.5% of pregnant women in the province—or 63,246 people—had anemia in 2020. Approximately 4,968 people, or 32.5% of pregnant women, still suffer from anemia, especially in Bogor Regency alone(Dinas Kesehatan Provinsi Jawa Barat, 2023).

One of the most dynamic stages of a person's life is adolescence. As children grow into adults, they go through a period of fast physical, mental, emotional, and social development(Kementerian Kesehatan RI, 2014). According to statistics, there are 1.2 billion adolescents in the world today, more than ever before, representing 16 percent of the world's population. The UN states that as adolescents between the ages of 10 and 19 years experience a transition between childhood and adulthood and with it, significant growth and development (UNICEF., 2021). During this phase, significant psychological, behavioral and physical development occurs; due to marked physical activity and rapid growth spurts, adolescents require additional nutritional needs (D. Hartanto. *et al.,* 2020).

Based on the survey, the prevalence of anemia among adolescent boys and girls aged 12-14 years (10.1 percent) in rural areas was lower than the tendency of anemia among the same age group (15.8 percent) in urban areas. Overall, adolescents reported a diet high in carbohydrates and low in animal protein (for example, only 23.9 percent consumed meat/poultry/fish at least once a day). One example is that adolescents in Klaten are less likely than their peers in West Lombok to consume foods rich in vitamins and minerals, such as fruits and vegetables (UNICEF., 2021).

Data from the Padang City Health Office for SMA/SMK/MA showed that anemia in female adolescents was highest in SMKN as much as 37.5%. Female adolescents have a ten times greater risk of suffering from anemia compared to male adolescents. This is because female adolescents menstruate every month and are in their growth period, so they need more nutritional intake. An imbalance in consuming iron is also a cause of anemia in adolescents. Anemia can also be brought on by factors like parental education, economic status, teenage girls' awareness of anemia, iron and vitamin C intake, and menstrual cycle length..

Menstruation and excessive bleeding each month, iron deficiency, vitamin B12 deficiency, chronic illnesses, malaria, hookworm infection, heredity, or genetics are some of the causes of anemia in adolescents.2 Iron metabolism and use are impacted by infectious illnesses, which are necessary for the production of hemoglobin in the blood. Additionally, a number of viral disorders can disrupt red blood cell synthesis and digestion. Hemoglobin production is disrupted in anemia brought on by inadequate dietary intake. These nutrients include protein, iron (Fe), which is a necessary component of hemoglobin creation or the formation of red blood cells, and pyridoxine (vitamin B6), which acts as a catalyst in the synthesis of heme in the hemoglobin molecule. Thus, the purpose of this study is to identify the anemia risk factors in teenage girls at SMKN.

METHODS

This study is a case-control study design conducted on adolescent girls. Sampling was carried out using the purposive sampling method, where 32 adolescent girls with anemia were used as the case group, and 32 adolescent girls who were not anemic were used as the control group. Hemoglobin levels were measured using the Easy Touch GCHB tool, while data on nutritional intake and history of infectious diseases were collected through interviews using the SQFFQ and questionnaires. Data were analyzed univariately and bivariately with the Chi-Square statistical test.

RESULTS

1. **Univariate**

a. **Frequency Distribution of Protein Intake in Adolescent Girls**

Table 1. Frequency Distribution of Protein Intake in Adolescent Girls

Protein intake	Frequency (F)		Control	
	N	%	N	%
Not enough	23	71.9	8	25.0
Enough	9	28.1	24	75.0

Total	32	100	32	100

Based on the table below, it can be seen that the protein intake was more or less found in the case group, namely 71.9%, compared to the protein intake in the control group, namely 25%.

b. Frequency Distribution of Vitamin C Intake in Adolescent Girls

Table 2. Frequency Distribution of Vitamin C Intake in Adolescent Girls

Vitamin C	Frequency (F)		Control	
	N	%	N	%
Not enough	24	75.0	12	37.5
Enough	8	25.0	20	62.5
Total	32	100	32	100

Based on the table above, it can be seen that the intake of vitamin C was more or less found in the case group, namely 75%, compared to the intake of vitamin C in the control group, namely 37.5%.

c. Frequency Distribution of Fe Intake in Adolescent Girls

Table 3. Frequency Distribution of Female Fe Intake

Vitamin C	Frequency (F)		Control	
	N	%	N	%
Not enough	30	93.8	29	90.6
Enough	2	6.2	3	9.4
Total	32	100	32	100

Based on the table above, it can be seen that Fe intake was more or less found in the case group, namely 93.8%, compared to Fe intake in the control group, namely 90.6%.

d. Frequency Distribution of Infectious Disease History in Adolescent Girls

Table 4. Frequency Distribution of Infectious Disease History in Adolescent Girls

History of Infectious Diseases in Adolescent Girls	Frequency (F)		Control	
	N	%	N	%
Once	16	50	7	21.9
Never	16	50	25	78.1
Total	32	100	32	100

Based on the table above, it can be seen that adolescent girls who have had a history of infectious diseases are more often found in the case group, namely 50% compared to the control group, namely 21.9%.

2. **Bivariate**

Table 5. Risk factors for protein intake on the incidence of anemia in adolescent girls

Risk Factors	p-value	OR	95% CI
Insufficient/insufficient protein intake	0.00	7,667	2,524 - 23,284
Insufficient/insufficient intake of Vit C	0.00	5.0	1,709 - 14,628
Insufficient/insufficient Fe intake	0.64	1,552	0.241 - 9.974
History of infectious disease ever/not	0.01	3,571	1,204–10,596

Table 5 presents the analysis of risk factors associated with anemia among adolescent girls. The results indicate that inadequate protein intake was significantly associated with the incidence of anemia (p = 0.00). Adolescent girls with insufficient protein intake had a 7.67 times higher risk of developing anemia compared to those with adequate protein intake (OR = 7.667; 95% CI: 2.524–23.284).

Inadequate vitamin C intake was also significantly related to anemia (p = 0.00), with an odds ratio of 5.0 (95% CI: 1.709–14.628), indicating that adolescents with low vitamin C intake were five times more likely to experience anemia than those with sufficient intake.

Furthermore, a history of infectious disease showed a significant association with anemia (p = 0.01). Respondents who had experienced infectious diseases had a 3.57 times higher risk of anemia compared to those without such history (OR = 3.571; 95% CI: 1.204–10.596).

Conversely, iron (Fe) intake was not significantly associated with anemia (p = 0.64). Although the odds ratio was greater than one (OR = 1.552), the wide confidence interval (95% CI: 0.241–9.974) suggests a lack of statistical significance and indicates that iron intake was not a determining risk factor for anemia in this study.

a. **Risk Factors of Protein Intake on Anemia**

Based on the results of the Chi Square test and the Odd Ratio test, the p value was obtained = 0.00 OR = 7.667 with 95% CI (2.524 - 23.284). This shows that adolescent girls with low protein intake are at risk of developing anemia 7.667 times compared to adolescent girls with sufficient protein intake.

b. **Risk Factors of Vitamin C Intake on Anemia**

Based on the results of the Chi Square test and the Odd Ratio test, the p value was obtained = 0.00 OR = 5.0 with 95% CI (1,709 - 14,628). This shows that adolescent girls with low vitamin C

intake are at risk of developing anemia 5.0 times compared to adolescent girls with sufficient vitamin C intake.

c. Risk Factors of Fe Intake on Anemia Incidence

Based on the results of the Chi Square test and the Odd Ratio test, the p value was obtained = 0.64 OR = 1.552 with 95% CI (0.241 - 9.974). This shows that Fe intake is not a risk factor for anemia in adolescent girls.

d. Risk Factors of Infectious Disease History on Anemia Incidence

Based on the results of the Chi Square test and the Odd Ratio test, the p value was obtained = 0.01 OR = 3.571 with 95% CI (1.204 - 10.596). This shows that adolescent girls who experience infectious diseases are at risk of developing anemia by 3.571 times compared to adolescent girls who do not experience infectious diseases.

DISCUSSION

1. Risk Factors of Protein Intake with Anemia Incidence

According to the study's findings, there is a substantial correlation between the occurrence of anemia and protein intake. Based on the odd ratio test, it was found that adolescent girls who experience anemia have insufficient protein intake when viewed from the nutritional adequacy figures for adolescent girls. Adolescent girls with insufficient protein intake are at risk of experiencing anemia by 7.667 times compared to adolescent girls with sufficient protein intake.

The study's findings are consistent with earlier research showing important relationships between protein intake and anemia occurrence. According to the study, female students with anemia consumed considerably less protein on average (g/day) than their non-anemic counterparts. This study also showed that protein intake was significantly related to the incidence of anemia as a protective factor in grade XI female students of SMA Negeri 11 Medan, both before and after controlling for sociodemographic variables. In addition to iron intake, protein intake plays an important role in preventing anemia. This is because protein intake is needed by the body to form globin, which will eventually form hemoglobin (H. Firmansyah *et al.,* 2024) .

Sources of protein consumed by adolescent girls are chicken, eggs, tofu and tempeh. Protein is divided into animal protein and vegetable protein, where animal protein is heme iron and vegetable protein as a source of nonheme iron needed for the production of hemoglobin. Insufficient protein consumption will slow down the formation of hemoglobin, so that if there is a lack of hemoglobin, there will be a risk of anemia. Protein plays a role in the process of transporting nutrients including iron and the digestive tract into the blood, from the blood to the tissues and through the cell membrane into the cells, so that if there is a lack of protein it will cause interference with absorption and transportation (R. El Azizy., 2019) .

2. Risk Factors of Vitamin C Intake with Anemia Incidence

Based on the results of the study showed that there is a significant relationship between vitamin C intake and the incidence of anemia. Based on the results obtained that adolescent girls who experience anemia have insufficient protein intake when viewed from the nutritional adequacy figures for adolescent girls. Adolescent girls with insufficient vitamin C intake are at risk of experiencing anemia by 5,000 times compared to adolescent girls with sufficient vitamin C intake.

Vitamin C was linked to hemoglobin levels in grade XI female students at SMAN 1 Mantup, according to earlier studies on the association between vitamin C intake and the occurrence of anemia (B. Dengan *et al.,* 2022) . However, this is in contrast to research conducted with 28 female nutrition students (87.5%) who did not experience anemia with a sufficient intake category. The results of the Chi-square test at a 95% confidence level statistically showed that there was no relationship between vitamin C intake and the incidence of anemia ($p > 0.05$). Based on the results of interviews with the SQ-FFQ questionnaire on the sample, the most widely consumed source of vitamin C came from fresh fruits such as oranges, but many were also consumed in the form of juice with various fruits ranging from oranges, mangoes, guavas and others (CN Sadrina and NS Mulyani., 2021) . The impact of vitamin C on iron absorption is so important that it is recommended that every time we eat we must be accompanied by at least 25 mg of vitamin C and can be more if we also consume a lot of iron absorption inhibitors.

In the small intestine, vitamin C changes ferric iron into ferrous iron for better absorption. Vitamin C inhibits the formation of hemosiderin, which is hard to mobilize to release iron when needed. The absorption of iron in the form of heme is quadrupled by vitamin C. Because it facilitates the transfer of iron from transferrin in plasma to liver ferritin, vitamin C is crucial for iron absorption (Sholihah, Andari, & Wirjatmadi, 2019).

3. Risk Factors of Fe Intake with Anemia Occurrence

Iron intake and the prevalence of anemia in teenage girls did not significantly correlate, according to the study's findings. Based on the results obtained, adolescent girls who experience anemia have insufficient Fe intake when viewed from the nutritional adequacy figures for adolescent girls. Adolescent girls with insufficient Fe intake are at risk of experiencing anemia by 1.552 times compared to adolescent girls with sufficient Fe intake.

Similar to earlier research, this study found a strong and positive correlation (r = 0.507) between the incidence of anemia and iron consumption level. The results showed a p value <0.001 with OR = 8.737 (CI = 3.309-29.560). The OR results indicate that adolescent girls with low iron consumption levels are at 8.737 times greater risk of developing anemia compared to adolescent girls who have sufficient consumption levels, while the positive relationship indicates that if iron intake is higher, Hb levels are also higher (N. Sholihah *et al,.* 2019).

Because iron is the primary element that is crucial to the synthesis of hemoglobin, which is the process by which blood is formed, the correlation between iron and hemoglobin levels can be explained. The spleen and muscles store the remaining excess iron, while the liver and spinal cord

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store it as ferritin protein and hemosiderin. The necessity for red blood cell production in the spinal cord will always be satisfied if iron levels are enough. Iron imbalance, however, will occur if the body's stores of iron decline and the quantity of iron ingested from food also falls, causing hemoglobin levels to fall below normal.

4. Risk Factors of Infection History with Anemia Occurrence

According to the study's findings, the incidence of anemia and infectious disorders are significantly correlated. Adolescent girls with infectious diseases are 3.571 times more likely to develop anemia than adolescent girls without infectious diseases, as demonstrated by the findings of the Chi Square and Odd Ratio tests, which produced the 95% CI (1.204 - 10.596) p value = 0.01 OR = 3.571.

According to earlier studies, the p value is less than 0.05, indicating a correlation between the incidence of infectious diseases and anemia. This implies that the incidence of infectious diseases is linked to the incidence of anemia. This study shows that there is a relationship between anemia and the occurrence of infectious diseases, this is likely due to other factors that support the occurrence of infectious diseases, especially influenza, such as weather factors and environmental factors. Factors that influence the occurrence of infection include environmental factors, socio-economic factors, and the behavior of the community itself which is not good for personal and public health, complete immunization and low nutrition (Annisa, Rahfiludin, & Fatimah, 2018). Based on research conducted on adolescent girls, 16 adolescent girls had a history of infectious diseases during the last 1 month, consisting of infectious diseases such as diarrhea and influenza. Anemia can reduce the body's immune system so that it is more susceptible to infection. Infection is an important factor in causing anemia is a consequence of inflammation and food intake that cannot meet iron needs.

CONCLUSIONS

Based on the results of the study that has been conducted on the Risk Factors for Anemia in Adolescent Girls at SMKN, it was found that a lack of protein intake significantly increases the risk of anemia in adolescent girls. Adolescents with insufficient protein intake have a 7.667 times greater risk of experiencing anemia compared to those with sufficient protein intake. Vitamin C intake was also found to be a risk factor for anemia. Adolescent girls with low vitamin C intake have a 5 times greater risk of experiencing anemia. Infectious diseases are another significant factor, where adolescents who have experienced infectious diseases have a 3.571 times greater risk of developing anemia than those who have not experienced infections. Iron (Fe) intake, although an important nutrient, was not found to be a significant risk factor in this study (p = 0.64), with an Odds Ratio of 1.552. This study recommends that adolescent girls increase their consumption of foods rich in protein, vitamin C, and iron and maintain their health to avoid infectious diseases in order to reduce the risk of anemia.

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