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DETERMINANTS OF ANEMIA OCCURRENCE IN ADOLESCENT GIRLS IN PEKALONGAN REGENCY

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ABSTRACT

Introduction: Anemia in adolescent girls is a global health issue that affects physical condition, academic performance, and quality of life. Adolescence is marked by the need for iron, but various risk factors such as inadequate diet, abnormal menstruation, low adherence to Fe tablet consumption, low physical activity, and low family economic status contribute to the increased prevalence of anemia. This study aims to analyze the relationship between dietary patterns, menstrual patterns, Fe tablet consumption, physical exercise, and economic status with the incidence of anemia in adolescent girls in Pekalongan Regency and to identify the most dominant factors.
Method: The research uses a quantitative cross-sectional design with 190 respondents selected through cluster random sampling. Data were obtained through questionnaires and digital hemoglobin testing. Analysis used univariate tests, bivariate tests (Chi-square), and multivariate tests (multiple logistic regression).
Result : The research results show that respondents have poor eating patterns (77.9%), irregular menstrual patterns (68.9%), non-compliance with iron tablet consumption (86.8%), low physical activity (74.7%), and low economic status (52.1%), with an anemia prevalence of 54.2%. Bivariate tests found that all variables were significantly related to the occurrence of anemia ($p<0.05$), while multivariate analysis identified eating patterns as the most dominant factor (sig. 0.000).
Conclusion: These findings indicate that eating patterns play a significant role in the occurrence of anemia in adolescent girls, thus the necessary interventions include improving balanced nutritional intake, reproductive health education, increasing compliance with iron tablet consumption, promoting physical exercise, and educating about high-nutrition foods at affordable prices.

Keywords: determinants, anemia, female adolescents.

INTRODUCTION

Anemia remains one of the global public health problems that predominantly affects vulnerable groups, especially children, pregnant women, and adolescent girls. According to WHO, globally, 30% of women aged 15–49 years experience anemia, while in Indonesia, the prevalence of anemia among adolescent girls aged 15–24 years is recorded at 15.5% (World Health Organization, 2023); (Silangen, 2025). This condition has serious impacts on growth, cognitive development, academic achievement, and the productivity of adolescents. In the long term, anemia that continues into pregnancy can increase the risk of obstetric complications, preterm birth, low birth weight infants, and even neonatal death (Kemenkes, 2022).

The factors influencing anemia in adolescent girls are quite complex, ranging from a diet low in iron, abnormal menstrual patterns, adherence to iron supplementation (TTD), levels of physical activity, to family economic status (Budiarti et al., 2021); (Vironika et al., 2024). Adolescents from low-income families are more vulnerable to anemia due to limited access to nutritious food and healthcare services. Additionally, monthly menstruation increases the need for iron,

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making adolescent girls more at risk of iron deficiency (Yunarsih & Antono, 2017). Low adherence to TTD consumption also poses a serious problem, as evidenced by only 1.4% of adolescents adhering to the consumption as recommended, despite the high distribution coverage (Nurjanah & Azinar, 2023).

The Indonesian government has implemented a weekly iron supplement program through schools since 2015, reinforced by the National Movement for Nutritional Action, which includes activities such as group iron supplement consumption, nutrition education, and healthy breakfasts (Helmyati et al., 2024); (Kemenkes, 2022). However, the incidence of anemia in several regions remains high. Data from the Pekalongan District Health Office in 2024 shows that the prevalence of anemia among adolescent girls is 3.5%. The aim of this study is to identify the determinants of anemia occurrence in adolescent girls in Pekalongan District.

MATERIALS AND METHODS

This research is a non-experimental quantitative study with a cross-sectional design. The research setting was conducted at MAN Pekalongan and SMK Muhammadiyah Kedungwuni from June to August 2025. The population of the study consisted of all female adolescents aged 15-19 years in 12 senior high schools/equivalent in the working area of Puskesmas Kedungwuni 1, totaling 3,073 students. The sample was determined using the cluster random sampling method, resulting in the selection of MAN Pekalongan (278 students) and SMK Muhammadiyah Kedungwuni (86 students) with an accessible population of 364 students. The sample size was calculated using Slovin's formula with a margin of error of 5%, resulting in 190 respondents selected through simple random sampling.

The independent variables include dietary patterns, menstrual patterns, iron tablet consumption, physical activity, and family economic status, while the dependent variable is the occurrence of anemia. Data was collected using a structured questionnaire that had been tested for validity and reliability, containing items about dietary patterns, menstrual patterns, iron tablet consumption, physical activity, and family economic status. Anemia status was determined through the examination of hemoglobin (Hb) levels using a digital hemoglobinometer of the Mission Hb brand from finger capillary blood, with an anemia limit of Hb < 12 g/dL.

Data analysis includes univariate analysis for variable distribution, bivariate analysis using Chi-Square test, and multivariate analysis with multiple logistic regression to determine the dominant factors influencing the occurrence of anemia. This research has been approved by the Ethics Research Committee of Muhammadiyah University of Pekajangan Pekalongan on June 3, 2025, with letter number 124/KEP-UMPP/IV/2025.

RESULTS

The presentation of respondent characteristic data includes class and age.

Table 1 Respondents Characteristics

Characteristics	F	P	Standar Deviasi
Age			
16 years	28	14,7	0,37523
17 years	136	71,6	
18 years	22	11,6	
19 years	4	2,1	
Class			
10	32	16,8	0,59
11	158	83,2	

Based on Table 1, the characteristics of the research respondents indicate that the majority of the female adolescents are 17 years old (71,6%), followed by 16 years old (14,7%),

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18 years old (11,6%), and 19 years old (2,1%), with a standard deviation of 0,37. In terms of grade level, the majority of respondents are from 11th grade (83,2%) and the rest are from 10th grade (16,8%), with a standard deviation of 0,59. This indicates that the characteristics of the respondents are relatively homogeneous both in terms of age and grade.

Table 2 frequency distribution

Variable	F	P
Diet Pattern		
Less	148	77,9
Enough	42	22,1
Good	0	0
Menstrual Pattern		
Not Normal	131	68,9
Normal	59	31,1
Fe Tablet Consumption Pattern		
Disobedient	115	60,5
Less Obedient	50	26,2
Compliant	25	13,2
Physical Exercise		
Low	142	74,7
Enough	48	25,3
Economic Status		
Low Status	99	52,1
Status Sufficient	91	47,9
Status Anemia		
Anemia	103	54,2
Not Anemic	87	45,8
Total	190	100

Based on table 2, it is known that the majority of respondents have an inadequate diet (77,9%). Additionally, more than half of the respondents experienced abnormal menstrual patterns (68,9%) and were noncompliant in taking iron tablets (60,5%). The majority of respondents also had a low level of physical activity (74,7%). Overall, more than half of the total respondents were identified as experiencing anemia, at 54,2%.

Table 3 The relationship between Eating Patterns, Menstrual Patterns, Iron Tablet Consumption Patterns, Physical Exercise, and Economic Status with the Incidence of Anemia in Adolescent Girls

Variable		Anemia Status				Total		p	OR	CI 95% Lower-Upper
		Anemia		Not Anemic						
		n	%	n	%	N	%			
Diet Pattern	Less	99	66,9	49	33,1	148	100	0,000	19,194	6,481-56,841
	Enough/Good	4	9,5	38	90,5	42	100			
Menstrual Pattern	Not Normal	91	69,5	40	30,5	131	100	0,000	8,910	4,273-18,581
	Normal	12	20,3	47	79,7	59	100			
Fe Tablet Consumption Pattern	Disobedient/ Less Obedient	97	58,8	68	41,2	165	100	0,001	4,517	1,714-11,901
	Compliant	6	24	19	76	25	100			
Physical Exercise	Low	88	62	54	38	142	100	0,000	3,585	1,784-7,206
	Enough	15	31,3	33	68,8	48	100			
Economic Status	Low Status	72	72,7	27	27,3	99	100	0,000	5,161	2,778-9,588
	Status Sufficient	31	34,1	60	65,9	91	100			

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Total	103	100	87	100	190	100

Based on the results of bivariate analysis using the chi-square test in Table 3, it was found that there are significant relationships between all independent variables and the incidence of anemia in adolescent girls. Poor dietary patterns are significantly associated with anemia (p=0.000) with an odds ratio (OR) of 19,194 (95% CI: 6,481–56,841), meaning that adolescents with poor dietary patterns are 19 times more likely to experience anemia compared to those with adequate/good dietary patterns. Irregular menstrual patterns are also significantly related to anemia (p=0,000) with an OR of 8,910 (95% CI: 4,273–18,581). Compliance with iron tablet consumption shows a significant relationship (p=0,001), where non-compliant adolescents are 4.5 times more likely to experience anemia (OR 4.517; 95% CI: 1,714–11,901). Low physical activity has a significant relationship (p=0,000) with anemia, with an OR of 3,585 (95% CI: 1.784–7,206). Likewise, low economic status is associated with anemia (p=0,000), with an OR of 5,161 (95% CI: 95%: 2,778–9,588).

Table 4 The Influence of Eating Patterns, Menstrual Patterns, Iron Tablet Consumption Patterns, Physical Exercise, and Economic Status on the Incidence of Anemia in Adolescent Girls

Variable	Exp (B)	CI 95%		p	Nagelkerke R Square
		Lower	Upper		
Diet Pattern	0,096	0,030	0,313	0,000	0,459
Menstrual Pattern	0,240	0,099	0,584	0,002	
Fe Tablet Consumption Pattern	0,925	0,259	3,311	0,905	
Physical Exercise	0,391	0,165	0,924	0,032	
Economic Status	0,388	0,183	0,824	0,014	

Based on Table 4 of the results of the multiple logistic regression analysis, a good diet significantly reduces the risk of anemia by 90,4% (Exp(B))=0,096; p=0,000), normal menstrual patterns by 76% (Exp(B))=0,240; p=0,002), good physical exercise by 60,9% (Exp(B))=0,391; p=0,032), and good economic status by 61,2% (Exp(B))=0,388; p=0,014), while iron tablet consumption only reduces the risk by 7,5% but is not significant (Exp(B))=0,925; p=0,905). The Nagelkerke R Square value of 0.459 indicates that 45,9% of the variation in the occurrence of anemia can be explained by these five variables.

DISCUSSION

The Relationship Between Eating Patterns and the Incidence of Anemia in Adolescent Girls

The research results show that the majority of respondents (77,9%) have poor eating patterns, with a 19 times higher risk of anemia compared to adolescents with good eating patterns (p=0,000; OR=19,194; 95% CI =6,481–56,841). An imbalanced diet, particularly low in iron, directly contributes to the disruption of hemoglobin synthesis. The theory of hematopoiesis emphasizes that iron is an essential component of hemoglobin, and its deficiency will hinder oxygen transport in the body (Khonsary, 2017). Iron absorption is also influenced by bioavailability, where heme iron from animal foods is more easily absorbed (15–35%) compared to non-heme (2–20%), while the consumption of tea/coffee containing tannins and polyphenols can inhibit its absorption (Yulia Warda & Adhila Fayasari, 2021).

This finding is consistent with previous research reporting a significant relationship between diet and the incidence of anemia (Dzul Istiqomah Hasyim, 2018). (UNICEF, 2021) also emphasizes the importance of intake of iron, folic acid, vitamins, and animal protein to prevent anemia in adolescents. Factors

influencing adolescents' diets include low nutritional knowledge, negative body image, and strict dieting practices (Niswah et al., 2021). External factors such as peer influence, fast food trends, modern consumption culture, social media, and economic constraints also reinforce unhealthy eating patterns (Chung et al., 2021); (Dewi et al., 2023). Therefore, poor dietary habits among adolescents are influenced not only by individual aspects but also by social, cultural, and economic factors, making anemia prevention interventions require a comprehensive approach through nutrition education, family strengthening, and improving access to affordable healthy food.

The Relationship Between Menstrual Patterns and the Incidence of Anemia in Adolescent Girls

More than half of the respondents (68,9%) had abnormal menstrual patterns, with a nearly nine times higher risk of anemia compared to those with normal patterns (p=0,000; OR=8,910; 95% CI = 4,273–18,581). Excessive blood loss during menstruation gradually depletes the body's iron reserves and triggers iron deficiency anemia (Almatsier, 2016). This is consistent with the research (Sari et al., 2022) which found abnormal menstruation as a predictor of anemia in adolescents in Jatinangor.

Theoretically, according to hematopoiesis (Khonsary, 2017), iron is very important for hemoglobin synthesis, so excessive loss due to menstruation disrupts erythrocyte formation. (World Health Organization, 2016) also emphasizes that adolescent girls are a vulnerable group for anemia because the need for iron increases along with growth and menstrual bleeding. Other factors that influence menstrual patterns include stress, nutritional status, and physical activity. High stress can disrupt the hypothalamic-pituitary-ovarian function leading to ovulation disorders (Jha et al., 2020). Adolescents with low or high BMI are also more likely to experience irregular cycles (Itriyeva, 2022). A study in Sidoarjo even found that stress has a stronger correlation with menstrual cycle disorders compared to BMI (Qulistan Balqis Ulwani et al., 2025). Thus, abnormal menstrual patterns are related not only to excessive bleeding but also to psychological factors and nutritional status that further increase the risk of anemia in adolescent girls.

The Relationship Between Iron Tablet Consumption Patterns and Anemia Incidence in Adolescent Girls

Most respondents (60,5%) did not adhere to iron tablet consumption, with a 4,5 times higher risk of anemia compared to those who did adhere (p=0.001; OR=4,517; CI 95% = 1,714–11,901). This result is consistent with studies (Aji & Kurniawati, 2024) and (Anjarwati & Ruqoiyah, 2020) that also found a significant correlation between adherence to iron tablet consumption and anemia incidence in adolescents. However, some adolescents still experienced anemia even if they adhered, and some did not experience anemia even if they did not adhere, indicating that other factors such as dietary patterns, nutritional status, and menstruation also play a role.

The adherence to Fe tablet consumption is still low globally, even reported to be below 26% (Silitonga et al., 2023). Common barriers include forgetfulness, side effects, or the assumption that it is unnecessary (Siabani & Arya, 2018). Support from teachers, parents, and peers has been shown to increase adherence, especially when schools implement programs for drinking Fe tablets together accompanied by education, with an odds ratio of more than 7 (None et al., 2020). The weekly TTD program from the Indonesian Ministry of Health through the National Action for Nutrition Movement also emphasizes the importance of institutional support. Thus, although Fe tablets play a crucial role in preventing anemia, their effectiveness is highly influenced by adolescent adherence, as well as social support, education, regular distribution, and ongoing monitoring. Efforts for improvement should not only focus on providing tablets but also on innovative strategies to enhance acceptance and adherence among adolescents.

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The Relationship Between Physical Exercise and the Incidence of Anemia in Adolescent Girls

Most respondents (74,7%) had low physical activity, and the analysis results showed a significant relationship with the incidence of anemia (p=0,000; OR=3,585; 95% CI=1,784–7,206). This means that adolescents with low physical activity are 3,5 times more likely to experience anemia compared to those who are active. Physical activity is known to play a role in iron metabolism, as intense exercise stimulates the production of erythropoietin (EPO), which increases the formation of erythrocytes and suppresses hepcidin, thus optimizing iron absorption from the (Chaput et al., 2020). Research (Fitria & Yulita, 2021) also shows that regular exercise can improve hemoglobin levels in adolescent girls.

The low level of physical exercise among respondents may be related to the heavy academic load, especially in the 11th grade, which can reduce time for sports. This is in line with the findings of (Galeano-Rojas et al., 2024) and (Liu et al., 2025) that academic stress decreases physical activity, although exercise plays a role in reducing stress, improving sleep quality, and maintaining mental health. (WHO, 2020) adds that a sedentary lifestyle, excessive use of gadgets, and a lack of sports facilities also contribute to the low level of physical activity among teenagers. Thus, physical exercise is not only important for fitness but also plays a role in preventing anemia through physiological and psychosocial mechanisms. Active teenage girls who engage in sports are likely to have better hemoglobin status compared to those who are less active.

The Relationship Between Economic Status and the Incidence of Anemia in Adolescent Girls

The research results show that more than half of the respondents (52,1%) come from families with low economic status, and bivariate analysis proves a significant relationship with the incidence of anemia (p=0,000; OR=5,161; CI 95%: 2,778–9,588). This is in line with the theory stating that economic status affects a family's ability to meet nutritional needs, access health services, and supplements, which indirectly impacts hemoglobin status through dietary patterns (Rahmadani et al., 2023). Research (Towantja & Ferianto, 2024) also shows that families with incomes below the minimum wage tend to buy cheap foods that are high in carbohydrates and low in iron, thus increasing the risk of anemia.

In this context, economic limitations make it difficult for adolescents to access sources of heme iron from red meat or liver, which are more easily absorbed by the body. However, there are affordable plant-based food alternatives such as tempeh, tofu, legumes, spinach, moringa leaves, and anchovies that are rich in iron. A study (Rahmadona, 2022) shows that simple cooking techniques, such as steaming tempeh or beef liver for 10 minutes, can preserve iron content better than boiling. The absorption of non-heme iron can also be enhanced by consuming foods rich in vitamin C, such as guava or oranges (Ayupir, 2021).

This finding indicates that although low economic status is a risk factor for anemia, interventions through nutrition education are essential. Health workers can play a role in providing guidance on the utilization of local nutritious food at affordable prices. With this strategy, low-income families still have the opportunity to meet the iron needs of adolescents and reduce the risk of anemia.

The Influence of Eating Patterns, Menstrual Patterns, Iron Tablet Consumption, Physical Exercise, and Economic Status on the Occurrence of Anemia in Adolescent Girls

The results of multivariate analysis show that out of five variables studied, four were found to have a significant impact on the occurrence of anemia, namely eating patterns, menstrual patterns, physical exercise, and economic status, while iron tablet consumption was not significant. The most dominant variable is eating patterns (Exp(B)=0,096; p<0,001), where adolescents with good eating patterns have a 90,4% lower risk of experiencing anemia. These findings emphasize the importance of heme iron intake from animal sources which is more easily absorbed compared to non-heme, as well as the role of vitamin C as an enhancer and

polyphenols (tea/coffee) as inhibitors of iron absorption (Moustarah & Daley, 2025); (WHO, 2025).

Menstrual patterns also have a significant effect (Exp(B)=0,240; p=0,002), where adolescents with normal menstrual patterns are 76% less likely to experience anemia. Excessive blood loss during menstruation has been shown to disrupt hematopoiesis and reduce hemoglobin (Fitria & Yulita, 2021); (Khonsary, 2017). Physical activity decreases the risk of anemia by 60,9% (Exp(B)=0,391; p=0,002) because regular exercise can suppress hepcidin levels and increase erythropoietin production, which supports red blood cell formation (Coimbra et al., 2017). Economic status also plays a role (Exp(B)=0,388; p<0,001), where adolescents from economically stable families have a 61,2% lower risk of experiencing anemia, particularly due to access to nutritious diets (Dzul Istiqomah Hasyim, 2018).

Meanwhile, the consumption of Fe tablets (Exp(B)=0,925; p=0,905) did not have a significant effect after being controlled along with other variables, which indicates that its effectiveness is highly influenced by compliance, timing of consumption, and interaction with food/drinks (Salim et al., 2025); (Nurjanah & Azinar, 2023). The Nagelkerke R Square value of 0,459 indicates that the five variables explain 45,9% of the variation in anemia, while the remainder is influenced by factors outside the model. Overall, dietary patterns emerged as the most dominant factor, with significant contributions from menstrual patterns, physical activity, and economic status. Therefore, anemia prevention interventions for adolescent girls need to focus on nutrition education, menstrual monitoring, promotion of physical activity, and family economic empowerment as a holistic approach.

CONCLUSIONS

This study shows that most adolescent girls in Pekalongan Regency have poor eating patterns, irregular menstruation, low adherence to iron tablet consumption, low physical activity levels, and come from families with low economic status, resulting in more than half of the respondents experiencing anemia. Bivariate analysis found a significant relationship between eating patterns, menstruation patterns, iron tablet consumption, physical exercise, and economic status with the incidence of anemia. However, the results of multivariate analysis indicate that the significant factors are eating patterns, menstruation patterns, physical exercise, and economic status, while iron tablet consumption does not have an independent effect. Eating patterns proved to be the dominant factor, where adolescents with good eating patterns have a 90.4% lower risk of experiencing anemia compared to those with poor eating patterns. Teen girls are encouraged to improve their intake of balanced nutritious food and exercise regularly. Schools and health centers are expected to strengthen nutrition education and conduct regular Hb examinations. Future researchers are advised to study school-based interventions that combine nutrition education, the distribution of iron tablets, and health promotion.

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