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Original Research

Determinant Associated with Anemia in Adolescent Girls: A School-Based Cross-Sectional Study

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Abstract

In Indonesia, anemia remains a pressing public health problem among adolescent girls, with a prevalence rate of 32% based on the Basic Health Research (Riskesdas) 2018. This highlights anemia as an ongoing issue that requires continuous attention. Adolescent girls are particularly vulnerable because iron needs increase during growth, and blood loss occurs regularly through menstruation. Inadequate intake of nutritious foods, poor adherence to iron supplementation (TTD), limited knowledge, and economic barriers may further contribute to this problem. This cross-sectional study investigated the determinants of anemia among adolescent girls attending a public vocational high school in Tebet, Jakarta, Indonesia. A total of 221 Grade 11 students were included through total sampling. Anemia status (Hb < 12 g/dL) was obtained from puskesmas screening, while data on knowledge, nutritional status, menstrual pattern, maternal education, socioeconomic status, and iron supplement (TTD) intake were collected via a structured questionnaire. Chi-square analysis revealed significant associations between anemia and knowledge level, menstrual pattern, nutritional status, adherence to TTD, maternal education level, and socioeconomic status ($p < 0.05$). The findings emphasize the need for strengthened school-based anemia prevention through nutrition education, routine Hb screening, and parent-involved adherence monitoring, particularly among low-income students. The findings indicate the need for schools and primary health centers (puskesmas) to strengthen education on anemia and adolescent nutrition, implement routine screening (nutritional status and menstrual pattern), and improve adherence to TTD through regular mentoring that involves parents, particularly mothers, and targeted support for students from low-income households.

Keywords: Anemia Adolescent Girls, Cross-Sectional Study, Iron Supplement Tablet

INTRODUCTION

Anemia is considered a major public health problem globally, mainly affecting women of reproductive age and adolescent girls. This disorder involves a decrease in either red blood cell numbers or hemoglobin concentration, resulting in reduced oxygen transport to the body tissues (Hall & Guyton, 2016). It can also be defined as a decline in hemoglobin concentration or erythrocyte count below normal values according to age and sex, which ultimately disrupts oxygen delivery to the tissues (Hoffbrand & Moss, 2016). The World Health Organization (WHO) reports that anemia affects 40% to 88% of the global population, while the prevalence among adolescent girls in developing countries is approximately 53.7% (World Health Organization, 2020). The WHO has also reported that more than 1.62 billion individuals, approximately 24.8% of the global population, are affected by anemia, with the highest prevalence observed among preschool-aged children and adolescent girls. The WHO classifies anemia as a public health problem when its prevalence exceeds 15% (World Health Organization, 2015). In Southeast Asia, anemia among adolescent girls remains high due to a combination of increased iron requirements during growth and regular blood loss through menstruation, compounded by unhealthy dietary behaviors such as frequent consumption of fast food and drinking tea or coffee, both of which can inhibit iron absorption (World Health Organization Regional Office for South-East Asia, 2022).

In Indonesia, addressing anemia in adolescent girls remains a national health priority. Data from the Indonesian Ministry of Health (Riskesdas) indicate that 22.7% of adolescent girls suffered from iron-deficiency anemia in 2021, while Riskesdas 2018 reported a prevalence of 32%, representing a substantial increase from 18.4% in Riskesdas 2013. Despite national programs that include weekly TTD supplementation, monitoring, and nutrition education, evidence suggests low adherence and limited behavioral changes among adolescents. Few studies have specifically examined school-level determinants in urban Jakarta populations, creating a gap that this study attempts to fill (Ministry of Health of the Republic of Indonesia, 2018). These challenges in program implementation are closely linked to inadequate awareness and education regarding anemia, negative perceptions of TTD-related side effects, and insufficient support from teachers and peers, all of which contribute to the continued prevalence of anemia among adolescent girls(Ramdhani et al., 2025). The burden is further exacerbated by socioeconomic conditions, family educational background, menstrual patterns, nutritional status, and restrictive dieting practices driven by concerns about body image (Hasyim, 2018). Consequently, despite nationwide implementation, the effectiveness of the TTD program remains limited, underscoring the need for a comprehensive evaluation of the behavioral and social factors influencing its success (Pramardika, 2019).

Given these ongoing challenges, the long-term consequences of anemia during adolescence are particularly concerning, as anemia can adversely affect physical health, cognitive development, academic performance, productivity, and future reproductive health (Siti et al., 2025). This concern is further amplified at the regional level, where the prevalence of anemia among adolescent girls in DKI Jakarta has reached 48.3%, exceeding national estimates (Provincial Health Office Report, 2023). Despite this high burden, limited evidence is available on how school-level and social conditions influence adherence to iron supplementation among adolescents in urban settings. Therefore, a comprehensive evaluation of risk factors, behavioral determinants, socioeconomic conditions, and the effectiveness of existing program implementation is essential to inform targeted interventions and reduce low hemoglobin levels in adolescent girls (Helmyati et al., 2023).

Based on these issues, the research question of this study is: what risk factors are correlated with anemia among adolescent girls in a public vocational high school (SMKN) in Tebet, Jakarta. This study aimed to evaluate the factors influencing the occurrence of anemia among adolescent girls, including knowledge, nutritional intake, adherence to iron supplementation (TTD), and menstrual patterns.

METHODS

This study aimed to identify the factors associated with anemia in adolescent girls. An analytic observational study with a cross-sectional design was conducted to examine the relationship between anemia and its associated factors at a single point in time. The study was conducted on October 10, 2025, at a public vocational high school (SMKN) in the Tebet area. The study population consisted of all 11th-grade female students aged 15–18 years. A total sampling technique was applied; therefore, all 221 eligible students were included as the study participants. In addition to the student respondents, one School Health Unit (UKS) teacher and three youth counselors from the Youth Red Cross (PMR) were involved to support coordination and data collection activities. The inclusion criteria were students who were present on the day of data collection and willing to participate, while students who were absent were excluded.

Data were collected from primary and secondary sources. Primary data were obtained using a structured questionnaire that assessed several risk factors, including knowledge of anemia, body mass index (BMI), maternal education, family income, menstrual patterns, and iron supplementation (TTD) consumption. Data collection was conducted directly at the school, where respondents completed the questionnaire via Google Forms using their mobile devices under the supervision of the researcher. Secondary data on anemia status were obtained through collaboration with the local primary health center (puskesmas), which had previously conducted hemoglobin screening among students as part of a school health program.

The questionnaire was adapted from a previously validated instrument developed by (Lestari, 2018) and included sections on respondent characteristics, parental background, menstrual history, TTD consumption, and knowledge of anemia (Lestari, 2018). The online questionnaire was designed in a simple and user-friendly format to facilitate completion by the students. The questionnaire link was distributed in coordination with UKS teachers and school authorities.

Data were analyzed using SPSS version 25 (IBM Corp., Armonk, NY, USA). A descriptive analysis was performed to summarize participant characteristics, and the chi-square test was used to examine the association between anemia status and risk factors. This study was approved by the Ethics Committee (0521/Usakti/FK-PKS/II/2025).

RESULT

This study was successfully conducted with the support and collaboration of the local primary health center (puskesmas) and the school, which enabled the completion of the research activities. The study began with anemia screening of adolescent girls at a public vocational high school (SMKN) in the Tebet area, assisted by the local puskesmas. This was followed by data collection on the risk factors associated with anemia among the students. Interviews with a teacher and youth counselors indicated that the main reasons for not taking TTD were its unpleasant taste and side effects such as nausea, while only a small proportion

understood the importance of TTD in preventing anemia. The following section presents the proportion of patients with anemia and their associated risk factors.

Univariate Analysis

Table 1. Frequency Distribution of the Dependent Variable and Independent Variables

Variable	Frequency (n=221)	Percentage (%)
Incidence of anemia		
Anemia	67	30.3
Non anemic	154	69.7
Knowledge		
Poor	71	32.1
Adequate	91	41.2
Good	59	26.7
Iron Supplement Tablet (TTD) Consumption		
No	137	62.0
Yes	84	38.0
Nutritional Status		
Underweight	58	26.2
Normal	140	63.3
Obese	23	10.4
Menstrual Pattern		
Abnormal	118	53.4
Normal	103	46.6
Mother's Education		
Primary-Junior High School (SD-SMP)	82	37.1
Senior High School-Bachelor's Degree (SMA-Sarjana)	139	62.9
Socioeconomic status		
Below the regional minimum wage (<UMR)	133	60.2
Equal to or above the regional minimum wage (≥ UMR)	88	39.8

Data source: Primer data

Based on Table 1, the distribution of respondents by anemia status shows that 67 students (30.3%) were anemic, and 154 students (69.7%) were not anemic. Regarding knowledge level, 59 (26.7%) had good knowledge, 91 (41.2%) had adequate knowledge, and 71 (32.1%) had poor knowledge. For TTD (iron supplement tablet (TTD) consumption, 137 students (62.0%) reported not taking TTD, while 84 students (38.0%) reported taking TTD. In terms of nutritional status, 58 students (26.2%) were underweight, 140 students (63.3%) had normal nutritional status, and 23 students (10.4%) were overweight. Regarding menstrual patterns, 103 students (46.6%) reported normal menstruation, and 118 students (53.4%) reported irregular menstruation. Based on maternal education, 82 students (37.1%) had mothers with primary to junior high school education (SD–SMP), and 139 students (62.9%) had mothers with senior high school to bachelor's degree education (SMA–Sarjana). Finally, regarding socioeconomic status, 133 students (60.2%) came from households with income below the regional minimum wage (< IDR 5,396,761), while 88 students (39.8%) came from households with income equal to or above the regional minimum wage (≥ IDR 5,396,761).

Bivariate Analysis

Table 2. Bivariate Analysis of Risk Factors Associated with Anemia Among Adolescent Girls

Variable	Anemia	Non-Anemic	Pvalue
Knowledge			0.001
Poor	33 (46.5%)	38 (53.5%)	
Adequate	22 (24.2%)	69 (75.8%)	
Good	12 (20.3%)	47 (79.7%)	
Iron Supplement Tablet (TTD) Consumption			0.000
No	56 (40.9%)	81 (59.1%)	
Yes	11 (13.1%)	73 (86.9%)	
Nutritional Status			0.001
Underweight	13 (22.4%)	45 (77.6%)	
Normal	41 (29.3%)	99 (70.7%)	
Obese	13 (56.5%)	10 (43.5%)	
Menstrual Pattern			0.000
Abnormal	61 (51.7%)	57 (48.3%)	
Normal	6 (5.8%)	97 (94.2%)	
Mother's Education			0.002
Primary-Junior High School (SD-SMP)	35 (42.7%)	47 (57.3%)	
Senior High School-Bachelor's Degree (SMA-Sarjana)	32 (23.0%)	107 (77.0%)	
Socioeconomic status			0.000
Below the regional minimum wage (<UMR)	56 (42.1%)	77 (57.9%)	
Equal to or above the regional minimum wage (≥ UMR)	11 (12.5%)	77 (87.5%)	

Data source: Primer data

The Chi-square test produced a p-value of 0.001, indicating a significant association between knowledge level and anemia status. Among adolescents with limited knowledge, 33 (46.5%) were anemic, while 38 (53.5%) were not. In the group with sufficient knowledge, 22 (24.2%) were anemic and 69 (75.8%) were not. Conversely, in the cohort with good knowledge, only 12 students (20.3%) were anemic and 47 students (79.7%) were not.

The chi-square test for the variable related to TTD (iron supplement tablet) consumption yielded a p-value of 0.000, demonstrating a significant link between TTD consumption and anemia. Among adolescents who did not take TTD, 56 (40.9%) were anemic, while 81 (59.1%) were not. Conversely, of those who consumed TTD, only 11 students (13.1%) were anemic, and 73 students (86.9%) were not. The chi-square test showed p = 0.001 for nutritional status, indicating a significant association between nutritional status and anemia. Among underweight adolescents, 13 (22.4%) were anemic and 45 (77.6%) were not. Among those with normal nutritional status, 41 students (29.3%) were anemic, and 99 students (70.7%) were not anemic. In the obese group, 13 students (56.5%) were anemic and 10 (43.5%) were not.

The chi-square test showed a p-value of 0.000 for the menstrual pattern variable, indicating a strong link between menstrual pattern and anemia. Among the adolescents with abnormal menstrual patterns, 61 (51.7%) had anemia, and 57 (48.3%) did not. In comparison,

among those with normal menstrual patterns, only six students (5.8%) had anemia, and 97 (94.2%) did not. For maternal education, the chi-square test showed p = 0.002, indicating that the mother's education level was significantly associated with anemia. Among adolescents whose mothers had primary to junior high school education (SD–SMP), 35 (42.7%) were anemic and 47 (57.3%) were not anemic. In contrast, among those whose mothers had senior high school to bachelor's degree education (SMA–Sarjana), 32 students (23.0%) were anemic and 107 students (77.0%) were not anemic. For socioeconomic status, the chi-square test yielded p = 0.000, indicating a significant association between socioeconomic status and anemia incidence. Among adolescents from households with income below the regional minimum wage (UMR), 56 (42.1%) were anemic and 77 (57.9%) were not anemic. In contrast, in the group with income equal to or above the UMR, only 11 students (12.5%) were anemic, while 77 students (87.5%) were not.

DISCUSSIONS

The results of this study show a link between knowledge level and the incidence of anemia in adolescent girls. Adolescents with good knowledge of anemia tended to have normal hemoglobin levels compared with those with poor knowledge. This may be because knowledge plays an important role in shaping health behaviors, including awareness of the need to meet iron requirements and to take iron supplement tablets (TTD) regularly (Ghadam et al., 2023). Limited knowledge may also lead adolescents to misunderstand or be unaware of the manifestations, etiology, and strategies to prevent anemia (van Zutphen et al., 2021). These outcomes are in agreement with the findings reported by Kalsum et al. (2025), who showed that knowledge is closely related to anemia among adolescent girls and that improving knowledge may help reduce anemia prevalence (Kalsum et al., 2025).

The findings of this study indicate a meaningful relationship between TTD consumption and the occurrence of anemia among adolescent girls. For the prevention and treatment of anemia, iron supplementation delivered through school-based programs has been shown to be effective, feasible to implement, and relatively low-cost, and therefore can help reduce anemia among adolescent girls. Providing iron (Fe) tablets starting in adolescence is considered more appropriate because iron requirements increase during this period, and improvements in hemoglobin levels are often observed more quickly. In addition, supplementation in adolescent girls offers long-term benefits for reproductive health, making it more effective than supplementation only during pregnancy (Yani et al., 2025). This study is in agreement with the results of Singh et al. (2020), who reported that Fe tablet consumption was significantly associated with a reduction in anemia among adolescent girls (Singh et al., 2020). Iron supplementation has also been linked to improved cognitive function in children and adolescents, particularly in terms of attention, memory, and concentration. Evidence suggests that regular and consistent intake produces better outcomes than irregular use, as improvements in iron status occur more consistently. Overall, this supports the view that adherence to iron supplementation, together with a nutritious diet, is essential to maximize the cognitive benefits of iron (Alblewi, 2024).

The findings of this study demonstrate an association between nutritional status, particularly obesity, and the prevalence of anemia in adolescent girls. Although obesity is characterized by excess energy intake, it is often accompanied by poor diet quality and inadequate micronutrient intake, which can disrupt metabolism and hemoglobin (Hb) synthesis. Obesity-related chronic inflammation may impair iron metabolism and

erythropoiesis in the bone marrow, leading to reduced hemoglobin levels and anemia (Rahmatina et al., 2025). These findings are consistent with Enggardany et al. (2021), who reported a significant relationship between nutritional status and hemoglobin levels in adolescent girls, indicating that abnormal nutritional status, including overweight and obesity, increases anemia risk (Enggardany et al., 2021). Poor dietary patterns among obese adolescents, such as frequent consumption of iron-poor fast food and limited nutritional awareness, further contribute to this condition (Soans et al., 2025). During adolescence, increased nutrient requirements and monthly menstruation exacerbate iron deficiency risk in obese adolescent girls, predisposing them to anemia (Thomas et al., 2015).

The results of this study indicate an association between menstruation and the occurrence of anemia in adolescent girls. Menstruation occurs monthly and causes adolescent girls to lose a certain amount of blood and iron; therefore, a higher iron intake is needed to replace these losses. When menstrual bleeding is heavier than normal, iron stores may decline more rapidly, increasing the risk of anemia (Söderman et al., 2025). These results are in line with those a of study conducted by Sigit et al. (2024), which reported a significant relationship between the menstrual cycle and hemoglobin levels among adolescent girls (Sigit et al., 2024). In addition, multivariate analysis has shown that adolescents who have begun menstruating are 2.57 times more likely to experience iron deficiency than those who have not yet menstruated, reinforcing menstruation (blood loss) as a major factor that increases the likelihood of iron deficiency or anemia (Moschonis et al., 2013).

The evidence from this study points to an association between maternal education and the prevalence of anemia among adolescent girls. Based on data from the Indonesian Ministry of Health (2019), maternal education is a key determinant of family health. Higher educational attainment may enable individuals to access, process, and apply information more easily in daily life (Ministry of Health, 2019). In line with this, research conducted by Choi et al. (2011) also reported that maternal education is significantly associated with anemia among adolescent girls (Choi et al., 2011). Adolescent girls whose mothers had low educational levels or no schooling were 1.45 times more likely to develop anemia than those whose mothers were educated. Low maternal education has been identified as an important factor influencing the adequacy of nutritional intake, including iron intake, among adolescents. Moreover, maternal education, together with other factors such as dietary patterns and menstrual characteristics, has been shown to have a significant relationship with anemia among adolescent girls (Regasa & Haidar, 2019).

The research outcomes suggest a connection between socioeconomic status and the occurrence of anemia among adolescent girls. Economic conditions influence a family's ability to provide nutritious food, including animal protein sources of iron, such as meat, liver, and fish. Low economic status may also limit access to healthcare services (Sumarlan et al., 2018). These results correspond with Novelia et al. (2022), who indicated that family income is associated with anemia prevalence, as financial constraints can affect both the quality and quantity of nutritional intake in adolescents (Novelia et al., 2022).

CONCLUSIONS

The data suggest that anemia among adolescent girls is significantly correlated with several risk factors, including knowledge level, consumption of iron supplement tablets (TTD), nutritional status (BMI), menstrual pattern, maternal education, and socioeconomic status. Schools and primary health centers (puskesmas) should strengthen education on anemia

and adolescent nutrition, conduct routine health screening, and improve adherence to TTD intake by involving parental support, especially from mothers, to reduce anemia risk among adolescent girls. This study had several limitations. The cross-sectional design prevented the establishment of causal relationships. Self-reported data may have introduced a recall bias. Additionally, dietary intake was not quantitatively measured, which may limit the interpretation of nutritional status. Future research should incorporate longitudinal monitoring and dietary assessments.

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DETERMINAN ASSOCIATED WITH ANEMIA IN ADOLESCENT GIRLS: A SCHOOL-BASED CROSS-SECTIONAL STUDY

ABSTRACT

Anemia among adolescent girls remains a major public health concern in Indonesia, with a prevalence of 32% based on the 2018 Basic Health Research (Riskesdas). This highlights anemia as an ongoing issue that requires sustained attention. Adolescent girls are particularly vulnerable because iron needs increase during growth, while blood loss occurs regularly through menstruation. Inadequate intake of nutritious foods, poor adherence to iron supplementation (TTD), and limited knowledge and economic barriers may further contribute to the problem. This study aimed to identify factors associated with anemia among adolescent girls in a public vocational high school located in the Tebet area of Jakarta. An analytic observational study with a cross-sectional design was conducted in one SMKN in Tebet. All 221 female students in grade 11 were included through total sampling. Primary data were collected using a questionnaire on anemia-related risk factors. Qualitative information covered students' knowledge of anemia and their consumption of TTD. Associations were examined using the chi-square test with a significance level of $p < 0.005$. Factors significantly associated with anemia included students' knowledge, menstrual pattern, nutritional status, TTD consumption, maternal education, and socioeconomic status. The findings indicate the need for schools and primary health centers (puskesmas) to strengthen education on anemia and adolescent nutrition, implement routine screening (nutritional status and menstrual pattern), and improve adherence to TTD through regular mentoring that involves parents particularly mothers and targeted support for students from low-income households.

Keywords: anemia adolescent girls; cross-sectional study; iron supplement tablet.

INTRODUCTION

Anemia remains one of the largest public health problems worldwide, particularly among women of reproductive age and adolescent girls. Anemia is a condition in which the number of red blood cells or the hemoglobin level in the blood decreases, thereby reducing the blood's capacity to transport oxygen to body tissues (Hall & Guyton, 2016). It can also be defined as a decline in hemoglobin concentration or erythrocyte count below normal values according to age and sex, which ultimately disrupts oxygen delivery to tissues (Hoffbrand & Moss, 2016). According to the World Health Organization (WHO), the global prevalence of anemia ranges from 40% to 88%, while the prevalence among adolescent girls in developing countries is approximately 53.7% (World Health Organization, 2020). WHO has also reported that more than 1.62 billion people around 24.8% of the global population are affected by anemia, with the highest prevalence observed among preschool-aged children and adolescent girls. WHO classifies anemia as a public health problem when its prevalence exceeds 15% (World Health Organization, 2015). In Southeast Asia, anemia among adolescent girls remains high due to a combination of increased iron requirements during growth and regular blood loss through menstruation, compounded by unhealthy dietary behaviors such as frequent consumption of fast food and the habit of drinking tea or coffee, both of which can inhibit iron absorption (World Health Organization Regional Office for South-East Asia, 2022).

In Indonesia, anemia among adolescent girls remains a national health priority. According to the Indonesian Ministry of Health (Kemenkes RI) in 2021, the prevalence of iron-deficiency anemia among adolescent girls was 22.7%. The 2018 Basic Health Research (Riskesdas) reported that anemia prevalence reached 32% among adolescent girls, a marked increase from 18.4% in Riskesdas 2013. This upward trend suggests that, although the government has implemented prevention programs including the distribution of iron supplement tablets (TTD), hemoglobin (Hb) screening, and balanced nutrition education in schools the programs have not yet been fully effective (Ministry of Health of the Republic of Indonesia, 2018). Adherence to iron tablet consumption among adolescent girls remains low due to limited knowledge and education about anemia and supplementation, negative perceptions related to TTD side effects, and insufficient support from teachers and peers. These factors contribute to the persistence of anemia among adolescent girls (Ramdhani et al., 2025). In addition, socioeconomic conditions and family education, menstrual patterns, nutritional status, and restrictive dieting practices linked to body image concerns are also associated with the high prevalence of anemia in this population (Hasyim, 2018).

Although an iron supplementation program (TTD) has been implemented for adolescent girls, its

implementation has not been fully effective, as some adolescents continue to experience anemia (Dwi Pramardika, 2019). Anemia during adolescence can have long-term consequences, affecting physical health, cognitive development, academic performance, productivity, and future reproductive health (Siti Naila Sya'bani et al., 2025). This concern is consistent with the high prevalence reported in DKI Jakarta, reaching 48.3% (Jakarta Provincial Health Office, 2023). Therefore, a comprehensive evaluation of risk factors, behavioral determinants, socioeconomic conditions, and the effectiveness of program implementation is essential to improve interventions and reduce anemia among adolescent girls (Helmyati Siti et al., 2023).

Based on these issues, the research question of this study is: what risk factors are associated with anemia among adolescent girls in a public vocational high school (SMKN) in Tebet, Jakarta. This study aims to assess the risk factors that influence the occurrence of anemia among adolescent girls, including knowledge, nutritional intake, adherence to iron supplementation (TTD), and menstrual patterns.

METHODS

This study aims to identify factors associated with the causes of anemia among adolescent girls. An analytic observational design with a cross-sectional approach was employed, allowing an objective description of factors related to anemia at the time of data collection. The study was conducted on October 10, 2025, at a public vocational high school (SMKN) in the Tebet area, targeting all 11th-grade female students aged 15–18 years. Total sampling was applied; therefore, all 221 eligible 11th-grade students were included as respondents. In addition, one School Health Unit (UKS) teacher and three youth counselors from the Youth Red Cross (Palang Merah Remaja/PMR) were involved as supporting informants. Inclusion criteria comprised all students who were present and willing to complete the questionnaire, while students who were absent during the activity were excluded from the study.

Data were collected from two sources: primary and secondary data. Primary data were obtained through a questionnaire covering risk-factor variables, including level of knowledge, body mass index (BMI), maternal education, family income, menstrual pattern, and TTD consumption. Data collection was conducted directly at the school, where respondents completed the questionnaire via Google Forms on their own devices under the researcher's supervision. Data on anemia status among the adolescent girls were obtained through collaboration with the local primary health center (puskesmas), which had conducted anemia screening at the school.

The questionnaire was developed in an online format by adapting a previously validated instrument (Lestari Desy Indah Nur, 2018). It covered respondent identity, parental characteristics, menstrual history, TTD consumption, and knowledge about anemia. The Google Form was designed with a simple and user-friendly layout so that it could be completed easily on each student's mobile phone. The questionnaire link was then distributed through coordination with the School Health Unit (UKS) teacher and the school administration. Data were analyzed using the chi-square test to identify the most influential risk factors associated with anemia, and the results were used as a basis for designing anemia prevention interventions at the school.

RESULT

This study was successfully conducted with the support and collaboration of the local primary health center (puskesmas) and the school, enabling the research activities to be completed properly. The study began with anemia screening among adolescent girls at a public vocational high school (SMKN) in the Tebet area, assisted by the local puskesmas. This was followed by data collection on risk factors associated with anemia among the students. Interviews with a teacher and youth counselors indicated that the main reasons students did not take TTD were its unpleasant taste and side effects such as nausea, while only a small proportion understood the importance of TTD in preventing anemia. The following section presents the proportion of anemia cases and their associated risk factors.

Univariate Analysis

Table 1. Frequency Distribution of the Dependent Variable and Independent Variables

Variable	Frequency (n=221)	Percentage (%)
Incidence of anemia		
Anemia	67	30.3
Non anemic	154	69.7
Knowledge		
Good	59	26.7
Adequate	91	41.2
Poor	71	32.1
Iron Supplement Tablet (TTD) Consumption		
Yes	84	38.0
No	137	62.0
Nutritional Status		
Underweight	58	26.2
Normal	140	63.3
Obese	23	10.4
Menstrual Pattern		
Normal	103	46.6
Abnormal	118	53.4
Mother's Education		
Primary-Junior High School (SD-SMP)	75	33.9
Senior High School-Bachelor's Degree (SMA-SARJANA)	146	66.1
Sosioeconomic status		
Below the regional minimum wage (<UMR)	133	60.2
Equal to or above the regional minimum wage (≥ UMR)	88	39.8

Data source: Primer data

Based on the table above, the distribution of respondents by anemia status shows that 67 students (30.3%) were anemic and 154 students (69.7%) were not anemic. Regarding knowledge level, 59 students (26.7%) had good knowledge, 91 students (41.2%) had adequate knowledge, and 71 students (32.1%) had poor knowledge. For TTD (iron supplement tablet) consumption, 84 students (38.0%) reported not taking TTD, while 137 students (62.0%) reported taking TTD. In terms of nutritional status, 58 students (26.2%) were underweight, 140 students (63.3%) had normal nutritional status, and 23 students (10.4%) were obese. For menstrual patterns, 103 students (46.6%) reported normal menstruation, whereas 118 students (53.4%) reported irregular menstruation. Based on maternal education, 75 students (33.9%) had mothers with primary to junior high school education (SD–SMP), and 146 students (66.1%) had mothers with senior high school to bachelor's degree education (SMA–Bachelor). Finally, regarding socioeconomic status, 133 students (60.2%) came from households with income below the regional minimum wage (< IDR 5,396,761), while 88 students (39.8%) came from households with income equal to or above the regional minimum wage (≥ IDR 5,396,761).

Bivariate Analysis

Table 2. Bivariate Analysis of Risk Factors Associated with Anemia Among Adolescent Girls

Variable	Anemia	Non Anemic	P/Value
Knowledge			0.001
Good	33 (46.5%)	38 (53.5%)	
Adequate	(24.2%)	69 (75.8%)	
Poor	12 (20.3%)	47 (79.7%)	
Iron Supplement Tablet (TTD)			0.000
Consumption	56 (40.9%)	81 (59.1%)	
Yes	11 (13.1%)	71 (86.9%)	
No			
Nutritional Status			0.001
Underweight	13 (22.4%)	45 (77.6%)	
Normal	41 (29.3%)	99 (70.7%)	
Obese	13 (56.5%)	10 (43.5%)	
Menstrual Pattern			0.000
Normal	61 (51.7%)	57 (48.3%)	
Abnormal	6 (5.8%)	97 (94.2%)	
Mother's Education			0.002
Primary-Junior High School (SD-SMP)	35 (42.7%)	47 (57.3%)	
Senior High School-Bachelor's Degree (SMA-SARJANA)	32 (23.0%)	107 (77.0%)	
Sosioeconomic status			0.000
Below the regional minimum wage (<UMR)	56 (42.1%)	77 (57.9%)	
Equal to or above the regional minimum wage (≥ UMR)	11 (12.5%)	77 (87.5%)	

Data source: Primer data

The Chi-square test showed p = 0.001, indicating a significant association between knowledge level and anemia status. Among adolescents with poor knowledge, 33 students (46.5%) were anemic and 38 students (53.5%) were not anemic. Among those with adequate knowledge, 24 students (24.2%) were anemic and 69 students (75.8%) were not anemic. In contrast, among adolescents with good knowledge, only 12 students (20.3%) were anemic, while 47 students (79.7%) were not anemic.

For the TTD (iron supplement tablet) consumption variable, the Chi-square test yielded p = 0.000, indicating that TTD consumption is significantly associated with anemia status. Among adolescents who did not consume TTD, 56 students (40.9%) were anemic, while 81 students (59.1%) were not anemic. In contrast, among those who consumed TTD, only 11 students (13.1%) were anemic and 71 students (86.9%) were not anemic.

For nutritional status, the Chi-square test showed p = 0.001, indicating a significant association between nutritional status and anemia. Among underweight adolescents, 13 students (22.4%) were anemic and 45 students (77.6%) were not anemic. Among those with normal nutritional status, 41 students (29.3%) were anemic and 99 students (70.7%) were not anemic. In the obese group, 13 students (56.5%) were anemic, while 10 students (43.5%) were not anemic.

For the menstrual pattern variable, the Chi-square test produced p = 0.000, indicating a significant association between menstrual pattern and anemia status. Among adolescents with an abnormal menstrual pattern, 61 students (51.7%) were anemic and 57 students (48.3%) were not anemic. In contrast, among those with a normal menstrual pattern, only 6 students (5.8%) were anemic, while 97 students (94.2%) were

not anemic.

For maternal education, the Chi-square test showed p = 0.002, indicating that mother's education level is significantly associated with anemia. Among adolescents whose mothers had primary to junior high school education (SD–SMP), 35 students (42.7%) were anemic and 47 students (57.3%) were not anemic. In contrast, among those whose mothers had senior high school to bachelor's degree education (SMA–Bachelor), 32 students (23.0%) were anemic and 107 students (77.0%) were not anemic.

For socioeconomic status, the Chi-square test yielded p = 0.000, indicating a significant association between socioeconomic status and anemia incidence. Among adolescents from households with income below the regional minimum wage (UMR), 56 students (42.1%) were anemic and 77 students (57.9%) were not anemic. In contrast, in the group with income equal to or above the UMR, only 11 students (12.5%) were anemic, while 77 students (87.5%) were not anemic.

DISCUSSIONS

The findings of this study indicate an association between knowledge level and the occurrence of anemia among adolescent girls. Adolescents with good knowledge tend to have normal hemoglobin levels compared with those who have poor knowledge. This may be because knowledge plays an important role in shaping health behaviors, including awareness of the need to meet iron requirements and to take iron supplement tablets (TTD) regularly (Ghadam et al., 2023). Limited knowledge may also lead adolescents to misunderstand or be unaware of the symptoms, causes, and prevention of anemia (van Zutphen et al., 2021). These results are consistent with findings reported by Kalsum et al. (2024), showing that knowledge is closely related to anemia among adolescent girls, and that improving knowledge may help reduce anemia prevalence (Kalsum et al., 2025).

The results of this study show a significant association between TTD consumption and the occurrence of anemia among adolescent girls. For the prevention and treatment of anemia, iron supplementation delivered through school-based programs has been shown to be effective, feasible to implement, and relatively low-cost, and therefore can help reduce anemia among adolescent girls. Providing iron (Fe) tablets starting in adolescence is considered more appropriate because iron requirements are increasing during this period, and improvements in hemoglobin levels are often observed more quickly. In addition, supplementation in adolescent girls offers long-term benefits for reproductive health, making it more effective than initiating supplementation only during pregnancy (Yani et al., 2025). This study is consistent with the findings of Singh et al. (2020), who reported that Fe tablet consumption was significantly associated with a reduction in anemia among adolescent girls (Singh et al., 2020). Iron supplementation has also been linked to improved cognitive function in children and adolescents, particularly in attention, memory, and concentration. Evidence suggests that regular and consistent intake produces better outcomes than irregular use, as improvements in iron status occur more steadily. Overall, this supports the view that adherence to iron supplementation together with a nutritious diet is essential to maximize the cognitive benefits of iron (Alblewi, 2024).

The findings of this study indicate an association between nutritional status and the occurrence of anemia among adolescent girls. Nutritional status reflects the balance between dietary intake and the body's nutritional needs. An imbalance caused by inadequate nutrient intake can disrupt metabolism and the formation of essential blood components, including hemoglobin. In particular, deficiencies in protein and iron directly affect erythropoiesis (red blood cell production) in the bone marrow, leading to reduced hemoglobin levels and ultimately anemia (Rahmatina et al., 2025). These results are consistent with the study by Enggardany et al. (2021), which reported a significant relationship between nutritional status and hemoglobin levels in adolescent girls, where a lower body mass index (BMI) is associated with a higher risk of anemia (Enggardany et al., 2021). Poor nutritional status among adolescent girls often results from irregular eating patterns, restrictive dieting, or frequent consumption of fast food that is low in iron, combined with limited awareness of the importance of a balanced diet (Soans et al., 2025). During adolescence, the body requires higher amounts of nutrients such as iron, folate, vitamin B12, and protein to support growth and hemoglobin synthesis. These requirements increase further because adolescent girls

menstruate monthly; therefore, inadequate iron intake can easily lead to iron-deficiency anemia (Thomas et al., 2015).

The results of this study indicate an association between menstruation and the occurrence of anemia among adolescent girls. Menstruation occurs monthly and causes adolescent girls to lose a certain amount of blood and iron; therefore, higher iron intake is needed to replace these losses. When menstrual bleeding is heavier than normal, iron stores may decline more rapidly, increasing the risk of anemia (Söderman et al., 2025). This finding is consistent with the study by Sigit et al. (2024), which reported a significant relationship between the menstrual cycle and hemoglobin levels among adolescent girls (Sigit et al., 2024). In addition, multivariate analysis has shown that adolescents who have begun menstruating are 2.57 times more likely to experience iron deficiency than those who have not yet menstruated, reinforcing menstruation (blood loss) as an important risk factor for iron deficiency and anemia (Moschonis et al., 2013).

The findings of this study indicate an association between maternal education and the occurrence of anemia among adolescent girls. According to the Indonesian Ministry of Health (2019), maternal education is one of the key determinants of family health. Higher educational attainment may enable individuals to more easily access information, process it, and apply it in daily life (Ministry of Health of the Republic of Indonesia, 2019). Consistent with this, a study by Choi et al. (2011) also reported that maternal education is significantly associated with anemia among adolescent girls (Choi et al., 2011). Adolescent girls whose mothers had low educational levels or no schooling were 1.45 times more likely to experience anemia than those whose mothers were educated. Low maternal education has been identified as an important factor influencing the adequacy of nutritional intake, including iron, among adolescents. Moreover, maternal education together with other factors such as dietary patterns and menstrual characteristics has been shown to have a significant relationship with anemia among adolescent girls (Regasa & Haidar, 2019).

The findings of this study indicate an association between socioeconomic status and the occurrence of anemia among adolescent girls. Economic conditions influence a family's ability to provide nutritious foods, including animal-protein sources of iron such as meat, liver, and fish. Low economic status may also limit access to healthcare services (Sumarlan et al., 2018). These results are consistent with Novelia et al. (2022), who reported that family income is associated with anemia prevalence, as financial constraints can affect both the quality and quantity of adolescents nutritional intake (Novelia et al., 2022).

CONCLUSSIONS

The findings show that anemia among adolescent girls is significantly associated with several risk factors, namely knowledge level, consumption of iron supplement tablets (TTD), nutritional status (BMI), menstrual pattern, maternal education, and socioeconomic status. Schools and primary health centers (puskesmas) should strengthen education on anemia and adolescent nutrition, conduct routine health screening, and improve adherence to TTD intake by involving parental support especially from mothers so that anemia risk among adolescent girls can be reduced.

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