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Exploration of Knowledge and Behaviors of Adolescent Girls Regarding Iron-Deficiency Anemia Using a Sequential Explanatory Mixed-Method Approach: A Study at Pasundan 1 Senior High School, Bandung City

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KEYWORDS

Iron-Deficiency Anemia, Knowledge, Behavior, Adolescent Girls.

ABSTRACT:

Introduction: Iron-deficiency anemia (IDA) is a major nutritional problem commonly experienced by adolescent girls due to increased iron requirements during menstruation and unbalanced dietary patterns. This condition affects health, academic performance, and productivity. The prevention of IDA strongly depends on adolescents' knowledge and behaviors in maintaining adequate iron intake and adhering to iron supplementation (TTD) consumption. This study aims to describe the level of knowledge and behaviors of adolescent girls at Pasundan 1 Senior High School in Bandung regarding IDA.

Methods: This study employed a mixed-method approach with a Sequential Explanatory design. The quantitative phase was conducted through a survey using a questionnaire administered to 74 female students in grades X and XI selected through simple random sampling. The measured variables included levels of knowledge and behaviors related to iron-deficiency anemia (IDA). The qualitative phase involved in-depth interviews with teachers to explore their perceptions of anemia incidence and prevention efforts in the school. Quantitative data were analyzed using univariate analysis, while qualitative data were processed through data reduction, presentation, and conclusion drawing.

Results: Most students had a high level of knowledge (97.3%) and demonstrated good preventive behaviors toward anemia (86.5%). The interviews revealed that symptoms of anemia, such as dizziness and fatigue, were still commonly observed, and highlighted the important roles of schools and healthcare workers in providing iron supplementation (TTD) and health education.

Conclusions: The high level of knowledge suggests that information accessed through social media, schools, and healthcare providers contributes positively to students' understanding of IDA. However, inappropriate behaviors such as consuming tea/coffee (which inhibit iron absorption) were still identified. Continuous nutritional education, monitoring of iron supplementation, and cross-sector collaboration are needed to reduce the prevalence of anemia among adolescent girls.

1. Introduction

Anemia affects one-third of the global population and contributes to increased morbidity and mortality, reduced work productivity, and impaired neurological development (Engle-Stone et al., 2017). Indonesia faces a triple burden of malnutrition, namely undernutrition, overnutrition, and micronutrient deficiencies occurring simultaneously (Andriani et al., 2023; Togatorop, 2023). A lack of information regarding the etiology of anemia has hindered the design and monitoring of effective anemia control strategies. The World Health Organization (WHO) states that more than 30% of the world's population suffers from anemia. According to WHO, anemia in adolescents is defined as hemoglobin levels below 12 g/dL for females and below 13 g/dL for males (Hasyim et al., 2018).

Iron-deficiency anemia (IDA) has a prevalence of 4.3–20% in developed countries and 30–48% in developing countries. In Indonesia, IDA remains an unresolved nutritional problem among pregnant women and adolescents (Safitri et al., 2024). Micronutrient deficiencies commonly found in Indonesia include anemia, which results from inadequate iron (Fe) intake. Iron plays an essential role in hemoglobin synthesis and

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oxygen transport throughout the body (Dapur Umami, 2023). This condition is most common among adolescent girls, with an estimated one in four experiencing anemia (Meisara, 2021).

Anemia among adolescent girls is a global health concern, with a prevalence of 29.9% among individuals aged 15–19 years. This issue negatively affects their health, education, and productivity (WHO, 2024). The prevalence is higher among females than males due to iron loss during menstruation, which increases iron requirements. According to the 2018 Basic Health Research (Riskesdas), 32% of Indonesian adolescents suffer from anemia—equivalent to 3–4 out of every 10 adolescents (Boli et al., 2022). Meanwhile, the 2023 Indonesian Health Survey (SKI) reported that the prevalence of anemia among girls aged 12–18 years reached 33.5% (World Health Organization, 2011). In West Java Province, the prevalence of anemia among adolescent girls in 2021 reached 68.3%. The coverage of iron supplementation (TTD) in the province was only 25.2%, far below the national target of 52%.

Management of anemia in adolescents prioritizes addressing iron deficiency through appropriate supplementation strategies supported by collaboration between the health, education, and community sectors to ensure effective prevention and treatment (Andini & Agestika, 2022). However, the implementation of iron supplementation programs has not yet reached optimal coverage. Data show that only 21% of supplementation programs are carried out according to standards, and merely 5% of adolescent girls consistently consume TTD. To increase the effectiveness of these programs, improvements in management, quality of implementation, and intensified health education activities are required.

Low perceived susceptibility among adolescent girls regarding anemia—despite risks from menstruation, inadequate iron intake, or unhealthy lifestyles—reduces their motivation for prevention. IDA that persists into adulthood, particularly during pregnancy, increases the risk of adverse outcomes such as preterm birth and low birth weight (LBW) (Handayani et al., 2024). Therefore, adolescent girls are recommended to consume iron supplements before becoming pregnant to prevent these risks. This government program supports anemia prevention by increasing iron stores when consumed correctly and contributes to improved health, growth, and development. In Indonesia, TTD is provided to all girls aged 12–18 years (Kemenkes RI, 2020), containing 60 mg elemental iron and 0.4 mg folic acid, consumed once weekly throughout the year in schools (Silitonga et al., 2024).

Low perceived severity—defined as beliefs about the seriousness of anemia's impacts physically, psychologically, and socially—remains an issue. Many adolescent girls fail to recognize that anemia can lead to fatigue, poor concentration, reduced academic performance, and pregnancy-related risks. Adolescents often skip breakfast and consume inadequate fruits, vegetables, and milk, leading to insufficient micronutrients such as iron, calcium, zinc, folate, and vitamins A, D, and C. Deficiencies in iron, folate, and vitamin B12 contribute to nutritional anemia among adolescents (Ocktariyana et al., 2024). Popular beverages such as tea, coffee, chocolate, and milk contain tannins and calcium, which inhibit iron absorption, while consumption of vitamin C–rich fruits and vegetables that enhance absorption is often inadequate (Linasari et al., 2024; Putri, 2025). These habits, along with dieting behaviors driven by body-image concerns, further increase anemia risk (Fajriyah & Fitriyanto, 2016).

During adolescence, iron requirements rise due to increased muscle mass, blood volume expansion, higher hemoglobin concentration, and enzymatic activity (Cohen & Powers, 2024). Adolescents require approximately 26 mg of iron per day due to rapid growth. IDA commonly occurs among adolescent girls due to significant iron loss during menstruation. Contributing factors include heavy menstrual bleeding, nutritional deficiencies (iron, folate, and protein), leukemia, and chronic diseases (Djannah & Wisudawati, 2023).

Adolescence is characterized by significant changes, including lifestyle adaptation and dietary behavior shifts. Advances in technology and modern trends influence adolescents through widespread information exposure, sometimes resulting in inadequate nutritional awareness. This may lead to insufficient iron intake and anemia (Caturiyantiningtiyas et al., 2015), which negatively affects students by impairing academic performance and intellectual capacity (Jain & Chandra, 2012). Anemia related to malnutrition in adolescent girls is also caused by limited knowledge and awareness of nutrition.

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Ineffective communication and information-sharing among parents further complicate efforts to improve dietary practices and health behaviors essential for anemia prevention (Iskandar, 2009).

Inadequate healthy behaviors—such as avoiding vegetables, striving for a slim body shape, following disproportionate diets, and mismatched nutrient intake with activity levels—increase anemia susceptibility. Health-supportive behaviors are influenced by understanding, motivation, and practical skills, which can be shaped through health education programs. Behavioral adjustment serves as a strategic foundation to promote healthier habits among adolescent girls (Rahmawati, 2018).

A study by Dea Pratiwi et al. (2023) at SMA Negeri 1 Rejang Lebong involving 30 adolescents aged 15–19 years showed that 63.33% had good knowledge, 53.33% had positive attitudes, but 53.33% displayed poor practices, indicating a gap between knowledge, attitudes, and behavior (Pratiwi & Sunarti, 2023). Another study by Nurmalitasari Ansika et al. (2021) at Prambontergayang Health Center involving 188 adolescent girls found that although 87.8% had good knowledge about anemia, 78.7% did not practice anemia-prevention behaviors (Nurmalitasari et al., 2022).

Specific interventions such as health education and iron supplementation programs are designed to prevent and manage anemia. However, their effectiveness depends heavily on adolescents' knowledge and health behaviors. Currently, in Bandung City—including at Pasundan 1 Senior High School—studies examining the knowledge and behaviors of adolescent girls related to iron-deficiency anemia remain limited.

Therefore, this study aims to explore adolescents' knowledge and behaviors related to anemia in the school environment, supporting the institutional excellence of the Faculty of Medicine, Universitas Pasundan, through its Public Health Empowerment Program, which seeks to empower school communities (teachers and students) in sustainable nutrition awareness and anemia prevention. This study reinforces the role of the Faculty of Medicine in community empowerment and serves as a foundation for developing sustainable health programs to foster adolescent self-reliance in maintaining their health. Ultimately, this research contributes to strengthening school-level health empowerment and provides benefits to the broader Pasundan community, particularly at SMA 1 Pasundan.

2. Methods

Research Design

This study employed a mixed-method approach using a Sequential Explanatory design. The quantitative phase was conducted first to assess the knowledge and behaviors of adolescent girls regarding iron-deficiency anemia. This was followed by a qualitative phase involving interviews with teachers to obtain deeper insights into anemia-related issues and school-based prevention efforts. The study used a cross-sectional approach, with data collected at a single point in time.

Population, Subjects, and Research Objects

1. Research Population

   Target Population: All female students at Pasundan 1 Senior High School, Bandung, in 2025.

   Accessible Population: Female students enrolled in Grades X and XI across 11 classes. Grade XII students were excluded due to a structured curriculum and examination preparation, which limited research access.

2. Research Sample

   All Grade X and XI students meeting the inclusion and exclusion criteria were considered eligible for sampling.

   a. Sampling Technique

      A probability sampling method with simple random sampling was used. Each eligible student had an equal chance of being selected.

   b. Sample Size

      Sample size was calculated using a proportion estimation formula:

$$n = \frac{Z^2 P(1-P)}{d^2}$$

   Where:

   - Z=1.96Z = 1.96Z=1.96 (95% confidence level)
   - P=0.335P = 0.335P=0.335 (prevalence of anemia among Indonesian adolescents)

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- d=0.10d = 0.10d=0.10 (precision)

The initial calculation yielded 89 participants. Using the finite population correction for 418 eligible students in Grades X and XI, the final required sample size was 74 respondents.

3. Inclusion and Exclusion Criteria

a. Inclusion Criteria

Quantitative Phase:

1) Female students in Grades X and XI.
2) Aged ≥ 15 years.
3) Have experienced menarche.
4) Willing to complete the questionnaire.

Qualitative Phase:

1) Teachers from Grades X or XI willing to participate in interviews.
2) Employed at the school for at least one year.
3) Able to articulate information clearly.
4) Have experience in school health programs (e.g., iron supplementation, health education).

b. Exclusion Criteria

Quantitative Phase:

1) Absent during data collection.
2) Diagnosed with anemia.
3) History of significant blood loss unrelated to menstruation within the last three months.
4) Incomplete or invalid questionnaire responses.

Qualitative Phase:

Teachers without relevant knowledge or involvement in anemia-related activities.

Research Instruments

This study employed questionnaires adapted from Dea Pratiwi (knowledge questionnaire) and Nurmalitasari Ansika (behavior questionnaire). Knowledge items were scored using 1 for correct answers and 0 for incorrect answers, while behavior items used a Likert scale. These instruments had previously undergone validity and reliability testing in earlier studies on iron-deficiency anemia among adolescent girls.

Research Location and Time

The study was conducted at Pasundan 1 Senior High School, located on Jalan Balonggede No. 28, Regol District, Bandung City, West Java. Data collection took place in August 2025.

Data Collection

Primary data were collected through Google Forms completed by Grade X and XI students who met the inclusion criteria. Additional information on anemia prevention was obtained through interviews with teachers.

Data collection methods included:

1. Questionnaire – Used to obtain quantitative data on students' knowledge and behaviors related to iron-deficiency anemia.
2. In-depth Interview – Structured interviews with teachers to explore perceptions of anemia and school-based health activities.

Data Processing and Analysis

1. Data Processing

Collected data were processed through the following steps:

a. Editing – Checking completeness and accuracy; incomplete responses were excluded.
b. Coding and Transformation – Converting responses into numerical data.
c. Data Entry – Inputting coded data into the database.
d. Cleaning – Identifying and correcting errors or inconsistencies.
e. Tabulation – Presenting data in tables for analysis.

2. Data Analysis

a. Quantitative Analysis

Univariate analysis was conducted to describe respondent characteristics using frequencies

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and percentages. Statistical analysis was performed using SPSS.

b. Qualitative Analysis

Data were analyzed through:

1) Reduction – Selecting and simplifying relevant information.
2) Presentation – Organizing data into clear descriptions.
3) Conclusion Drawing – Interpreting findings based on participants' perspectives.

3. Results

Descriptive Quantitative Results

This study involved 74 female students from Pasundan 1 Senior High School. Respondent characteristics included age, grade level, age at menarche, menstrual cycle regularity, prior exposure to anemia information, and sources of information.

Most respondents were middle adolescents aged 14–16 years (89.2%) and were predominantly Grade X students (55.4%). The majority experienced menarche at 11–12 years (66.2%) and reported having a regular menstrual cycle (67.6%). Most students had previously received information about anemia (83.3%), primarily from social media or the internet (32.4%) and healthcare workers (31.1%).

Knowledge Level of Adolescent Girls on Iron-Deficiency Anemia

Knowledge was assessed using 20 questions, and scores were categorized into high and low levels. The distribution of knowledge levels is presented in Table 1.

Table 1. Distribution of Knowledge Levels

Knowledge Level	Frequency (n)	Percentage (%)
High	72	97,3%
Low	2	2,7%
Total	74	100,0%

Source: Primary Research Data, 2025

Most respondents demonstrated a high level of knowledge (72 students; 97.3%), while only 2 students (2.7%) were categorized as having low knowledge.

Behavior Level of Adolescent Girls Regarding Iron-Deficiency Anemia

Behavior was assessed using 10 questions and categorized into good and poor behavior. The distribution is shown in Table 2.

Table 2. Distribution of Behavior Levels

Behavior Level	Frequency (n)	Percentage (%)
Good	64	86,5%
Bad	10	13,5%
Total	74	100,0%

Source: Primary Research Data, 2025

Most respondents demonstrated good behavior (64 students; 86.5%), while 10 students (13.5%) were categorized as having poor behavior.

Qualitative Findings: Teachers' Perceptions of Iron-Deficiency Anemia

Interviews with teachers revealed that symptoms of anemia—such as dizziness when standing and the common "5L" signs (lemah, letih, lesu, lunglai, lalai)—are frequently observed among students. These symptoms often manifest as lack of focus in class and frequent visits to the school health unit (UKS), which teachers noted negatively affects learning concentration and participation.

To address this issue, the school collaborates with the Pasundan Health Center through periodic iron supplementation (TTD) distributed every six months via the Youth Red Cross (PMR). Health information is also disseminated to students and parents through communication channels such as WhatsApp groups. A biology teacher explained:

"Education about anemia is integrated into classroom lessons." (Teacher A)

Teachers agreed that:

"The role of teachers is crucial in supporting anemia prevention efforts through information delivery, facilitating TTD distribution, and collaborating with health workers, as student health greatly influences learning effectiveness." (Teachers A & I)

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Discussion

Knowledge Level of Adolescent Girls on Iron-Deficiency Anemia

The analysis of the questionnaire showed that out of 74 respondents, the majority—72 individuals (97.3%)—had a high level of knowledge, while only 2 individuals (2.7%) were categorized as having a low level of knowledge. This indicates that most adolescents in this study possess adequate understanding of iron deficiency anemia, including its causes, symptoms, and preventive measures. These findings are consistent with the study by Dea Pratiwi et al. (2023), which reported that among 30 respondents, 19 students (63.33%) had high knowledge, whereas 11 students (36.66%) had low knowledge.

However, these results differ from a previous study conducted in Jatinangor District by Sari et al. (2019), which reported a higher proportion of low knowledge levels. In that study, the level of understanding among adolescents regarding anemia and its prevention showed that 48 respondents had low knowledge, 19 respondents had moderate knowledge, and only 2 respondents demonstrated good knowledge (P. Sari et al., 2019).

The high level of knowledge among adolescent girls (97.3%) in this study may be attributed to their strong curiosity, which enables them to seek additional information that reinforces their understanding. Moreover, adolescent girls today have greater ability to independently access information through mass media using their mobile phones. Higher knowledge encourages adolescents to choose iron-rich foods to support their health.

Many of the respondents had previously received information about anemia, with the majority obtaining such information from the internet or social media (32.4%), followed by health workers (31.1%). These findings align with the study by Sarwo et al., which reported that most adolescent girls gained knowledge about iron deficiency anemia from electronic media (62.7%). This is due to the ease with which the public can absorb information through electronic media, where access to up-to-date information is fast, and devices such as mobile phones are highly portable and can be carried anywhere, making information more accessible, especially for the younger generation (Prayogi et al., 2023).

Behavior of Adolescent Girls Toward Iron-Deficiency Anemia

Based on the questionnaire results, out of 74 respondents, 64 respondents (86.5%) exhibited good behavior, while 10 respondents (13.5%) fell into the poor behavior category. This finding is consistent with the study conducted by Sari et al., which reported that among 17 respondents, 16 individuals (94%) demonstrated good behavior, whereas only 1 subject (6%) exhibited poor behavior (N. M. W. R. Sari, 2022).

In the health field, behavior serves as a response that influences physical conditions, experienced illnesses, types of health services utilized, and consumption patterns within the social environment. The majority of respondents (86.5%) showed good behavior toward iron deficiency anemia because they agreed that the risk of anemia increases during menstruation and that consuming iron supplements (TTD) once per week can prevent anemia, while 13.5% demonstrated poor behavior (N. M. W. R. Sari, 2022). These findings align with the study by Puspitasari et al., which reported that anemia-preventive behavior among adolescent girls is significantly influenced by knowledge, attitudes, and intentions based on the Theory of Planned Behavior, indicating that the better the knowledge, the better the behavior (Puspitasari et al., 2022).

Research conducted by Hidayati et al. showed that most adolescent girls demonstrated good behavior in preventing anemia after receiving nutrition education, as evidenced by a significant increase in the routine consumption of iron tablets and the selection of iron-rich foods (Setyaningrum et al., 2023). Similar findings were reported by Sarwo et al., who identified a significant relationship between knowledge levels and behaviors related to iron tablet consumption with the incidence of anemia among adolescent girls in Bantul, where respondents with good behavior were less likely to experience anemia.

Furthermore, a study by Prasetya et al. emphasized that although knowledge is an important factor, support from the school environment and family also plays a crucial role in shaping healthy behaviors among adolescent girls for the prevention of iron deficiency anemia. Therefore, educational interventions should be carried out comprehensively by involving various stakeholders (Prasetya et al., 2021).

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Teacher Perceptions of Iron-Deficiency Anemia

Overall, the findings of this study indicate that most adolescent girls at SMA 1 Pasundan Bandung have good levels of knowledge and behavior related to the prevention of iron deficiency anemia. Quantitative analysis showed that 97.3% of respondents had a high level of knowledge and 86.5% demonstrated good behavior. These findings suggest that the majority of adolescent girls understand the basic concepts of iron deficiency anemia, including its causes, symptoms, and preventive measures such as consuming iron-rich foods and taking iron supplements. The high levels of knowledge and behavior are supported by easy access to information through social media and the internet (32.4%), as well as the role of health workers (31.1%) as sources of education. These results align with the Health Belief Model, which explains that adequate knowledge increases perceived benefits and encourages individuals to adopt healthy behaviors (Andani et al., 2021).

The qualitative findings provide a deeper understanding of the real conditions in the field. Interviews with teachers revealed that several students still experience symptoms of anemia such as dizziness, weakness, fatigue, lethargy, and decreased alertness (the "5Ls"). Teachers also mentioned that some students appear less focused during learning activities and frequently visit the school clinic due to complaints of fatigue. Based on interviews with teachers at SMA 1 Pasundan, it was stated that:

"There are students experiencing anemia symptoms who often complain of dizziness when standing and show the classic 5L symptoms—weakness, fatigue, lethargy, sluggishness, and lack of alertness. These symptoms are quite commonly found in the school environment, seen from students who appear unfocused during lessons and frequently visit the school clinic." (Teacher A&I)

This indicates that although knowledge and behavior related to anemia prevention are relatively good, the actual implementation of healthy behaviors in daily life is not yet optimal. This statement is consistent with the findings of More et al., which showed that iron deficiency anemia among adolescent girls can lead to decreased concentration ability (More et al., 2013).

The interviews also revealed that social support and supervision from the school play an important role in increasing students' adherence to iron supplement consumption. As a preventive measure against anemia, the school collaborates with the UPT Puskesmas Pasundan in implementing a routine iron supplementation program. Interviews with teachers revealed that:

"Social support such as supervision from teachers and educational integration within learning activities greatly helps improve adherence to iron supplement consumption." (Teacher A&I)

These findings reinforce the quantitative results showing positive behaviors among adolescents in preventing anemia and are consistent with the study by Tabita et al., which reported that adherence to iron supplement consumption increased significantly when supervision and social support were present (Silitonga et al., 2023). Furthermore, research by Madanijah et al. confirmed that knowledge, motivation, and the role of teachers significantly influence adolescents' adherence to consuming iron supplements (Madanijah et al., 2020).

The results of this study indicate that a high level of knowledge contributes to increasing perceived benefits related to iron supplement consumption, thereby encouraging more positive behaviors in preventing anemia. Social support from teachers and the school functions as cues to action that motivate students to adopt healthy behaviors and maintain adherence to iron supplementation. In addition, collaboration between schools and healthcare workers strengthens students' self-efficacy in independently and consistently practicing anemia prevention behaviors. Thus, the active roles of schools, teachers, and healthcare professionals are key factors in creating an environment conducive to promoting healthy behaviors and ensuring the success of anemia prevention programs among adolescent girls.

The qualitative and quantitative findings in this study complement each other. Quantitatively, the high levels of knowledge and behavior demonstrate the success of educational efforts and information dissemination regarding anemia. Qualitatively, it was found that environmental factors, teacher support, and real-life behavioral implementation still require strengthening. Although the quantitative results show favorable indicators, consistency in behavior and practical application still need improvement.

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Therefore, the integrated findings of this study show that high knowledge does not always directly translate into optimal preventive behavior regarding iron deficiency anemia. External factors such as teacher involvement, social support, and multisectoral collaboration with healthcare workers contribute significantly to the effectiveness of prevention efforts. Hence, anemia prevention among adolescent girls must be carried out through a comprehensive and continuous approach, including ongoing nutrition education, supervision of iron supplement intake, and active collaboration between schools, health centers, and families. This approach is expected to strengthen positive behavioral changes among adolescent girls and reduce the prevalence of iron deficiency anemia in the school environment.

Limitations of the Study

A key limitation of this study is the restricted timeframe for data collection, which prevented the researcher from conducting in-depth interviews with the primary respondents—the students. As a result, qualitative data were gathered only from teachers, whose perspectives, while valuable, do not fully represent the students' personal experiences, daily habits, or subjective perceptions related to iron-deficiency anemia. This limitation reduces the interpretive validity of the qualitative findings, as they rely on external observations rather than direct accounts from the adolescents. Additionally, academic schedules limited the opportunity to engage students in more comprehensive interviews.

4. Conclusion

The study found that most adolescent girls at SMA 1 Pasundan Bandung demonstrated a high level of knowledge regarding iron-deficiency anemia, with 72 students (97.3%) categorized as having strong understanding. In addition, the majority also exhibited good preventive behaviors, as shown by 64 students (86.5%) who practiced positive actions related to anemia prevention.

Recommendations

Future researchers are encouraged to expand the scope of the study by including additional variables such as hemoglobin measurement and by involving students and families as qualitative informants to obtain a more comprehensive understanding of the factors influencing anemia.

For educational institutions, these findings may serve as reference material for experiential learning programs focused on school-based adolescent health, including collaborations with local health centers to provide health education.

Students are advised to maintain balanced nutrition, regularly consume iron supplements (TTD), avoid habits that inhibit iron absorption such as drinking tea or coffee, and seek reliable health information through verified social media channels managed by healthcare professionals.

For the school, strengthening coordination with the local health center is recommended to enhance anemia prevention programs through routine TTD distribution, compliance monitoring, continuous health education, and regular hemoglobin screenings. Active involvement of teachers and the UKS/PMR team is essential to support sustainable improvements in students' health and academic performance.

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