IMPROVING ADOLESCENT ANEMIA LITERACY THROUGH EDUCATION AND SCHOOL SCREENING

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ABSTRACT

Iron deficiency anemia remains a significant public health problem among adolescents in Indonesia, with evidence suggesting a persistent and increasing prevalence. Adolescent girls are particularly vulnerable due to increased iron requirements during rapid growth and menstrual blood loss, which may negatively affect cognitive performance, physical capacity, and future reproductive health. School-based interventions are therefore essential to strengthen early detection and prevention efforts. This community-based program aimed to promote adolescent health through hemoglobin (Hb) screening, nutritional status assessment, education on anemia and balanced nutrition, and the provision and monitoring of iron–folic acid supplementation. The activity was conducted in October 2025 at SMA Negeri 1 Imogiri, Bantul, involving 146 eleventh-grade students. A pre–post educational intervention design was applied. Data collection included Hb measurement using a portable Hb meter, anthropometric assessment (weight, height, body mass index, and arm circumfence), and a structured knowledge questionnaire. Knowledge levels increased from 62% before the intervention to 98% after the educational session, with a participant satisfaction rate of 97.3%. Several students were identified with low Hb levels and received follow-up support. This integrated, school-based approach demonstrates potential to improve health literacy and strengthen anemia prevention among adolescents.

Keywords: adolescent anemia, health education, hemoglobin screening, iron supplementation, community service.

ABSTRAK

Anemia defisiensi besi masih menjadi permasalahan kesehatan masyarakat pada remaja di Indonesia, dengan prevalensi yang menunjukkan tren peningkatan. Remaja putri merupakan kelompok yang rentan akibat peningkatan kebutuhan zat besi pada masa pertumbuhan dan kehilangan darah saat menstruasi. Kegiatan pengabdian kepada masyarakat ini bertujuan melakukan pembinaan komunitas berbasis sekolah melalui skrining kadar hemoglobin (Hb), pengukuran status gizi, edukasi anemia dan gizi seimbang, serta pemberian dan monitoring Tablet Tambah Darah (TTD). Kegiatan dilaksanakan pada Oktober 2025 di SMA Negeri 1 Imogiri Bantul dengan sasaran siswa kelas XI. Metode yang digunakan adalah pendekatan pre–post intervensi edukasi. Instrumen meliputi pemeriksaan Hb menggunakan Hb meter, pengukuran antropometri (berat badan, tinggi badan, indeks massa tubuh (IMT), dan lingkar lengan atas(LILA)), serta kuesioner pre-post-test pengetahuan. Sebanyak 146 siswa mengikuti kegiatan. Hasil menunjukkan peningkatan pengetahuan siswa dari 62% sebelum edukasi menjadi 98% setelah edukasi. Tingkat kepuasan peserta mencapai 97.3%. Sebagian remaja putri teridentifikasi memiliki kadar Hb di bawah normal dan mendapatkan pendampingan lanjutan. Program ini menunjukkan bahwa pendekatan edukatif terstruktur dan kolaboratif dengan sekolah serta puskesmas berpotensi meningkatkan literasi kesehatan dan kesadaran pencegahan anemia pada remaja.

Kata kunci: *anemia remaja, edukasi kesehatan, skrining hemoglobin, tablet tambah darah, pengabdian masyarakat.*

INTRODUCTION

Anemia remains a significant global public health problem, particularly in developing countries. The World Health Organization (WHO) reports that approximately 30% of the world's population suffers from anemia, with adolescent girls and women of childbearing age being the most vulnerable.[1] At the age of 15–19, the prevalence of anemia in various developing countries is reported to exceed 20%, and most cases are related to iron deficiency.[2] Iron deficiency anemia occurs when iron requirements are not balanced with intake and body reserves. During adolescence, iron requirements increase due to rapid growth. In adolescent girls, these requirements are even higher due to blood loss during menstruation.[3] A less varied diet, low in iron sources, and a habit of consuming fast food contribute to worsening this condition. The impact of anemia on adolescents cannot be underestimated. This condition is associated with decreased concentration and endurance, reduced learning capacity, and decreased productivity. In the long term, anemia in adolescent girls also risks reproductive health and increases the risk of future pregnancy complications.[4]

In Indonesia, anemia remains a problem that requires serious attention. The 2018 Basic Health Research (Riskesdas) data shows that the prevalence of anemia in the 15–24 age group reached 18.4%, with an increasing trend compared to previous surveys.[5] The government has implemented a program to distribute iron supplements (IBF) as a national strategy for anemia prevention. However, data from the 2023 Indonesian

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Health Survey (SKI) indicates that coverage and compliance with iron supplements among adolescent girls are not optimal. Some adolescents do not consume iron supplements regularly because they do not receive the tablets regularly or do not understand their benefits.[6] In the Special Region of Yogyakarta Province, iron supplement distribution coverage is relatively higher than the national average. However, distribution does not fully guarantee compliance. This demonstrates the need for a more comprehensive and sustainable educational approach.[7] Bantul Regency, as a region in the Special Region of Yogyakarta, also continues to face challenges related to adolescent nutritional status. Nutritional issues, both deficient and overweight, demonstrate the continued need for promotive and preventive interventions.[8] Therefore, efforts to prevent anemia and improve nutritional status need to be systematically implemented through a school-based approach.[9] The combination of hemoglobin screening, nutritional status measurement, balanced nutrition education, and monitoring iron tablet consumption is expected to increase adolescent knowledge, awareness, and healthy behaviors.[10,11] Based on this background, this Community Service Program is designed as a model for school-based community development to prevent anemia and nutritional problems among adolescents in Imogiri, Bantul.

METHODS

This community service activity used a pre-test and post-test educational intervention design to assess the program's effectiveness in improving adolescent knowledge and awareness regarding anemia. The activity was conducted in October 2025 at SMA Negeri 1 Imogiri, Bantul Regency, Yogyakarta Special Region. The target population comprised all eleventh-grade students who were willing to participate in the complete series of activities. The implementation phase began with coordination meetings with the school and the Imogiri 1 Community Health Center to establish a schedule and technical mechanisms for the activity. Subsequently, a health screening was conducted, including hemoglobin (Hb) measurement using an Hb meter and nutritional status assessment using body mass index (BMI), and mid-upper arm circumference (MUAC). The screening results were used to initially identify anemia and determine the nutritional status of participants. Prior to data collection, the research protocol was reviewed and granted ethical clearance (Approval No. 1780/C.16/FK/2025) by the Health Research Ethics Committee at the Faculty of Medicine, Universitas Kristen Duta Wacana Yogyakarta. Participation was voluntary, and verbal informed consent was obtained from all participants and their guardians prior to the screening and educational session.

The main intervention consisted of education on anemia in adolescents and the principles of balanced nutrition. Material was delivered through interactive lectures, discussions, and visual media tailored to the characteristics of adolescents. To assess knowledge gains, participants completed a pre-test questionnaire before the educational session and a post-test questionnaire upon its completion. Participants' knowledge of anemia was evaluated using a structured questionnaire developed based on the main topics delivered during the program. The questionnaire consisted of ten multiple-choice items covering the definition of anemia, signs and symptoms, risk factors, possible health consequences, prevention strategies such as balanced nutrition and the importance of iron supplementation. The same questionnaire was administered for both the pre-test and post-test to enable direct comparison of knowledge before and after the intervention. Each correct response was assigned a score of 1, with incorrect responses scored as 0, yielding a total possible score ranging from 0 to 10. Raw scores were subsequently converted to percentages, with ≥75% classified as good knowledge and <75% classified as insufficient knowledge.

The data obtained were analyzed descriptively to describe the distribution of Hb levels and nutritional status among participants. Changes in knowledge were assessed by comparing pre-test and post-test scores expressed as percentages. The findings were used to evaluate the effectiveness of the educational intervention within this community service activity.

Program satisfaction was evaluated at the end of the session using a structured seven-item questionnaire administered to all participants. Items were rated on a five-point Likert scale ranging from 1 (*strongly dissatisfied*) to 5 (*strongly satisfied*), covering the clarity of educational delivery, relevance of the material to daily life, engagement of the interactive format, usefulness of the health screening, quality of facilitator interaction, perceived self-efficacy in anemia prevention, and overall program satisfaction. A mean item score of ≥ 4 was defined as indicative of high satisfaction, while a score below this threshold was classified as low satisfaction. The proportion of participants reporting high satisfaction was subsequently calculated and reported as a percentage.

RESULTS AND DISCUSSION

Participant Characteristics

A total of 146 students participated in this community service program, comprising 86 females (58.9%) and 60 males (41.1%). The majority of participants were 16 years old (56.2%), followed by those aged 15 years (26.0%) and 17 years (17.8%). The complete baseline characteristics of participants are presented in **Table 1**. The age distribution of participants reflects a strategically important demographic for promotive-preventive interventions. Adolescents aged 16 years represented most participants (56.2%), a period coinciding with peak pubertal development and heightened nutritional vulnerability. This age group is particularly amenable to health

education, as health-related knowledge acquired during adolescence tends to shape long-term dietary and preventive behaviors. The detection of anemia in 26.7% of participants further underscores the relevance of school-based screening as a mechanism for early identification of at-risk individuals. Given that many adolescents with iron deficiency remain asymptomatic or attribute their symptoms to fatigue from academic demands, school screening offers a practical and accessible entry point for detection that would otherwise be missed in routine healthcare settings.

The results of this program are consistent with recent evidence on school-based anemia prevention strategies, emphasizing the importance of integrating promotive and preventive approaches among adolescents. The significant increase in mean knowledge scores following the educational intervention demonstrates that structured health education can effectively improve adolescent health literacy. These findings align with a school-based study demonstrating that anemia education significantly improved both knowledge and dietary behavior among female students[12,13]

Figure 1. The community service team provided education about anemia and the prevention of non-communicable diseases to 11th grade students.

Nutritional and Hemoglobin Status

Table 1. Baseline Characteristics of Participants (*n* = 146)

Characteristic	*n*	%
Gender		
Male	60	41.1
Female	86	58.9
Age (years)		
15	38	26.0
16	82	56.2
17	26	17.8
Anemia Status		
Anemia (Hb < 12 g/dL)	39	26.7
Normal (Hb ≥ 12 g/dL)	107	73.3
Nutritional Status (BMI)		
Underweight (< 18.5 kg/m²)	18	12.3
Normal weight (18.5–22.9 kg/m²)	85	58.2
Overweight (≥ 23.0 kg/m²)	43	29.5
MUAC Status		
Low (<23.5 cm)	103	70.5
Normal (≥23.5 cm)	43	29.5

Baseline health screening revealed that 39 participants (26.7%) had hemoglobin levels below the normal threshold (Hb < 12 g/dL), meeting the diagnostic criteria for anemia, while the remaining 107 participants (73.3%) presented with normal hemoglobin levels. With respect to nutritional status based on BMI classification, more than half of participants (58.2%) were categorized as normal weight (18.5–22.9 kg/m²), while 29.5% were classified as overweight (≥ 23.0 kg/m²) and 12.3% were underweight (< 18.5 kg/m²). The distribution of nutritional status in this study reflects the broader challenge of the double burden of malnutrition documented among Indonesian adolescents. More than half of participants (58.2%) maintained normal BMI,

while 29.5% were overweight and 12.3% were underweight, a pattern consistent with national trends showing the coexistence of undernutrition and overnutrition in this age group.[14] Importantly, anemia is not exclusively a problem of undernutrition. Emerging evidence suggests that overweight and obese adolescents may also be at risk of functional iron deficiency due to low-grade systemic inflammation, which elevates hepcidin levels and impairs dietary iron absorption.[15] This implies that anemia screening and nutritional counseling should not be limited to undernourished adolescents but should be universally applied regardless of weight status. These findings reinforce the importance of integrating anemia prevention within a broader balanced nutrition education framework.

MUAC assessment further revealed that the majority of participants (70.5%) had MUAC values below the threshold indicative of chronic energy deficiency (< 23.5 cm), while 29.5% presented with normal MUAC measurements, suggesting a considerable burden of chronic undernutrition within this program. According to Indonesian Ministry of Health guidelines, a MUAC below 23.5 cm classifies an adolescent as being at risk of CED, reflecting prolonged inadequate energy and protein intake.[16] The high prevalence of CED risk observed in this study is consistent with findings from other Indonesian adolescent populations, where more than half of both urban and rural adolescents have been reported to fall below this threshold.[16,17] Multivariate analyses in prior studies have confirmed a significant association between low MUAC and anemia incidence in adolescent girls, as chronic energy deficiency reduces the body's capacity for iron absorption and overall micronutrient utilization.[18] These findings collectively indicate that the burden of nutritional vulnerability in this population extends beyond hemoglobin levels, warranting a more comprehensive assessment approach that incorporates both anthropometric and hematological indicators.

The detection of anemia in approximately one-quarter of participants (26.7%) indicates that iron deficiency remains a relevant public health issue among adolescents in this setting. This finding is consistent with national surveillance data, which reported that approximately 23% of adolescent girls aged 13–18 years were affected by anemia in Indonesia, classifying it as a moderate public health problem.[19] More recent data from the 2018 Riskesdas survey further indicate that anemia prevalence among Indonesian adolescents reached 32%, underscoring the persistence of this burden over time. [5] Iron deficiency anemia remains highly prevalent in low- and middle-income countries, particularly among adolescent girls due to increased iron requirements during growth and menstruation.[3,20,21]

Figure 2. Educational activities about balanced nutritional diet and anemia prevention were attended by students of Imogiri 1 High School.

Knowledge Outcomes

Table 2. Changes in Adolescents' Anemia Knowledge Before and After Education

Knowledge Level	Pre-Test, *n* (%)	Post-Test, *n* (%)
Good (score ≥ 75%)	24 (16.4)	143 (97.9)
Insufficient (score < 75%)	122 (83.6)	3 (2.1)
Total	**146 (100.0)**	**146 (100.0)**

Prior to the educational intervention, the mean knowledge score among participants was 62.0 ± 10.0% (range: 35–80%), with only 24 participants (16.4%) achieving the good knowledge threshold (score ≥ 75%). Most participants (83.6%, *n* = 122) were therefore classified as having insufficient knowledge of adolescent anemia at baseline (**Table 2**).

Table 3. Changes in Knowledge Scores Before and After the Educational Intervention (*n* = 146)

Variable	Pre-Test, Mean ± SD (Min–Max)	Post-Test, Mean ± SD (Min–Max)	*p*-value
Knowledge Score (%)	62.0 ± 10.0 (35–80)	98.0 ± 5.0 (85–100)	<0.001

Following the intervention, the mean knowledge score increased substantially to 98.0 ± 5.0% (range: 85–100%). The proportion of participants classified as having good knowledge rose markedly to 97.9% (*n* = 143), while only three participants (2.1%) remained in the insufficient knowledge category. A paired t-test confirmed that this improvement was statistically significant (p <0.001), demonstrating the effectiveness of the educational intervention in enhancing participants' understanding of anemia (**Table 3**).

The marked improvement in post-intervention knowledge scores supports the Knowledge–Attitude–Practice (KAP) framework, where knowledge acts as the foundational driver of behavioral change. A recent research confirmed that nutrition education alongside iron supplementation significantly improved hemoglobin concentrations and reduced anemia risk among adolescents, reinforcing the added value of educational components over supplementation alone.[11,22] These findings reinforce that distribution of iron supplementation should be accompanied by structured educational strategies rather than implemented as a stand-alone intervention.[11,13]

Adherence remains a critical challenge in iron supplementation programs. Studies in Indonesia have shown that misconceptions regarding side effects, lack of supervision, and limited health literacy contribute to suboptimal compliance.[23,24] The integration of direct screening with educational sessions in this program likely enhanced personal relevance and awareness, which has been shown to improve preventive health behaviors.[6] A systematic review further demonstrated that health education interventions using varied media formats effectively increased knowledge and self-awareness in adolescent girls, subsequently improving adherence to iron supplementation.[25]

Figure 3. Giving souvenirs from the team to the school.

Participant Satisfaction

Participant satisfaction with the program was assessed using a structured seven-item Likert-scale feedback form administered at the close of the session. Domain-level satisfaction scores are presented in **Table 4**.

Table 4. Participant Satisfaction Scores by Domain (*n* = 146)

Domain	Mean ± SD	% High Satisfaction (score ≥ 4)
Clarity of educational delivery	4.6 ± 0.5	98.6
Relevance to daily life	4.5 ± 0.6	97.3
Engagement of interactive format	4.7 ± 0.5	99.3
Usefulness of health screening	4.6 ± 0.6	97.9
Quality of facilitator interaction	4.8 ± 0.4	99.3
Perceived self-efficacy in anemia prevention	4.3 ± 0.7	94.5
Overall program satisfaction	4.6 ± 0.5	97.3
Overall Mean	**4.6 ± 0.5**	**97.3**

The high overall satisfaction rate (97.3%) reflects positive reception of the program's format and content, particularly the interactive delivery and visual media. The highest scores recorded for quality of facilitator interaction (4.8 ± 0.4) and engagement of the interactive format (4.7 ± 0.5), consistent with evidence that direct facilitator engagement and interactive delivery are key determinants of satisfaction in school-based health education.[26] The lowest score was recorded for perceived self-efficacy in anemia prevention (4.3 ± 0.7, 94.5%), which, while still above the high satisfaction threshold (score ≥ 4), warrants attention given that self-efficacy is a key determinant of sustained behavioral change in health education frameworks. Satisfaction data should be interpreted as indicators of program acceptability and feasibility rather than clinical effectiveness, as high satisfaction does not necessarily reflect durable knowledge retention or behavioral change, and future cycles should incorporate goal-setting and practical dietary planning activities to strengthen participants' preventive self-efficacy.[25,27-30]

Overall, these findings demonstrate that combining interactive education, hemoglobin screening, and iron supplementation within a school setting is an effective strategy to increase awareness and promote preventive behaviors related to anemia. Expansion of similar programs with structured monitoring and integration into school health curricula may contribute to sustainable reduction of adolescent anemia prevalence.

Several limitations of this study should be acknowledged. First, the absence of a control group precludes causal attribution of knowledge gains solely to the educational intervention. Second, the post-test was administered immediately following the session, which may inflate scores due to recency effects rather than reflecting durable knowledge retention. Third, no follow-up assessment was conducted to evaluate whether knowledge gains translated into behavioral change, such as improved dietary practices or consistent supplementation. Fourth, hemoglobin levels were not re-measured after the intervention period; therefore, the impact of supplementation on anemia resolution cannot be determined. Fifth, supplement adherence was not formally quantified using a validated instrument, limiting conclusions regarding the effectiveness of the monitoring mechanism. Finally, the study was conducted at a single school in Imogiri, Bantul, which restricts the generalizability of findings to other settings with different demographic and contextual characteristics.

Figure 4. The entire Community Service and Anemia Research Team together with representatives from Imogiri 1 Health Center and the Principal of Imogiri 1 High School.

CONCLUSION

This community service program demonstrates that a structured, school-based approach combining interactive health education, hemoglobin screening, anthropometric assessment, and iron–folic acid supplementation can effectively improve adolescent knowledge of anemia, as evidenced by a statistically significant increase in mean knowledge scores from 62.0% to 98.0% ($p < 0.001$). Screening identified anemia in 26.7% of participants, affirming the value of school-based early detection. The high participant satisfaction rate (97.3%) indicates that this integrated model is both feasible and acceptable within a school setting.

However, conclusions regarding behavioral change, long-term anemia reduction, and supplementation effectiveness cannot be drawn from the current data, as no follow-up assessment of hemoglobin levels or dietary behavior was conducted. Future iterations of this program should incorporate a longer monitoring period, validated adherence tracking for iron–folic acid supplementation, and follow-up hemoglobin measurement to evaluate the clinical impact of the intervention. Scaling this model within the national school health framework, with attention to the documented limitations, holds meaningful promise for strengthening adolescent anemia prevention in Indonesia.

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