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Enhancing Knowledge and Attitudes Regarding Anemia Among Adolescent Girls Through Multidisciplinary Education: A One-Group Pretest–Posttest Study in Central Sulawesi

Taqwin[1]*, Linda[2], Putri Mulia Sakti[3], Widya Pani[4], Anna Veronika Pont[4], Lisnawati[1]

[1] Applied Nursing Undergraduate Study Program of Palu, Poltekkes Kemenkes Palu, Indonesia
[2] Applied Bachelor of Midwifery Study Program of Palu, Poltekkes Kemenkes Palu, Indonesia
[3] Diploma III Midwifery Study Program Poso, Poltekkes Kemenkes Palu, Indonesia
[4] Diploma III Midwifery Study Program Palu, Poltekkes Kemenkes Palu, Indonesia

*Corresponding Author: taqwin.sahe78@gmail.com

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ABSTRACT

Anemia in adolescent girls is a serious public health problem, especially in developing countries. Teenage girls are prone to anemia due to rapid growth, menstruation, and low iron intake. This study aims to evaluate the effectiveness of comprehensive education in improving adolescents' knowledge and attitudes towards anemia, consumption of blood-boosting tablets, and anemia-preventing diet. The study used a pre-experimental design with a one-group pretest-posttest approach. Forty-one students aged 14-18 from Banawa Tengah I Public Senior High School, Donggala were selected using the quota method. A multidisciplinary team delivered educational interventions, including materials on anemia, blood-boosting tablets, and anemia diets. The measurement of knowledge and attitudes was carried out using questionnaires tested for validity and reliability. Data analysis used the Wilcoxon signed-rank test. The results showed an increase in the knowledge score from 6.46 to 7.90 and the attitude score from 47.32 to 49.37. Both variables had statistically significant differences ($\rho < 0.001$ for knowledge and $\rho = 0.008$ for attitude). In conclusion, direct and comprehensive education effectively increases adolescent girls' knowledge and attitudes about anemia prevention. Similar programs are recommended to be integrated into school health activities and supported by the role of families and communities.

Key Messages:

- Direct, multidisciplinary education significantly improves adolescent girls' knowledge and attitudes about anemia. The media-free, face-to-face approach offers a novel and impactful learning experience.
- High anemia prevalence highlights the need for school-based, integrated prevention strategies. This study addresses a research gap by combining anemia treatment, iron supplementation, and dietary education.

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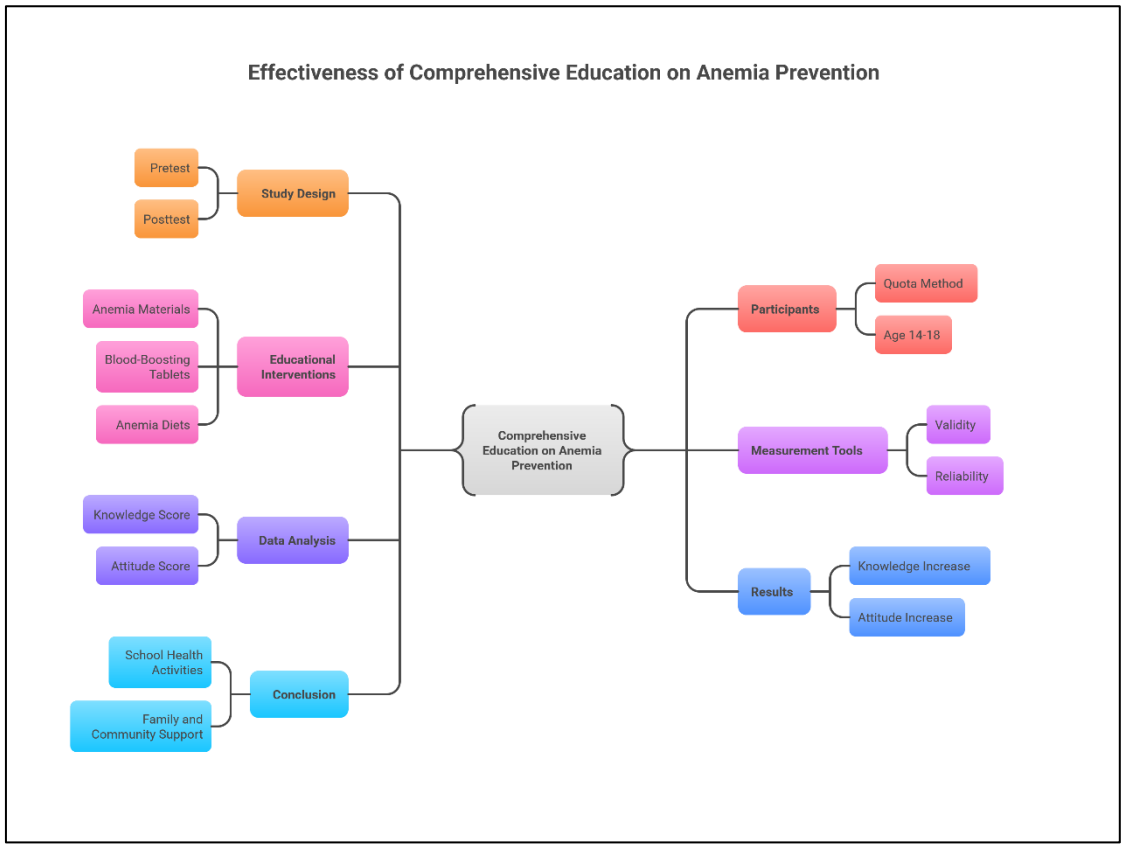
GRAPHICAL ABSTRACT



INTRODUCTION

Anaemia in adolescent girls is a persistent global health problem, especially in low- and middle-income countries. It is estimated that more than 30% of adolescents worldwide suffer from iron deficiency anemia, which negatively impacts physical growth, cognitive development, academic achievement, and future reproductive health (1–4). In African countries between 1998 and 2023, the prevalence of anemia in adolescent girls is 36%–50% (5–8). A study in India reported that the prevalence of anemia among teenage girls was 71.7% (9). In Indonesia, according to the 2018 Riskesdas data, the prevalence of anemia was 32% and another study in 2022 found that the percentage of anemia among adolescent girls was 58.7% (10,11). This condition underscores the importance of effective and targeted interventions for teenage girls.

Various risk factors have been associated with the incidence of anemia in adolescents, such as low iron intake, excessive menstrual bleeding, worm infections, lack of food diversity, and low adherence to the consumption of blood-boosting tablets (12,13). Some studies have attempted to address this problem through educational media such as animated videos, booklets, or educational games (14–18). However, very little research still evaluates the effectiveness of in-depth hands-on education delivered by health professionals from various fields. In addition, previous approaches have generally not integrated three key aspects simultaneously: understanding anemia, using iron and folic acid (IFA) supplementation, and anemia-preventing dietary strategies. As aforementioned, the problem of anemia intervention shows a gap in public health intervention strategies, especially in rural areas with a high prevalence of anemia.

Therefore, this study aims to evaluate the effectiveness of comprehensive educational interventions in improving the knowledge and attitudes of adolescent girls regarding anemia prevention. This intervention focuses on three main components: education about anemia, iron supplementation, and anemia prevention diets delivered collaboratively by educators, health center practitioners, and clinical nutritionists. This approach is expected to provide scientific evidence for developing school-based educational strategies to reduce the susceptibility of anemia in high-risk adolescents.

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METHODS

This study used a pre-experimental design with a one-group pretest–posttest approach to evaluate changes in adolescent girls' knowledge and attitudes before and after educational interventions. The research was carried out in July–August 2025 at Banawa Tengah I Public Senior High School, Donggala Regency, Central Sulawesi. The location was chosen based on anemia prevalence data in 2024, which showed a figure of 70.43%, with Banawa Tengah I Public Senior High School as the highest contributor.

The research sample consisted of 41 female students aged 14–18, selected using quota sampling. The quota was determined based on proportional representation from each grade level (X, XI, and XII) to ensure that all classes were represented according to their actual student distribution. Participants who met the inclusion criteria were recruited within each grade until the predetermined quota for that grade was reached**.** Inclusion criteria were: (1) actively enrolled students, (2) willingness to participate indicated by signed informed consent, and (3) participation in the entire series of interventions. Students who did not complete either the pretest or posttest or were uncooperative were excluded.

The intervention consisted of a 90-minute face-to-face interactive education session in small groups of 10–15 students to encourage active participation**.** A multidisciplinary team, including academics, public health practitioners, and clinical nutritionists, provided the education. The session covered three main topics: (1) understanding anemia (definition, symptoms, causes, risk factors, and government programs), (2) correct consumption of iron and folic acid tablets, and (3) anemia-preventing dietary strategies using local iron-rich foods. The session combined short lectures, question-and-answer segments, and group discussions.

Data were collected using a structured questionnaire that had undergone validity and reliability testing. Out of 20 knowledge items, only 9 met the validity criteria ($r > 0.312$), while 11 were excluded because their correlation values were below the threshold, indicating weak item–total consistency. Consequently, the final knowledge score was calculated by summing the correct responses from these nine valid items, providing a more accurate measurement of knowledge. For the attitude scale, all 15 items were declared valid. The reliability of the instrument was high, with Cronbach's Alpha = 0.874. Measurements were taken before and immediately after the intervention by trained enumerators.

Data were analyzed using the Wilcoxon signed-rank test because the normality test results showed an abnormal distribution ($\rho < 0.05$). Data processing was performed with the latest version of JASP software, using a significance level of 95% ($\alpha = 0.05$). This research received ethical approval from the Ethics Commission of the Poltekkes Kemenkes Palu (No: 001660/KEPK POLTEKKES KEMENKES PALU/2025).

RESULTS

Table 1 presents the basic characteristics of the 41 respondents involved in this study: adolescent students aged 14–18 at SMA Negeri 1 Banawa Tengah. Most respondents aged 16 (36.58%) and 15 (34.15%) indicated that the middle adolescent group comprised the most significant part of the sample. Most of the respondents came from class XI (43.90%), followed by class XII (29.27%) and class X (26.83%). Regarding the consumption status of Iron and Folic Acid (IFA), 68.30% of respondents reported never taking IFA, while 31.70% had a history of consumption. These findings suggest that adolescent girls have low levels of adherence to or access to iron supplementation programs, which may be an important predisposing factor for the incidence of anemia. The nutritional status of the respondents measured through the Body Mass Index (BMI) showed that almost 40% of the respondents were underweight (<18.5), while only 48.78% were in the normal category. A small proportion is also included in overweight (2.44%) and class I obesity (2.44%). Interestingly, as many as 7.32% of respondents were classified as class II obesity (≥30), indicating the existence of a dual burden of malnutrition in the school adolescent population, where deficiency and overnutrition can co-occur. Based on the measurement of hemoglobin levels, as many as 29 out of 41 respondents (70.73%) were identified as having anemia, while only 29.27% had hemoglobin levels in the normal range. The prevalence of this anemia is significantly higher than the national average and exceeds the 40% threshold set by the WHO to classify a public health problem as of severe public health significance.

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Table 1. Characteristics and Hemoglobin Levels of Respondents (n=41).

Characteristics	n	%
Age		
14 Years	4	9.76
15 Years	14	34.15
16 Years	15	36.58
17 Years	6	14.63
18 Years	2	4.88
Class		
X	11	26.83
XI	18	43.90
XII	12	29.27
IFA Supplementation		
Not	28	68.30
Ever	23	31.70
Body Mass Index for Age (BMI/A)		
Severely thin (<-3 SD)	16	39.02
Thin (<-2 SD)	20	48.78
Normal (-2 SD to +1 SD)	1	2.44
Overweight (> +1 SD)	1	2.44
Obese (> +2 SD)	3	7.32
Hemoglobin Status		
Anemia	29	70.73
No anemia	12	29.27

Table 2. Descriptive Analysis of Knowledge and Attitudes Before and After Intervention (N=41)

Research Variables	Mean	SD	SE	Coefficient of variation
Knowledge Before Intervention	6.463	1.518	0.237	0.235
Post-Intervention Knowledge	7.902	1.179	0.184	0.149
Attitudes Before Intervention	47.317	5.303	0.828	0.112
Attitude After Intervention	49.366	6.003	0.938	0.122

The descriptive analysis of the variables in the table above showed increased knowledge and attitude scores after the intervention. The average pre-intervention knowledge score was 6.463 with a standard deviation of 1.518 and increased to 7.902 with a standard deviation of 1.179 after the intervention. Similarly, the average attitude score before the intervention was 47.317 with a standard deviation of 5.303 and increased to 49.366 with a standard deviation of 6.003 after the intervention. This average increase shows a positive effect of the intervention on the improvement of respondents' knowledge and attitudes.

Table 3. Differences in Knowledge and Attitudes Before and After the Intervention.

Measurement 1	Measurement 2	w	Z	*P*	Rank-Biserial Correlation	SE Rank-Biserial Correlation
Knowledge Before Intervention	Knowledge After Intervention	35.000	-4.387	< .001	-0.875	0.197
Attitudes Before Intervention	Attitude After Intervention	131.000	-2.671	0.008	-0.533	0.197

The Wilcoxon Signed-Rank Test Table shows a significant difference between the knowledge score before and after the intervention (W=35.000, ρ<0.001, Rank-Biserial Correlation=-0.875). Similarly, there was an essential difference between attitude scores before and after the intervention (W=131,000, ρ=0.008, Rank-Biserial Correlation=-0.533). The value of ρ<0.05 for both variables showed that the anemia education intervention significantly improved the knowledge and attitudes of adolescent girls at SMA

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Negeri 1 Banawa Tengah. The high Rank-Biserial correlation showed a strong intervention effect.

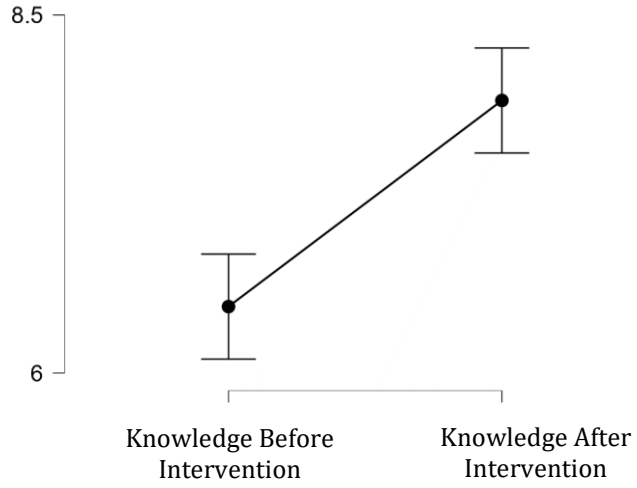

Figure 1: Mean Knowledge Scores Before and After the Educational Intervention

Figure 1 illustrates the mean knowledge scores of respondents (n = 41) before and after receiving a multidisciplinary educational intervention. The x-axis represents the two measurement points (pre-intervention and post-intervention), while the y-axis shows the mean knowledge scores. Data points indicate the mean values, and the error bars represent the standard error of the mean (SEM). The upward shift in the post-intervention scores demonstrates the positive impact of the educational program on participants' knowledge.

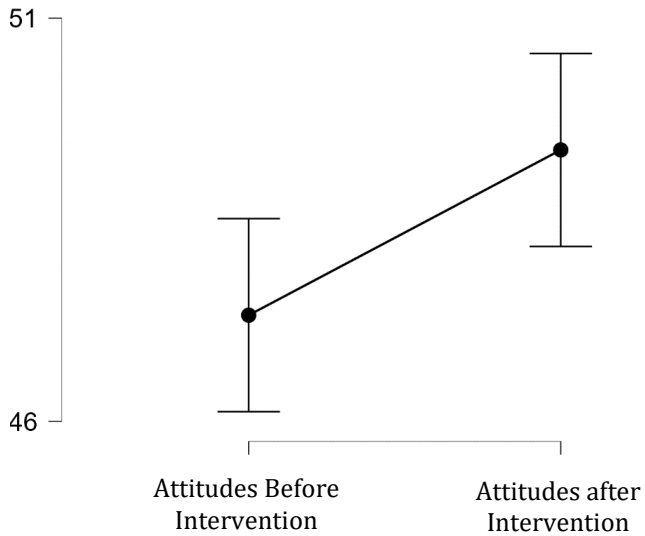

Figure 2: Mean Attitude Scores Before and After the Educational Intervention

Figure 2 illustrates the mean attitude scores of respondents (n = 41) before and after receiving a multidisciplinary educational intervention. The x-axis represents the two measurement points (pre-intervention and post-intervention), while the y-axis shows the mean attitude scores. Data points indicate the mean values, and the error bars represent the standard error of the mean (SEM). The post-intervention increases in mean scores and the upward separation of error bars indicate a consistent improvement in participants' attitudes toward anemia prevention.

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DISCUSSION

The results showed a significant increase in the knowledge and attitudes of adolescent girls after being given in-depth education about anemia, blood supplement tablets, and anemia diet. The average knowledge score increased from 6.463 to 7.902, while the attitude score increased from 47.317 to 49.366. The Wilcoxon Signed-Rank test corroborates these findings with a significance value of $\rho<0.001$ for knowledge and $\rho = 0.008$ for attitude. These findings are consistent with the findings of Anggraini et al (2023), who provide anemia prevention education, showing a significant increase in respondents' knowledge and attitudes after intervention (19). This improvement suggests that educational interventions can increase adolescents' awareness and understanding of anemia, which was previously dominated by ignorance or apathy. This increase also proves that a multidisciplinary team's systematic delivery of material (academics, health center practitioners, and hospital nutritionists) can reach students' cognitive and affective aspects, making them better prepared to independently and sustainably implement anemia prevention behaviors.

These findings align with previous studies showing that health education has effectively improved adolescent girls' knowledge and attitudes towards anemia. Research by Ernawati et al. (2022) using SHE Smart web-based media also showed a significant increase in knowledge, attitudes, and practices in anemia prevention (14). Likewise, Yuliana et al. (2024), through the media TESIMIA and Nabila et al. (2022) with educational booklets, prove the effectiveness of media-based education in changing adolescent behavior (15,17). However, what distinguishes this study is the direct and in-depth educational approach without media intermediaries, which can provide a strong and personalized effect of change. Thus, this study strengthens the previous findings while providing an alternative educational approach that is more interactive and based on direct interpersonal relationships.

This research can be explained through Bandura's Social Cognitive theory, which emphasizes that learning occurs in social contexts through observation, modeling, and reinforcement (20–22). In this study, adolescents receive education from various authoritative figures (health workers and academics), who convey information and become models of healthy behavior. This direct interaction shapes adolescents' perceptions and confidence to change attitudes and improve their knowledge. In addition, the behavioral change theory Health Belief Model (HBM) is also relevant, as it states that individuals' perceptions of health threats and the benefits of preventive measures influence their decisions to act (23–25). Education that includes information about the impact of anemia, the benefits of blood-boosting tablets, and local dietary strategies reinforces the perception of risks and benefits, ultimately encouraging attitude change.

The implications of this finding are pretty broad, especially for policymakers and schools. First, a hands-on, educational approach involving health workers and academics demonstrated promising effectiveness in this study. However, the absence of a control group and the single-site, small-sample context limit the strength of this conclusion. Educational approaches that improve the knowledge and attitudes of adolescent girls are consistent with the research of Manjilala et al (2025), Raihani et al (2024), Zakiah et al (2023)(26–28). Second, this approach suggests that the prevention of anemia should not only depend on the distribution of blood-boosting tablets, but should also be accompanied by intensive education on their use and a supportive diet. In addition, these results provide a basis for local government programs to design more systematic and comprehensive evidence-based interventions, especially in areas with a high prevalence of anemia, such as Donggala. Another implication is the importance of cross-sector collaboration in addressing adolescent health issues across the board.

One of the main strengths of this research is the educational approach, which is theoretical, practical, comprehensive, and delivered by a cross-professional team. The academic approach allows the material to be delivered in a diverse and in-depth manner, including definitions, symptoms, risks, and strategies for anaemia prevention. The validity and reliability of the instruments used were also well tested, demonstrating the quality of the measuring instrument (Cronbach's Alpha = 0.874). In addition, the use of non-parametric statistical tests (Wilcoxon) corresponding to the data distribution strengthens the validity of the analysis. The pretest-posttest approach in a group allows for direct and controlled measurement of change. This research also received official ethical approval, which shows compliance with the moral principles of the study and involves respondents with explicit informed consent.

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Although the results showed significant effects of the intervention, there were some limitations. First, the one-group pretest-posttest design does not use control groups, so it cannot eliminate the influence of outside factors that may affect the change. Second, the sample was limited to only one school with a total of 41 respondents, which limited the generalization of the results to a broader population. Third, measurements were only taken immediately after the intervention, so the long-term effects of this education on sustained behavior change are not yet known. Fourth, other factors that may play a role, such as nutritional status, worm infections, or iron consumption, are not objectively measured. This limitation must be considered when designing follow-up studies to make the results more comprehensive and representative.

For further development, it is recommended that future studies use randomized controlled trial designs to compare the effects of interventions more accurately. In addition, it is crucial to conduct medium- or long-term follow-up to measure noticeable behavioral changes, such as adherence to the consumption of blood-boosting tablets and increased hemoglobin levels. Another recommendation is to expand the research area to schools in other rural and urban areas to compare the effectiveness of interventions across social contexts. Advanced research can also integrate technology approaches, such as interactive educational apps or social media, to reach more adolescents with diverse learning styles. Finally, it is necessary to collaborate between the education, health, and family sectors to make intervention efforts holistic and sustainable.

CONCLUSION

This study shows that comprehensive educational interventions significantly improve adolescent girls' knowledge and attitudes towards anemia, consumption of blood-boosting tablets, and appropriate diets. Interventions delivered by multidisciplinary teams proved to be statistically effective in improving knowledge and attitude scores. The high prevalence of anemia (70.73%) among respondents emphasizes the need for an integrated and evidence-based prevention strategy. Education carried out directly and intensively, without media intermediaries, has proven to be a practical approach in increasing awareness and behavior to prevent anemia in the school environment.

Schools are advised to integrate anemia education into routine health promotion programs to optimize anemia prevention efforts by involving teachers trained as facilitators. Cooperation with health centers needs to be strengthened to ensure the availability of blood tablets and regular consumption monitoring. Parental involvement through counseling or simple communication media is also essential to reinforce dietary changes at home. In addition, the use of local foods rich in iron needs to be encouraged to increase the diversity of nutritional intake. An incentive approach for students active in wellness programs can also increase participation and compliance. Future studies should use a design with control groups, larger sample sizes, and long-term monitoring to verify and expand on these findings.

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CONFLICTS OF INTEREST

The author states that no conflict of interest affects the results of this study.

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