



School-Based Interventions for The Prevention of Anemia Among Adolescent Girls: A Literature Review

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INFORMASI

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ABSTRACT

Background: Anemia is a big health issue among adolescent girls particularly in developing countries, with serious consequences for growth, cognitive function, and overall well-being.

Objective: to examine the effectiveness of various intervention for anemia prevention in school setting among adolescent girls

Methods: A comprehensive literature search was conducted using Google Scholar, PubMed, EBSCO with relevant keywords in both English and Bahasa Indonesia. The included studies utilize different methodologies, such as quasi-experimental, Participatory Action Research (PAR), and media development using Analysis, Design, Development, Implementation and Evaluation (ADDIE)

Results: The findings consistently demonstrate that educational interventions, particularly those utilizing digital and interactive media, effectively enhance knowledge, foster positive attitudes and promote health behaviors

Conclusion: To maximize effectiveness, future programs should expand the use of digital platforms. Additionally, integrating culturally relevant and community based educational strategies can further enhance the long-term impact of anemia prevention efforts among adolescent girls.

INTRODUCTION

Anemia among adolescent girls remains a significant and unresolved public health problem, despite the implementation of various intervention programs. According to the World Health Organization (WHO), anemia is defined as a condition in which hemoglobin levels in the blood fall below the normal threshold based on age and sex (Sungkar et al., 2022). From a physiological perspective, this condition impairs the transport of oxygen to body tissues (Kusuma & Kartini, 2021). However, from a public health perspective, anemia reflects a much more complex issue involving nutritional, behavioral, social, economic, and policy-related factors (Novelia et al., 2022). Adolescent girls are particularly vulnerable to anemia due to rapid physical growth during puberty, which increases iron requirements significantly. In addition, menstrual blood loss further elevates iron needs compared to adolescent boys. When dietary iron intake is insufficient, an imbalance occurs between iron demand and supply in the body, ultimately leading to iron deficiency anemia (Deivita et al., 2021).

In Indonesia, the prevalence of anemia among adolescent girls remains a major public health concern. National data published by the Ministry of Health of the Republic of Indonesia indicate that anemia in this population group is still classified as a public health problem (Srinigrat et al., 2019). This suggests that existing efforts, such as iron tablet supplementation programs, have not yet achieved optimal and equitable impact across the population (Roche et al., 2021) at present WIFAS in the WHO-recommended formulation is not included in the Model Essential Medicines List (MEML. The consequences of anemia in adolescent girls extend beyond short-term symptoms such as fatigue, dizziness, and reduced immune function (Deivita et al., 2021). It also negatively affects cognitive performance, concentration, and academic achievement (Sungkar et al., 2022). Iron deficiency has been associated with reduced memory capacity and attention, which can indirectly influence educational outcomes (Samson & Fischer, 2022). In the long term, anemia during adolescence may contribute to poorer reproductive health outcomes, including increased risk of pregnancy complications and low birth weight in infants (Novelia et al., 2022).

Prevention of anemia cannot rely solely on curative or individual-level approaches. It requires a systematic and population-based strategy. Schools represent one of the most strategic settings for implementing anemia prevention interventions due to their direct and continuous access to adolescent populations. School

environments enable the integration of nutrition education into the curriculum, structured iron supplementation programs, periodic health screening, and the development of healthy behaviors through peer education and teacher support (N. K. T. Agustini, 2023). Various studies have evaluated the effectiveness of school-based interventions (Fitranti et al., 2022), including weekly iron supplementation (Marfiah et al., 2023), school canteen food fortification, and participatory health education programs (Kusuma & Kartini, 2021). Findings generally show short-term improvements in nutritional knowledge and hemoglobin levels (Syakir, 2018). However, several challenges remain, such as low adherence to supplementation, negative perceptions of side effects from iron tablets, insufficient monitoring systems, and limited cross-sector collaboration between the health and education sectors. Furthermore, most existing studies tend to focus primarily on clinical outcomes without adequately examining the contextual factors that influence program implementation. There is also a lack of comprehensive studies that systematically compare different school-based intervention models and identify the most effective and sustainable components, particularly in developing country contexts such as Indonesia. This indicates a clear research gap regarding how educational, supplementation, and policy-based interventions can be optimally integrated to achieve long-term impact.

Based on these conditions, a comprehensive literature review is needed to critically analyze various forms of school-based anemia prevention interventions among adolescent girls and to evaluate their effectiveness in reducing anemia prevalence. This review is expected to provide a scientific foundation for the development of more comprehensive, context-sensitive, and sustainable intervention models aimed at reducing anemia and improving adolescent health outcomes in the future.

METHODS

This study employed a systematic literature review (SLR) design to identify, critically appraise, and synthesize scientific evidence on school-based anemia prevention interventions among adolescent girls. The systematic review approach was chosen because it allows a structured, transparent, and reproducible process of searching and selecting literature, thereby minimizing bias in study selection and interpretation of findings. The review was conducted in accordance with the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines to ensure

comprehensive reporting at every stage, from identification to final synthesis of included studies.

A comprehensive literature search was conducted across several electronic databases, including PubMed, EBSCO, and Google Scholar. The search strategy combined Medical Subject Headings (MeSH) terms and free-text keywords using Boolean operators (AND, OR). The main keywords used included “anemia prevention,” “iron deficiency anemia,” “school-based intervention,” “adolescent girls,” “iron supplementation,” and “nutrition education.” The search was limited to studies published within the last ten years to ensure relevance to current policies and practices. In addition, only articles published in English and Indonesian were included. The selection of studies was carried out in four stages. The first stage involved identifying all records retrieved from each database search. The second stage consisted of screening titles and abstracts to remove studies that were not relevant to the research topic. The third stage involved assessing the eligibility of full-text articles to ensure they met the inclusion and exclusion criteria. The final stage was the determination of studies to be included in the final synthesis. This entire process was documented using a PRISMA flow diagram.

The inclusion criteria for this review were: (1) original research articles; (2) quantitative study designs such as randomized controlled trials (RCTs), quasi-experimental studies, or other intervention studies; (3) study populations consisting of adolescent girls aged 10–19 years; (4) interventions conducted in school settings; and (5) outcomes measuring anemia-related indicators such as hemoglobin levels, anemia prevalence, iron status, nutrition knowledge, or adherence to iron tablet consumption. Exclusion criteria included review articles, editorials, opinion papers, studies without clearly defined outcome measurements, and studies without full-text availability. Data extraction was performed using a standardized form developed by the researchers. The extracted information included study characteristics (author, year, and country), study design, sample size, participant characteristics, type and duration of intervention, measurement instruments, and key reported outcomes.

To ensure methodological quality, a critical appraisal of included studies was conducted using appropriate tools based on study design, such as the Joanna Briggs Institute (JBI) critical appraisal checklists. This assessment aimed to identify potential risks of bias, including selection bias, measurement bias, as well as internal and external validity of each study. Data synthesis was conducted using a narrative and thematic

approach. The included studies were grouped according to intervention type, including iron supplementation, nutrition education, school-based food fortification, and multi-component combined interventions. The analysis focused on comparing the effectiveness of these interventions in improving hemoglobin levels, reducing anemia prevalence, and enhancing nutrition knowledge and health behaviors. In addition, contextual factors influencing implementation success were identified, such as participant adherence, school policy support, involvement of health professionals, and intervention duration. These factors were considered important in understanding not only the effectiveness of interventions but also the conditions required for successful and sustainable implementation in school-based settings.

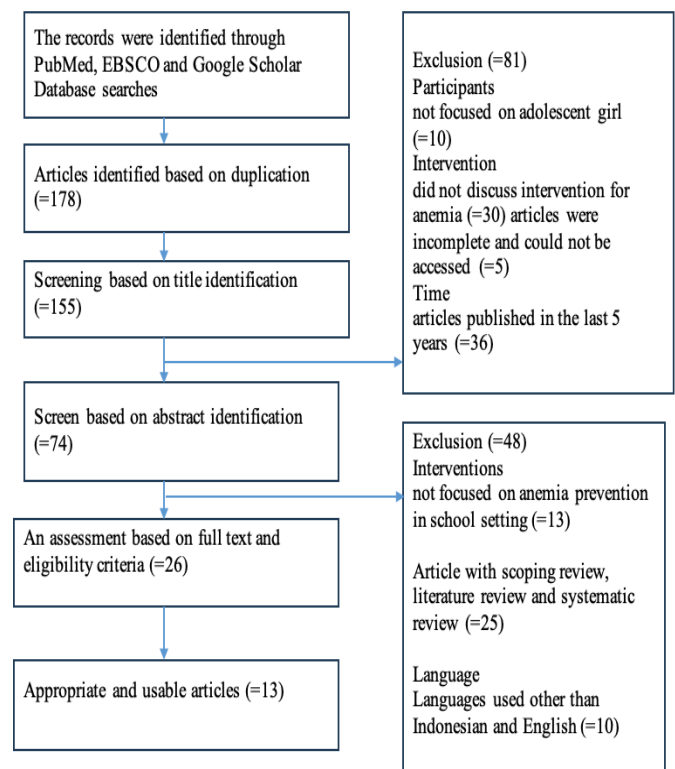


Figure 1. PRISMA Diagram of Literature Search

RESULT AND DISCUSSION

The findings from the reviewed studies consistently highlight the important role of educational interventions in improving knowledge, attitudes, and behaviors related to anemia prevention among adolescent girls. Across various study designs, particularly quasi-experimental and pre–post interventions, education has been shown to significantly enhance adolescents’ understanding of anemia, including its causes, symptoms, and prevention strategies. This suggests that increasing awareness remains a fundamental step in addressing anemia in this population.

Table 1. Summary of Article Review

Author, Year, Country	Title	Method	Results
Siregar et al. (2025)	Development of the anem sip education model for anemia prevention in adolescent girls	Design: ADDIE approach (Analysis, Design, Development, Implementation and Evaluation) Sample: adolescent girls Intervention: Android based intervention	Studies show that the Anem SIP intervention leads to significant improvements in knowledge, attitudes and adherence to iron folic acid supplement consumption
Ghafouri et al. (2026)	Comparative impact of edutainment education via web application and mobile application on anemia prevention	Design: Quasy experimental with pretest-posttest design Sample: adolescent girls Intervention: Web application, Mobile and Edutainment	Education improved knowledge or symptom recognition, regardless of the delivery method. The appeal of mobile education suggests that practical apps are valuable
Sari et al. (2022)	The Effect of Mobile Health (m-Health) Education Based on WANTER Application on Knowledge, Attitude, and Practice (KAP) Regarding Anemia among Female Students in a Rural Area of Indonesia	Design: Quasy experimental with pretest-posttest design Sample: adolescent girls Intervention: Mobile Health (m-Health) Education Based on WANTER Application	Adolescent's knowledge and attitude increased significantly in three months after intervention of WANTER
Jabbar et al. (2023)	Education on the Dangers of Anemia and the use of iron supplements (Fe) for students at SMP Negeri 5 Kendari	Design: Lecture, discussion and educational video Sample: adolescent girls Intervention: Lecture, discussion and educational video	Education improved student's understanding of anemia and the importance of consuming iron supplements
Amalia et al. (2024)	Education on Anemia for Adolescent Girls and Hemoglobin Testing Post Iron Supplementation at SMP Al- Ma'arif Tasikmalaya	Design: Participatory Action Research Sample: adolescent girls Intervention: Education on Anemia	Education improved the student's understanding of anemia and the importance of consuming iron supplements
Jadana et. Al (2019)	The Effect of Nutritional Education and Iron Supplementation on Hemoglobin Levels in Adolescent Girls	Design: Quasy experimental Sample: adolescent girls Intervention: Nutritional Education and Iron Supplementation	Nutritional Education and iron supplementation increased hemoglobin levels and knowledge in adolescent girls
Lende et al. (2024)	Analysis of the Consumption Behavior of Blood Supplement Tablets Among Female Students at Stikes Panakkukang	Design: Pre experiment (Pre-post test) Sample: adolescent girls Intervention: Consumption Behavior	Health education improved positive attituded towards the consumption of iron supplements

Annifah et al. (2020)	The Effect of Health Education Using Video Media on Knowledge about anemia in adolescent girl	Design: Quasy experimental Sample: adolescent girls Intervention: Health Education using video	Significant improvement in adolescent girls knowledge after video based education
Soesilawati et al. (2019)	The Effect of Health education on attitudes of adolescent girls regarding the consumption of Iron Supplements at SMP Negeri 3 Kediri	Design: Quasy experimental Sample: adolescent girls Intervention: Health Education	Health education improved positive attitudes toward the consumption of iron supplements
Ahmalinda et al. (2020)	The effect of nutritional education knowledge of anemia, iron supplementation, and iron intake in adolescent girls at High Schools in Cimahi	Design: Quasy experimental Sample: adolescent girls Intervention: nutritional education	Nutritional education improved knowledge, iron supplement consumption, and iron intake in adolescent girls.
Diana Solang et al. (2023)	Effectiveness of counseling using video media on knowledge about anemia among adolescent girls at SMAN 10 Bengkulu city	Design: Quasy experimental Sample: adolescent girls Intervention: Counselling using video media	Counseling using video media significantly improved adolescent girls knowledge about anemia
Firdaus et al. (2021)	The effect of nutrition education using anemia E-booklet Media on Anemia Knowledge and Iron Rich Food Consuption Behavior Among adolescent girls at SMA Negeri 1 Cisarua Bogor	Design: Quasy experimental Sample: adolescent girls Intervention: Nutrition education using anemia e-booklet Media	Nutritional education using anemia e-booklets improve knowledge and iron intake behavior among adolescent girls
Romanti et al. (2022)	The effect of poster media on increasing anemia knowledge among adolescent girls at SMAN 1 Kartasura	Design: Quasy experimental Sample: adolescent girls Intervention: Poster Media	Poster media effectively increased adolescent girls knowledge about anemia

A notable pattern emerging from the studies is the effectiveness of digital and technology-based interventions, such as mobile applications, web-based platforms, videos, and e-booklets. Interventions like the Anem SIP model, WANTER application, and other mobile health (m-health) approaches demonstrated substantial improvements not only in knowledge but also in attitudes and adherence to iron supplementation. These findings indicate that digital media provide an engaging, accessible, and scalable method for delivering health education. The interactive nature of these tools likely contributes to better retention of information and increased motivation among adolescent girls. In addition to digital approaches, conventional educational methods such as lectures, discussions, counseling, posters, and participatory action research also proved effective in improving knowledge and attitudes. Video-based education, in particular, showed consistent positive outcomes across multiple studies, suggesting that visual and audiovisual media can enhance comprehension and engagement. Furthermore, combining education with practical components, such as iron supplementation or hemoglobin testing, was found to produce more comprehensive outcomes, including improvements in hemoglobin levels and consumption behaviors. Another important finding is that educational interventions not only increase knowledge but also positively influence attitudes and practices. Several studies reported improved adherence to iron and folic acid supplementation and increased consumption of iron-rich foods. This indicates that well-designed education programs can lead to meaningful behavioral changes, which are essential for the long-term prevention of anemia.

1. Behavioral-based educational interventions

Education on anemia to change the behavior of the adolescents is commonly used as the intervention to prevent anemia. Traditional and multimedia-based educational approaches also showed consistent positive outcomes. Jabbar et al. (2023) demonstrated that lectures, discussions, and educational videos improved students' understanding of anemia and iron supplementation. Likewise, Diana Solang et al. (2023) found that video-based health education significantly increased knowledge among adolescent girls. Further supported these findings, showing that e-booklet-based nutrition education improved both knowledge and iron-rich food consumption behaviors (Pardosi, 2019). Poster-based education was also found effective, as reported by Romanti et al. (2022), who observed increased anemia knowledge following poster interventions. In the context of anemia prevention among adolescent girls, poor adherence to iron tablet consumption is often not due to lack of access, but rather low perceived need, fear of side effects, and limited social support. Behavioral-based educational interventions address these barriers systematically. They aim to develop positive attitudes toward iron supplementation by improving adolescents' understanding of anemia and its consequences. When students are informed about how anemia can reduce concentration, energy levels, physical fitness, and long-term reproductive health, they are more likely to evaluate iron supplementation as beneficial and relevant to their daily lives (Pardosi, 2019). This cognitive shift forms an important foundation for building a stronger intention to engage in healthy behavior. In addition to attitudes, subjective norms play a crucial role in shaping adolescent behavior. (Pardosi, 2019). During adolescence, peer influence and social acceptance are particularly strong (N. K. T. Agustini, 2023). If iron tablet consumption is not perceived as a normal or valued behavior within the school environment, students are less likely to adopt it consistently. Therefore, TPB-based educational programs seek to establish supportive social norms by involving peer discussions, engaging teachers, and empowering peers as role models or agents of change (Rakhshani et al., 2025). When influential figures within the school community actively support and normalize iron supplementation, students are more likely to feel social encouragement to participate (N. K. T. W. L. G. N. S. Agustini, 2024). However, although behavioral education can effectively strengthen knowledge, attitudes, and intention, research highlights a persistent intention-behavior gap. In other words, increased intention does not always translate into sustained behavior change. Without structural reinforcement such as

consistent school-based monitoring, reliable access to iron tablets, and ongoing reminders initial motivation may decline over time. Therefore, education based on behavioral theory is most effective when it serves as a foundational strategy that is reinforced by supportive environmental and institutional interventions. Theory of Planned Behavior-based education helps shape more rational and context-aware attitudes toward iron supplementation, strengthens social norms that support healthy behavior, and builds initial motivation among adolescent girls (Rakhshani et al., 2025). When combined with structural support systems, this approach has greater potential to produce sustained behavior change in anemia prevention efforts.

2. Nutrition education combined with iron supplementation programs

School-based iron supplementation programs, such as iron and folic acid (IFA) or Weekly Iron and Folic Acid Supplementation (WIFAS) and nutrition education can directly target iron deficiency as the primary cause of anemia. From a clinical perspective, these interventions are among the most effective strategies for rapidly improving haemoglobin levels and reducing the prevalence of anemia among adolescent girls. Several studies emphasized the impact of nutrition education combined with behavioral or supplementation strategies (Sasmita et al., 2022) attitude, and practice regarding anemia among school children. Methods: This is an interventional study among school children of Kendriye Vidyalaya, No. 2 Belgaum district, India. Structured and self-administered questionnaires were used to know the knowledge, attitude and practice of student anemia. The data were analyzed using paired t-test and McNemar test. Results: There was significant increment in the mean knowledge and attitude scores of the school children at the post-test evaluation. Overall increase of 51.2% in mean score of knowledge and overall increase of 20.7% in mean score of attitudes was found ($P < 0.05$ (Rima Andini & Agestika, 2022). Jadana et al. (2019) found that nutrition education combined with iron supplementation not only improved hemoglobin levels but also increased nutritional knowledge. Similarly, Ahmalinda et al. (2020) reported improvements in knowledge, iron supplement consumption, and dietary iron intake following structured nutrition education programs. Lende et al. (2024) also highlighted that health education positively influenced attitudes toward iron tablet consumption among female students (Abu-Baker et al., 2021) attitude, and practice (KAP. Schools provide a strategic delivery platform because they enable scheduled distribution, systemat-

ic record-keeping, and collective monitoring within a structured environment. Compared to broader community-based approaches, school settings offer a more organized system and a relatively homogeneous target population, which enhances implementation efficiency (Fitriani, 2025). Despite their strong clinical effectiveness, the success of supplementation programs is highly dependent on adherence (Syakir, 2018). Consistent consumption of iron tablets is the key determinant of biological impact. However, maintaining adherence is often challenging. Mild side effects such as nausea or constipation, negative perceptions about supplements, and limited understanding of long-term benefits frequently reduce motivation among students (Novelia et al., 2022). In many cases, programs that focus solely on distribution without accompanying education tend to become purely administrative activities, which may undermine long-term sustainability. Effective implementation requires several critical supporting factors. First, the school system support plays a central role. Teachers' involvement in supervising intake, maintaining distribution records, and providing accompanying education helps ensure that the program is consistently implemented (Khairunnisa et al., 2020). Schools with strong institutional commitment to health programs generally achieve better outcomes because supplementation becomes integrated into daily routines rather than treated as an optional activity. Second, monitoring and evaluation are essential for assessing program effectiveness. Regular hemoglobin measurements and adherence tracking allow educators and health providers to identify barriers, evaluate progress, and adjust strategies accordingly. Without proper monitoring, it becomes difficult to determine whether the program is achieving its intended health outcomes. Although school-based supplementation programs are highly effective in improving clinical indicators, they also have limitations. These interventions primarily address biological deficiencies but do not automatically change students' knowledge, attitudes, or long-term health behaviors (Abu-Baker et al., 2021) attitude, and practice (KAP. Without complementary education and supportive social norms, tablet consumption may remain passive and dependent on supervision. Once monitoring decreases, adherence often declines, reducing the sustainability of the intervention. Therefore, while iron supplementation programs in schools are crucial for immediate anemia control, they are most effective when integrated with educational and behavioral strategies that promote sustained understanding and voluntary compliance among adolescents.

3. Technology-based educational interventions

Combined interventions that integrate technology into anemia prevention programs represent a modern and increasingly relevant approach to adolescent health education. Several studies highlight the effectiveness of technology-based educational interventions. For example, Siregar et al. (2025) developed the Anem SIP Android-based education model and found significant improvements in adolescents' knowledge, attitudes, and adherence to iron-folic acid supplementation (Siregar, 2025). Similarly, Sari et al. (2022) reported that Mobile Health (m-Health) education using the WANTER application significantly improved knowledge and attitudes among adolescent girls in rural Indonesia (Sari et al., 2022) as adolescent girls, are more at risk of anemia because of high nutritional requirements. Health education through mobile applications influences the knowledge, attitude, and practice (KAP. In line with this, Ghafouri et al. (2026) compared web-based and mobile-based edutainment applications and found that both platforms effectively enhanced anemia-related knowledge and symptom recognition, with mobile applications showing higher user engagement and practical appeal. By combining iron supplementation with digital tools such as mobile applications, interactive media, and educational games, these interventions are more aligned with the learning preferences and daily habits of today's adolescents (Agustini, Ni Komang Tri; Yoga, 2024). From a pedagogical perspective, gamification enhances engagement, improves information retention, and creates a more enjoyable learning experience compared to traditional health education methods. Digital features such as reminders, point systems, leaderboards, badges, and reward mechanisms can significantly strengthen adherence to iron tablet consumption. These elements encourage repeated behavior through positive reinforcement while also promoting self-monitoring. In addition, peer-to-peer interaction within digital platforms helps reinforce positive social norms regarding supplementation. In this way, technology acts as a mediator between individual behavior and interpersonal influence, contributing not only to increased knowledge but also to the formation of supportive peer cultures around health behavior. From a theoretical standpoint, these interventions are strongly aligned with behavioral science frameworks. Within the Theory of Planned Behavior, digital interaction helps strengthen subjective norms, as adolescents are influenced by peer visibility, shared achievements, and collective participation in health-related challenges. When students observe their peers consistently engaging in supplementation and receiving recognition, the behavior becomes socially reinforced and perceived as

more acceptable and desirable. Furthermore, features such as reminders, self-monitoring tools, weekly challenges, and reward systems contribute to improved perceived behavioral control and self-efficacy, as explained in Social Cognitive Theory. Adolescents are not merely passive recipients of information; instead, they actively participate in managing and tracking their own behavior. This active engagement helps bridge the gap between intention and action by supporting habit formation and behavioral regulation over time. However, the effectiveness of technology-based interventions depends on several practical factors. Access to digital devices, levels of digital literacy, and sustained engagement with the application beyond the study period are critical determinants of success. Without continued use, the benefits of digital reinforcement may diminish over time. Therefore, ensuring usability, accessibility, and long-term integration into students' daily routines is essential for sustainability. Evidence from the literature suggests that combined biological-behavioral-digital interventions tend to produce more comprehensive outcomes compared to single-component approaches. These integrated strategies not only improve hemoglobin levels but also enhance knowledge, adherence, and behavioral consistency. As such, technology-based interventions represent an important advancement in anemia prevention, bridging clinical effectiveness with modern behavior change techniques to create more sustainable health outcomes among adolescents.

4. Awareness and participatory intervention

Empowerment-based using participatory of the community to increase awareness of the adolescents as active agents rather than passive recipients of health interventions. This approach emphasizes strengthening community action and creating supportive environments that enable sustained health behavior change. In the context of anemia prevention, adolescents are engaged through peer educator training or the formation of school-based anemia cadres (N. K. T. Agustini, 2023). These trained students take part in health education activities, awareness campaigns, and monitoring of iron supplementation consumption among their peers. Moreover, interventions focusing on awareness and participatory approaches showed meaningful effects. Amalia et al. (2024), using a participatory action research design, demonstrated that anemia education combined with hemoglobin testing improved students' understanding of anemia and the importance of iron supplementation. These findings suggest that active involvement of students in learning processes can strengthen awareness and engagement (Novelia et

al., 2022). A key strength of the empowerment approach lies in its ability to foster a sense of ownership and responsibility among adolescents. When young people are directly involved in delivering messages and organizing activities, they are more likely to internalize health values and influence their peers. This process also helps reinforce positive social norms, as healthy behaviors become collectively endorsed within the school environment rather than imposed from external authorities. Over time, such engagement contributes not only to individual behavior change but also to a broader shift in school culture toward health awareness and prevention (Kusuma & Kartini, 2021). The empowerment model operates through several interconnected mechanisms. First, it improves collective health literacy by providing structured training to selected students who then act as information multipliers within their peer groups. Second, it generates consistent social support through group discussions, school-based campaigns, and creative health promotion activities led by adolescents themselves. Third, it helps establish new social norms in which maintaining health and preventing anemia are viewed as shared responsibilities among students. One of the main advantages of this approach is its sustainability. When external support from health professionals decreases, empowered peer groups can continue educational and monitoring activities independently (Afriyani et al., 2023). This creates a more resilient system in which health promotion becomes embedded within the school community rather than relying entirely on external intervention. However, literature also indicates that the immediate biological impact of empowerment alone may be slower compared to direct supplementation programs if not accompanied by regular iron intake interventions. Adolescents do not exist in isolation but are embedded within strong social networks in both school and community settings. When change agents come from within these peer groups, health messages are often more readily accepted due to shared identity, equality of status, and emotional closeness (Agustini, 2024). Overall, empowerment-based models contribute to long-term behavioral and cultural transformation by building capacity, strengthening peer support systems, and embedding health responsibility within adolescent communities. When combined with supplementation and other structured interventions, this approach has the potential to create both immediate health benefits and sustained behavioral change.

CONCLUSION

School-based interventions are effective in improving anemia prevention among adolescent girls, particularly in increasing knowledge, attitudes, and iron supplementation behaviors. Both digital and traditional educational methods show positive results, while combining education with iron supplementation produces better outcomes, including improved hemoglobin levels. However, most studies focus on short-term effects, and sustained behavior change remains a challenge. Overall, integrated interventions that combine education, supplementation, and technology are the most promising approach for long-term anemia prevention in school settings. To enhance the impact of anemia prevention programs, future efforts should emphasize the expanded use of digital platforms due to their flexibility, wide reach, and ability to maintain engagement over time. In addition, integrating culturally appropriate materials and community-based approaches is crucial to ensure the interventions are relevant to the target audience. By tailoring educational strategies to local values and social contexts, these programs can achieve more sustainable and meaningful outcomes in preventing anemia among adolescent girls.

SUGGESTION

It is recommended that future anemia prevention programs place greater emphasis on the use of digital and interactive media to deliver educational content, as these approaches have proven effective in engaging adolescent girls and improving learning outcomes. Expanding access to such platforms can help ensure wider reach and sustained participation. In addition, program developers should incorporate culturally relevant materials and actively involve the community in the design and implementation of interventions. This approach will help ensure that the content is meaningful, acceptable, and aligned with local values and practices. Strengthening collaboration with schools, families, and community leaders can further support the continuity and effectiveness of these efforts. Ultimately, a combination of technology-driven strategies and community-based approaches is essential to achieve long-term success in preventing anemia among adolescent girls.

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