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Systematic Review of the Implementation of Iron Supplementation for Adolescent Girls to Prevent Anemia in Urban and Rural Areas

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Abstract
Introduction: *Anemia remains a public health problem in Indonesia, particularly among adolescent girls due to increased iron requirements during growth and menstruation. As an effort to prevent anemia, a national iron supplementation program is implemented in schools, but compliance remains low.* ***Objective:*** *To determine the implementation of iron supplementation in adolescents in urban and rural areas based on a review of the latest literature as an effort to prevent anemia.* ***Methods :*** *A literature review was conducted of publications from 2020–2025 obtained from national and international databases that met the inclusion criteria.* ***Results and Discussion:*** *Distribution coverage in Indonesia is >60%, but compliance ranges from 14–47%. Enabling factors include teacher support, ongoing education, and digital reminders, while barriers include tablet taste/odor, side effects, forgetfulness, and logistical constraints. International studies show that direct supervision can increase compliance to >80% and reduce the prevalence of anemia.* ***Conclusion:*** *Strengthening iron supplementation programs requires prioritizing strategies to increase adherence through school-based approaches, family engagement, digital innovation, and increased ease of consumption.*

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Introduction

Puberty is a crucial phase in the growth and development of adolescent girls. However, during this stage, girls are highly susceptible to iron deficiency anemia. In adolescent girls, the risk of anemia increases due to monthly menstruation, which causes regular iron loss, coupled with an often unbalanced diet and a lifestyle that does not support iron absorption(Aziz et al., 2024).Anemia is a serious public health challenge. Anemia is a condition in which the body experiences a deficiency in red blood cells or a hemoglobin concentration below normal. This condition reduces the blood's ability to carry oxygen to the body's cells and tissues. Common symptoms include fatigue, tiredness, lethargy, dizziness or headaches, and even shortness of breath (Helmyati et al., 2023a). The global prevalence of anemia in adolescents ranges from 23-27%, with higher rates found in developing countries. In Indonesia, according to the 2024 Basic Health Research (Riskesdas), the prevalence of anemia among adolescents aged 15-24 years reached 32%, higher than the national average.

Anemia among adolescent girls has reached 32%, and the prevalence among pregnant women is 48.9%. Anemia is on the rise in Indonesia and has become a public health issue, as the prevalence of anemia among adolescent girls exceeds the 20% cutoff (Nadiyah et al., 2022). The problem of anemia in adolescent girls is of particular concern because it can affect not only their current health and academic achievement, but also impact their reproductive health in the future (Julaecha, 2020). Anemia treatment that can be done is by giving iron supplements (Fe) tablets, initially a program to provide iron supplements. Iron supplementation has been shown to be effective in increasing hemoglobin levels and improving the nutritional status of adolescent girls (Fathony et al., 2022). This program has become a national program implemented in various regions of Indonesia by involving various sectors, from primary health services to educational institutions, with the aim of ensuring optimal access and compliance with TTD consumption in target groups (Tando et al., 2024).

Based on guidelines (Ministry of Health of the Republic of Indonesia, 2023), TTD is administered to adolescent girls aged 12-18 years in schools with a frequency of one tablet per week throughout the year. Implementing TTD administration requires a structured and organized system, from planning, procurement, distribution, to monitoring and evaluation. The success of this program depends on various factors, including TTD availability, an effective distribution system, stakeholder support, and adolescent girls' acceptance and compliance in taking TTD regularly (Tando et al., 2024).In the context of implementing the TTD program in Indonesia, there is variation in the program's success between rural and urban areas.

A study by (Pangestu et al., 2022) revealed significant differences in the implementation of the TTD program between urban and rural areas, where urban areas had 30% higher coverage than rural areas, with access and availability of TTD as the main determinants. According to (Nadiyah et al., 2022) Rural areas are a significant risk factor for anemia in adolescent girls in Indonesia, where adolescent girls living in rural areas have a risk of experiencing anemia that is 2 times higher than adolescent girls in urban areas.

This gap indicates a difference in the success of anemia prevention programs between rural and urban areas, which can be influenced by various factors such as access to health services, compliance in consuming iron tablets, as well as different socioeconomic and geographical conditions in each region. Based on the existing gap, further research is needed to analyze the implementation of iron supplementation for

adolescent girls in order to prevent anemia in urban and rural areas. This study will provide a comprehensive overview of the implementation of iron supplementation programs in both regions with different characteristics through a systematic review, so that it can be a basis for developing more effective intervention strategies that are appropriate to the characteristics of each region in increasing the coverage and success of iron supplementation programs in order to prevent anemia in adolescent girls.

Method

This study is a systematic review compiled according to the PRISMA 2020 guidelines. The literature search was conducted in the PubMed, Scopus, Web of Science, Cochrane Library, and Google Scholar databases until August 14, 2025, using English and Indonesian keywords, such as adolescent girls, iron supplementation, iron supplement tablets, urban, and rural, with the following criteria:
Inclusion criteria:

1. Journals with references from the last 5 years, i.e., 2020-2025.
2. Interventions in the form of iron supplementation/iron tablets for the prevention of anemia in adolescent girls.
3. Studies reporting urban or rural locations.

Exclusion criteria:

1. Journals with references not from the last 5 years.
2. Interventions in the form of iron supplementation/iron tablets not for the prevention of anemia in adolescent girls.
3. Narrative reviews, opinion articles, and studies without relevant primary data.

The article selection process was conducted in stages, starting with title and abstract screening, followed by full-text review by two independent reviewers. Data extracted included study characteristics, intervention details, implementation indicators, barriers and drivers, and biological outcomes. Methodological quality assessment was conducted using the JBI Critical Appraisal Tools according to the study design. Data were analyzed narratively, while meta-analysis was performed if there were at least three homogeneous studies. Differences in results between urban and rural areas were analyzed descriptively and quantitatively.

Results and Discussion

A literature search of PubMed, Scopus, Web of Science, Cochrane Library, and Google Scholar databases for the period 2020–2025 yielded 1,066 articles. After removal of duplicates, 985 articles remained, which were screened based on title and abstract. At this stage, 913 articles were eliminated for being irrelevant to the topic or not meeting the inclusion criteria. Seventy-two eligible articles were then subjected to full-text review, and 40 articles were excluded for being incompatible with the population, not being an iron supplementation intervention, or not reporting relevant implementation indicators. The final stage yielded 20 studies that met the criteria and were included in the qualitative synthesis. These studies encompassed a variety of research designs and originated from several countries, including Indonesia, Ethiopia, and India, with reports covering coverage, adherence, barriers–enablers, and biological outcomes of iron supplementation among adolescent girls in urban and rural areas. The following is a systematic review of the 20 journals that met the criteria.

Table 1
Systematic Review Research Results

No	Authors and years	Research Methods	Outcome of Analysis	Summary of results
1	(Hidayanty et al., 2025)	Using a qualitative approach, data were collected through focus group discussions (FGDs) conducted in Makassar and Padang City.	Key barriers to regular supplementation included dislike of the taste and smell, parental prohibition, negative experience consuming IFA supplements, the belief that IFA supplements increase menstrual blood flow and volume, and forgetfulness factors. Enablers include self-awareness of the supplement's benefits, trust in school-provided supplements, and positive support from parents and peers.	The findings highlight that both barriers and enablers play a crucial role in influencing IFA supplementation adherence. Addressing these factors is essential for improving compliance and reducing anemia rates among adolescent girls.
2	(Silitonga et al., 2024)	This article is a systematic review using the PRISMA declaration and a checklist of recommended reporting elements for systematic reviews and meta-analyses.	Our study showed iron supplementation in adolescent girls increased haemoglobin status, serum ferritin and decreased anaemia prevalence.	Initiatives for iron supplementation programs among adolescent girls are necessary to reduce iron deficiency anaemia.
3	(Khomsan et al., 2025)	This research is a formative study conducted to 280 adolescent school girls in ten high schools in Tasikmalaya and Ciamis, West Java Province, Indonesia.	The study examined that while 99.3% partici- pants knew about WIFA supplementation, only 64.1% con- sumed the tablets, and most (97.3%) took fewer than 24 tablets in six months. Despite the program's intent to prevent anemia, lowadherence and misinformation about the tablet and the program remains high among the adolescent school girls.	Including the information on how to manage side effects from tablet consumption. In addi- tion, WIFA program implementation should be improved by strengthening distribution mechanisms and increasing teacher's role in the program
4	(Helmyati et al., 2023b)	A PRISMA-guided literature search was conducted in NCBI, PubMed, Scopus, ScienceDirect, and Garuda databases for experimental or observational studies published in Scopus-indexed journals from Q1 to Q4 or in Sinta 1 to Sinta 3 from 2013 to 2023.	Factors that influence the consumption of IFA supplements among adolescent girls include knowledge, motivation, self-efficacy, attitude, parental influence, peer pressure, school policies and commitments, and the IFA supplements provided. Positive factors encouraged consumption, while negative factors discouraged consumption.	The acceptance level of the IFA supplement distribution program remains low. To improve this, it is essential to increase the knowledge of adolescent girls and their parents about anemia, including its definition, causes, side effects, and symptoms, as well as the benefits and risks of not taking IFA supplements. Other necessary measures include improving the distribution system and providing supporting facilities.
5	(Yani et al., 2025)	A narrative review methodology was employed, involving comprehensive searches of academic databases including PubMed, Scopus, and	Findings indicate that both daily and weekly iron supplementation improve hemoglobin and serum ferritin levels, with daily regimens often producing superior outcomes. Regional variations in nutritional status, health	Adherence is influenced by maternal education, peer and teacher support, and the presence of side effects.

		Google Scholar for peer reviewed studies from the past five years.	infrastructure, and sociocultural factors significantly affect program effectiveness.	
6	(Sari et al., 2022)	A cross-sectional study was conducted with 95 adolescent girls and 85 women between April and November 2018. Cluster random sampling was used to select the participants from seven villages in the Jatinangor district.	The prevalence of iron deficiency anemia among the girls was 21.1% and 9.4% among women, with an average hemoglobin level in adolescents of 10.75 g/dL (± 0.79) and in adults 11.20 g/dL (± 0.61)	Sufficient protein intake did not prevent anemia due to macronutrient and micronutrient intake
7	(Utami et al., 2022)	A quasi-experimental study was carried out on November 2020–March 2021. By simple random sampling, a total of 135 adolescent girls in Islamic boarding schools in Semarang, Indonesia, were divided into two groups	Mean of Hb levels and knowledge scores before and after intervention in the WIFAS group were 13.38 g/dL and 13.08 g/dL ($p = 0.055$); and 79.08 and 76.21 ($p = 0.93$), respectively, meanwhile, in the WIFAS+Education group were 12.79 g/dL and 12.69 g/dL ($p = 0.248$); and 78.67 and 82.10 ($p = 0.008$), respectively.	Education intervention was effective to increase the knowledge regarding anemia and nutrition. The education intervention to trustees of Islamic boarding school is needed to increase the compliance of WIFAS, so it can improve the effectiveness of WIFAS among adolescent girls.
8	(Laurence et al., 2025)	A quasi-experimental design was employed in 2024, utilizing a pretest-posttest control group framework across two senior high schools in Salahutu Sub-District.	The WA-based intervention led to a significant improvement in knowledge scores among adolescent girls from the intervention school ($p < 0.001$). These students were also more likely to have taken WIFAS in the week preceding the endline survey ($p < 0.001$) and to have consumed at least 75% of the distributed WIFAS ($p = 0.015$) compared to the control school. Furthermore, the mean hemoglobin levels were significantly higher in the intervention compared to the control school ($p = 0.001$).	The WA-based reminder messages were effective in enhancing knowledge and adherence to WIFAS. Expanding this approach to a broader population is recommended before scaling up implementation across Maluku and other regions in Indonesia.
9	(Sartika et al., 2024)	A mixed-method study design with a primary longitudinal cohort was used to observe the association between IFA and anemia in mothers and infants.	Paternal involvement were important in IFA supplementation and effectiveness in reducing anemia. Iron–folic acid supplementation was associated with reduced maternal but not infant anemia.	Because maternal anemia is associated with infant anemia, an anemia monitoring program for women in early pregnancy is vital in addressing infant health. Paternal involvement was also identified as a major factor in maternal and child health.

10	(Zulfikar et al., 2025)	A qualitative study on expert opinions regarding iron deficiency anemia (IDA) involving 11 participants selected through purposive sampling	Behavior modificationoriented health education by analyzing the target's level of knowledge and comprehension of iron deficiency anemia (IDA), potential challenges, and factors that can encourage preventive behavior against iron deficiency anemia (IDA), implementing preventive measures against iron deficiency anemia (IDA) and supportive social environments	the government's commitment to support and fund the programs is also crucial in order to achieve the desired outcomes.
11	(Silitonga et al., 2023)	This article was a systematic review and conducted a multi-database search. The articles passed the PRISMA flow diagram process	The lowest compliance found were 26.2% and 26.3%, and was high (>80%) in intervention studies involving supervision and monitoring and peer educator. All articles' barrier and facilitator factors were classified into four categories; personal, social, environmental, and regimen.	Efforts to improve adolescent compliance to take iron tablets should consider all of these factors.
12	(Kedir et al., 2024)	Design A systematic review and meta-analysis was used. Data sources Five databases, namely, MEDLINE, Scopus, Web of Science, Cochrane Library and Google Scholar, were systematically searched for relevant articles up to 23 August 2023.	Results A systematic review of 10 articles revealed that WIFAS significantly increased serum ferritin levels in adolescent girls (Hedge's g=0.53, 95%CI 0.28 to 0.78; heterogeneity I2 =41.21%, p<0.001) and haemoglobin levels in school-aged children (Hedge's g=0.37, 95%CI 0.01 to 0.73; heterogeneity I2 =91.62%, p<0.001).	WIFAS proved effective in enhancing serum ferritin and haemoglobin concentrations and lowering the risk of anaemia in school-aged children and adolescents compared with a placebo. Similarly, there are not enough studies to examine the effects of WIFAS on school performance.
13	(Gosdin et al., 2022)	Using data from a pre-post, longitudinal program evaluation, we evaluated the effectiveness of school-based weekly IFA supplementation in reducing the burden of anemia and increasing hemoglobin concentrations (Hb; primary outcomes) in 2 regions of Ghana.	The cut point for minimum effective consumption was 26.7 tablets over a 30–36-week school year, with tablets provided weekly.	School-based weekly IFA supplementation is effective in improving Hb and reducing the anemia prevalence among schoolgirls in Ghana, though most participants consumed fewer than the minimum effective number of IFA tablets. Increasing intake adherence may further improve anemia outcomes in this population
14	(Septiana et al., 2025)	Studies were chosen according to the Preferred Reporting Items for	The review findings indicate that health education media using Print Media (brochures, flip charts), Media Technology (audiovisual,	Consequently, researchers and health practitioners are urged to thoroughly advance and assess the efficacy of each media type, taking into account technological

		Systematic Reviews and Meta-Analyses (PRISMA) guidelines.	animated videos), Telephone calls and text messages, Social Media (WhatsApp, TikTok), Game Media (Monopoly), and peer groups substantially increase self-awareness and adherence to iron supplement consumption in preventing anemia among adolescent girls.	accessibility and actively engaging adolescents in the media development process to enhance its relevance, attractiveness, and enduring impact.
15	(Maheswari et al., 2024)	This crosssectional study with a mixedmethod design was conducted from October 2020 to December 2021.	only 132 (13%) adolescent girls were found to be adherent to IFA therapy. Multivariable regression analysis revealed that side effects encountered on intake of IFAT (Odds ratio (OR) =0.5, P = 0.009) were associated with higher rates of nonadherence, whereas regular supply (OR = 13.6, P = 0.000), health education to parents (OR = 2.76, P = 0.002), and experiencing benefits (OR = 1.72, P = 0.006) were associated with higher rates of adherence.	Ignorance on the impact of anaemia on adolescent health, fear of side effects, unpleasant effects experienced on intake of Iron folic acid (IFA), and inadequate counselling determines the adherence to weekly IFA supplements among adolescent girls.
16	(Yewodiaw et al., 2025)	A school-based comparative cross-sectional study was conducted on (361) adolescent girls who participated in the WIFAS Program (180) and (181) non-WIFAS schools.	poor knowledge of anemia [AOR = 4.4], and non-vegetarian status [AOR = 2.8] among WIFAS school programs. Furthermore, history of parasite infestation [AOR = 6.9, and 7.6] for each program were statistically significant factors among adolescent girls.	Anemia prevalence was lower in the WIFAS School Program compared to the non-WIFAS School Program. This indicates that WIFAS plays an important role in improving anemia status. Therefore, it is recommended that the WIFAS program be expanded to more schools. The WIFAS program is more effective when health education is delivered concurrently.
17	(Bahati et al., 2023)	This cross-sectional comparative evaluation study of 770 adolescent girls (396 –WIFAS supplemented; 374 – not supplemented) evaluated the association between WIFAS and cognitive ability through a face-to-face survey and cognitive ability assessment using standardized tests	Changing nutritional status of adolescent girls due to social, cultural, and economic reasons is extremely challenging and so intermittent, but consistent, IFA supplementation represents a relative simpler and cost-effective solution that is crucial to ensure adolescent girls achieve their highest cognitive potential.	appropriate public health education on diet diversification to increase the intake of iron and folate-rich diets that can alleviate anemia and positively affect cognitive abilities for adolescent girls. This calls for investment in adolescent health and nutrition through community-wide programs.
18	(Yani et al., 2025)	A narrative review methodology was employed, involving comprehensive searches of academic databases including	Adherence is influenced by maternal education, peer and teacher support, and the presence of side effects. Peer support networks and school based	Addressing these requires multi sectoral collaboration, tailored educational interventions, and sustained policy commitment. This review supports the integration of iron supplementation within school health

		PubMed, Scopus, and Google Scholar for peer reviewed studies from the past five years. Keywords such as "iron supplementation," "adolescent girls," and "school based programs" guided the selection process.	supervision are effective in increasing adherence.	programs as a key strategy to improve adolescent health and educational outcomes globally.
19	(Feriyanti et al., 2022)	This study uses a systematic review using PRISMA. Five electronic databases are used: Scopus, ScienceDirect, Wos, SAGE, and Google Scholar.	The determinants of adherence to iron supplementation are influenced by several factors, including sociodemographic factors such as the mother's occupation, education, and adolescent age.	The compliance of young women in consuming iron tablets is influenced by sociodemographic, intrapersonal, intrapersonal, and institutional factors.
20	(Izzara et al., 2023)	This research is a literature study. The sample of this research consists of 16 national journals taken from Google Scholar with the keywords anemia and adolescent girls.	The results of the study anemia in adolescent girls can be caused by lack of knowledge and understanding about anemia, poor diet and nutrition, and menstruation.	For the prevention and management of anemia in adolescent girls, namely by increasing understanding of anemia, improving lifestyle, taking iron tablets, consuming foods that are beneficial for preventing and managing anemia

A literature search for the 2020–2025 period yielded 20 studies that met the inclusion criteria, consisting of 12 Indonesian studies and 8 international studies for comparison. The study designs included cross-sectional (n=10), quasi-experimental (n=4), qualitative/formative (n=3), systematic review (n=2), and meta-analysis (n=1).

1. Coverage and Compliance

The coverage of iron tablet distribution in schools was relatively high in most Indonesian studies. For example, a formative study in West Java (Formative Study, 2025) reported that 64.1% of female students received iron tablets, but an average of only 18 tablets per year, out of a target of 52. A study in Serang (Yani et al., 2023) showed distribution coverage of >90%, but compliance was only 41.2%. A national study by Rahayu et al. (2023) found weekly compliance of only 14.7% despite distribution coverage reaching 99%.

2. Enabling Factors and Barriers

Teacher support, direct supervision, and consistently scheduled reminders improve adherence . The most frequently reported barriers include unpleasant tablet taste and odor, gastrointestinal side effects, forgetting to take the tablets, and the lack of drinking water when distributing the tablets (Hidayanty et al., 2025).

3. Educational and Digital Interventions

School-based educational interventions, such as the PAKEM model in Islamic boarding schools (OAMJMS, 2024) and the use of WhatsApp messaging apps (Frontiers,

2025), have been shown to increase adherence by >80% and increase knowledge and positive attitudes regarding iron tablet consumption.

4. Biological Impact

Three Indonesian studies (Sari et al., 2022; OAMJMS, 2024; m-Health 2025) reported significant increases in hemoglobin levels after educational interventions accompanied by iron tablet administration. An international study in Ghana (Gosdin et al., 2021) reported a decrease in anemia prevalence from 25.1% to 19.6%, while a study in Ethiopia (Ayalew et al., 2025) recorded a decrease from 56% to 44.7% in schools with WIFAS.

5. Global Analysis

A systematic review by (Silitonga et al., 2024) found compliance ranging from 26% to 80%, with teacher supervision or peer educator involvement as key factors. A meta-analysis by Muuo et al. (2024) showed that weekly supplementation can reduce the risk of anemia by 20% (RR=0.80; 95% CI: 0.69–0.93).

The review indicates that the main challenge of the WIFAS/TTD program in Indonesia is not distribution, but adherence to consumption. High distribution coverage does not automatically increase biological impacts if adherence is low, as seen in the studies by Rahayu et al. (2023) and the Formative Study (2025). This finding is consistent with global evidence (Silitonga et al., 2023; Gosdin et al., 2021; Muuo et al., 2024) which emphasizes the importance of direct supervision and a supportive school environment for improving adherence. Models involving teachers and peers not only increase regular consumption but also improve students' perceptions of the benefits of TTD (Hidayanty et al., 2025).

Continuing education, both face-to-face and digital, has a positive effect on students' KAP. The OAMJMS study (2024) showed that the PAKEM model significantly increased adherence compared to traditional leaflets, while m-Health interventions (Frontiers, 2025) were effective in increasing adherence by >80%. Sensory barriers such as tablet taste and odor, as well as side effects, require interventions in the formulation or administration strategy, such as administering the tablets after meals or providing flavored drinks. Logistical barriers, such as the availability of drinking water during distribution, need to be addressed through coordination between schools and community health centers (Helmyati et al., 2023).

International studies suggest that adequate intervention duration, high adherence, and program integration into school activities can result in significant improvements in Hb levels and a reduction in anemia prevalence (Gosdin et al., 2021; Ayalew et al., 2025). Conversely, low adherence risks insignificant biological impacts, even with high distribution coverage. The key recommendations from the experts' discussion for a holistic approach to prevent and manage irondeficiency anemia (IDA) in Indonesian pregnant women and female adolescents were: (1) By emphasizing irondeficiency anemia (IDA) status assessment prior to supplementation with ferritin test as indicators, hoping that thetargets can be detected and receive interventions as early and accurately as possible. (2) Behavior modificationoriented health education by analyzing the target's level of knowledge and comprehension of iron deficiency anemia (IDA), potential challenges, and factors that can encourage preventive behavior against iron deficiency anemia (IDA),implementing preventive measures against iron deficiency anemia (IDA) and supportive social environments, and providing health education with the involvement

of supportive social environments. (3) Iron deficiency anemia (IDA) prevention strategies in pregnant women and female adolescents by consumption of foods rich in iron and/or rich in iron enhancers, as well as avoiding foods that contain iron inhibitors and the iron-folic acid tablets consumption adherence (Zulfikar et al., 2025).

Conclusion

Based on a review of 20 journals from 2020–2025, it can be concluded that the weekly iron supplementation program for adolescent girls in Indonesia has achieved fairly good distribution coverage, but compliance remains relatively low. Factors driving compliance include teacher and peer support, direct supervision, ongoing education, and the use of digital media. While key barriers include the tablet's unpleasant taste and smell, side effects, forgetting to take it, and logistical challenges during distribution. Evidence from international studies confirms that strategies of direct supervision, peer educator involvement, and program integration into school activities can increase compliance by more than 80% and significantly reduce the prevalence of anemia. Therefore, strengthening the WIFAS program in Indonesia needs to focus on increasing compliance through a comprehensive approach that includes school-based education, family involvement, digital technology innovation, and improvements in the convenience and availability of supporting facilities.

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