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Efficacy of Iron Tablet Supplementation on Hemoglobin Levels in Adolescents: A Systematic Review

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ABSTRACT

Introduction: Iron deficiency anemia is one of the most common nutritional problems among adolescents and can significantly affect physical growth, cognitive development, and overall health. Iron tablet supplementation is widely recognized as a primary intervention to increase hemoglobin levels and prevent anemia in this population.

Objective: This study aims to evaluate the effectiveness of iron tablet supplementation in increasing hemoglobin levels among adolescents with anemia.

Method: A systematic literature review was conducted using four databases: PubMed, JSTOR, ProQuest, and Garuda. The review included studies published between 2019 and 2025 that examined iron tablet supplementation in adolescents diagnosed with anemia. Hemoglobin levels were assessed before and after supplementation to determine effectiveness. Study selection, data extraction, and quality appraisal were performed independently by two reviewers following the PRISMA guidelines and using the CASP checklist.

Results: Four studies involving a total of 430 adolescent participants met the inclusion criteria. All included studies reported a significant increase in hemoglobin levels following daily iron tablet supplementation, particularly among adolescent girls. One month of supplementation was found to be effective in reducing the prevalence of anemia.

Conclusion: Iron tablet supplementation is an effective intervention for increasing hemoglobin levels and reducing the incidence of anemia in adolescents. These findings support the continued use of iron supplementation programs as a public health strategy to improve adolescent health and prevent long-term complications associated with iron deficiency anemia.

Keywords: adolescent, anemia, hemoglobin, iron supplementation, iron tablets

Introduction

Iron deficiency anemia (IDA) remains one of the most prevalent nutritional disorders among adolescents globally, particularly affecting adolescent girls due to rapid physical growth and menstrual blood loss during puberty (Munthe et al., 2023; Setiawan, 2022). Hemoglobin, an essential component for oxygen transport in the blood, becomes deficient during IDA, leading to fatigue, impaired cognitive and motor development, decreased academic performance, and reduced productivity (Damayanti et al., 2020; Indrawatiningsih et al., 2021). Globally, anemia is a major public health concern, with around 1.62 billion people affected (Mirani et al., 2021). In Indonesia, according to the 2017 Demographic and Health Survey (SDKI), the prevalence of anemia among females aged 13–18 years was 23%, and among males, it was 17% (Nurhidayati et al., 2021).

Adolescents, especially girls, are highly vulnerable to IDA due to inadequate iron intake, menstrual losses, and increased physiological demands. In Indonesia, the anemia prevalence among girls aged 18–24 years is 27.2%, with major contributing factors including low dietary iron intake (94.5%), insufficient iron reserves (31.4%), and other micronutrient deficiencies (49.5%) (Cia et al., 2022). The effects of anemia extend beyond physical symptoms, affecting concentration, academic achievement, growth, reproductive health, immune function, and overall quality of life (Astuti et al., 2023; Hartati et al., 2020; Nurrahman et al., 2020; Apriyanti et al., 2019). In addition, anemia may exacerbate existing health conditions such as HIV, cardiovascular diseases, and chronic kidney failure (Nurrahman et al., 2020).

Despite efforts to address IDA through dietary changes, nutritional education, and infection control, iron supplementation remains a cornerstone of anemia prevention strategies (Fadila et al., 2018; Nurhidayati et al., 2021). Iron tablets are widely recommended for adolescent girls, as studies have consistently demonstrated their effectiveness in increasing hemoglobin levels (Mamuaya et al., 2023; El Shara et al., 2017; Fathony et al., 2022; Andaruni et al., 2018). However, adherence remains a challenge due to side effects, lack of awareness, and dietary factors that affect iron absorption.

Several studies have evaluated the impact of iron supplementation, either alone or in combination with other nutritional interventions. Reported increases in hemoglobin levels range from 1.2 to 2.4 g/dL, depending on the dosage and duration of treatment (Tonasih et al., 2019; Yuanti et al., 2020; Permatasari et al., 2018). Iron combined with zinc or vitamin C has shown synergistic effects by enhancing iron absorption. Indicators such as increased hemoglobin levels and decreased anemia prevalence are used to measure program success (Wahyuni et al., 2021).

Nevertheless, there remain barriers to optimal program implementation. Compliance issues, side effects, and limited nutrition education reduce program effectiveness (Fadila et al., 2016). Studies emphasize the need for a comprehensive approach involving regular monitoring, community-based education, and dietary improvements to optimize the benefits of iron supplementation (Indraswari et al., 2020; Wahyuni et al., 2021). This systematic review aims to synthesize evidence on the effectiveness of iron tablet supplementation in increasing hemoglobin levels among adolescents and provide evidence-based recommendations to strengthen anemia prevention strategies.

Objective

This study aims to evaluate the effectiveness of iron tablet supplementation in increasing hemoglobin levels among adolescents with anemia**.**

Method

Study Design

This study is a systematic literature review conducted in accordance with the PRISMA 2020 (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines.

Search Strategy

A comprehensive literature search was carried out to identify relevant studies published between January 1, 2019, and December 31, 2024. The search was conducted across four databases: PubMed, ProQuest, Garuda, and JSTOR. The time frame was restricted to the last decade to ensure the inclusion of the most recent and relevant literature in the field of adolescent anemia and iron supplementation.

Search terms included Medical Subject Headings (MeSH) and relevant keywords such as "iron tablets" and "anemia." Two independent reviewers (NM and MF) conducted the database searches. Detailed search strategies and query syntax can be found in Supplementary File 1.

Tabel 1. MeSH term on search strategy phase

Source	Link	Keyword	Num
Pubmed	https://tinyurl.com/4smex6sw	(iron tablets[MeSH Terms]) AND (anemia[MeSH Terms])	100
ProQuest	https://tinyurl.com/bf4x28jh	((iron tablets)) AND (anemia)	200
Garuda	https://tinyurl.com/yeysx8vf	iron tablets AND anemia	100
JSTOR	https://tinyurl.com/5cuc7xmv	((iron tablets) AND (anemia))	75
		Total	**475**

The inclusion criteria targeted adolescents aged 10 to 19 years who were diagnosed with anemia due to iron deficiency. No restrictions were applied based on race, religion, or geographic region. The intervention of interest was the administration of iron (Fe) tablets—pharmaceutical formulations containing iron salts such as ferrous sulfate, ferrous fumarate, or ferrous gluconate. These supplements are commonly prescribed to treat iron deficiency anemia by promoting hemoglobin synthesis and erythropoiesis. Iron absorption primarily occurs in the duodenum and upper jejunum via divalent metal transporter 1 (DMT1), followed by transferrin-mediated transport in the plasma. To reduce gastrointestinal side effects such as nausea and constipation, iron tablets are often co-administered with vitamin C to enhance absorption.

Comparative groups included those receiving a placebo or standard care without iron supplementation. Studies were eligible if they reported hemoglobin level changes before and after the intervention using validated methods such as the Hemoglobin Cyanide (HiCN) method or Point-of-Care Testing (POCT). Only studies with a follow-up duration of at least two weeks and up to three months were considered, as this duration is required to observe measurable hematologic changes. Eligible study designs included experimental and quasi-experimental studies evaluating the effectiveness of iron supplementation in increasing hemoglobin levels.

Exclusion criteria included studies not published in English or Bahasa Indonesia due to language limitations. Studies were also excluded if they involved participants under the age of 10 or over 19, or individuals with chronic illnesses or mental health disorders. Additionally, studies with follow-up periods shorter than two weeks and non-original research types (e.g., case reports, editorials, letters, reviews, book chapters, abstracts, or opinion pieces) were not considered.

Study Selection and Data Extraction

Three independent reviewers (EN, MF, and ARF) screened titles and abstracts for eligibility. Any discrepancies in study selection were resolved through discussion or adjudication by a senior researcher (HM). Two other reviewers (NM and EN) independently extracted data from the included studies. Extracted data included the authorship, year of publication, study location, study design, sample size, intervention specifics, measurement instruments, and main findings.

Quality Assessment and Critical Appraisal

Two reviewers (EN and AN) independently evaluated the methodological quality of the included studies. Disagreements were resolved by discussion or with input from the senior researcher (HM). The Critical Appraisal Skills Programme (CASP) checklist was used to assess each study's internal and external validity, focusing on the clarity of research objectives, study design appropriateness, sampling strategies, risk of bias, reliability of outcomes, and generalizability of findings. This rigorous appraisal process ensured that only high-quality, evidence-based studies contributed to the final synthesis.

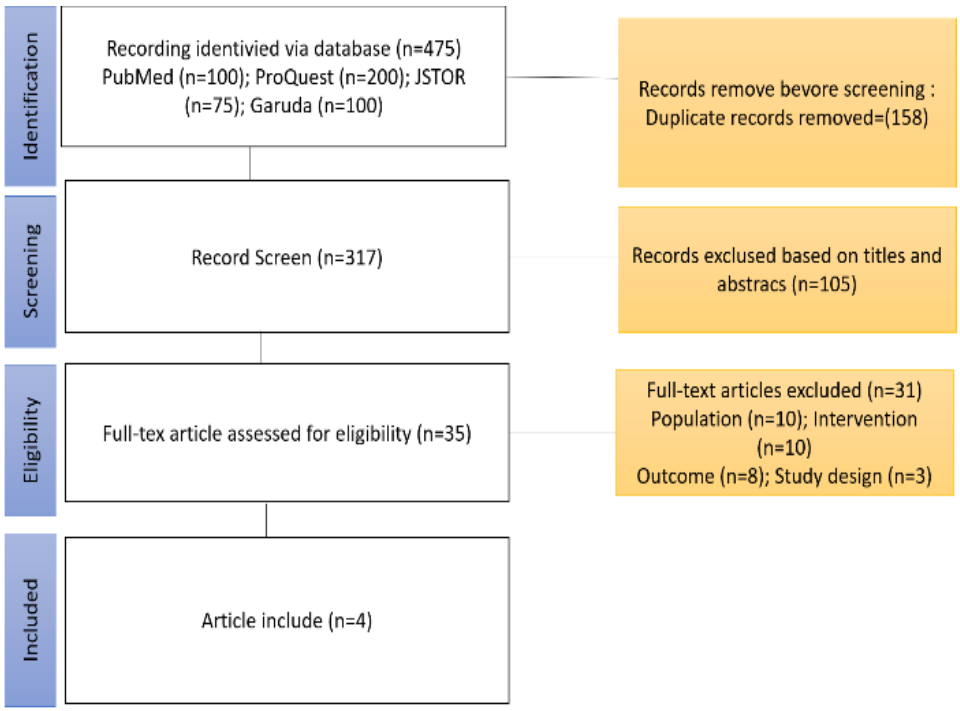

Figure 1. Screening process flowchart based on PRISMA 2020

Result

Study Selection

The initial database search yielded 475 articles. After removing 158 duplicates, 317 articles were screened by title and abstract. Following this screening, 35 articles were eligible for full-text assessment. Ultimately, 4 articles met the predefined inclusion and exclusion criteria and were included in this systematic review. The complete selection process is illustrated in Figure 1 below, in accordance with the PRISMA 2020 flowchart.

Study Characteristics

All included studies investigated the effectiveness of iron (Fe) supplementation in increasing hemoglobin levels among adolescents diagnosed with anemia. The characteristics of each intervention, including duration, method, and facilitator, are summarized in Table 2.

Table 2. Characteristics of Interventions

Author	Intervention and Facilitator	Number of Sessions	Duration	Method/Media	Topic
Tonasih et al. (2019)	Fe tablet, facilitated by the author, conducted in Cirebon	8 meetings	Not stated	Circular letter by Cirebon government	Administration of Fe tablets to increase hemoglobin
Yuanti Y et al. (2020)	Fe tablet, facilitated by the author, conducted in Bekasi	Not stated	1 month	Not mentioned	Not mentioned
Damayanti et al. (2021)	Fe tablet, facilitated by the author, conducted in Kubu Raya, West Kalimantan	Not stated	14 days	Not mentioned	Not mentioned
Wahyuni et al. (2021)	Fe tablet, facilitated by the author, conducted in Pesanggrahan District	16 times	Not stated	Direct education using digital comic media	Fe tablets to increase hemoglobin levels in adolescents

The table presents four studies involving Fe tablet interventions aimed at improving hemoglobin levels, with all interventions facilitated by the researchers in different regions of Indonesia. Tonasih et al. (2019) conducted eight sessions in Cirebon supported by a circular letter from the local government to promote Fe tablet administration. Yuanti et al. (2020) implemented a one-month intervention in Bekasi, although the number of sessions, method, and specific outcomes were not reported. Similarly, Damayanti et al. (2021) carried out a 14-

day intervention in Kubu Raya, West Kalimantan, but provided limited information regarding session details or educational strategies. In contrast, Wahyuni et al. (2021) conducted a more comprehensive intervention in the Pesanggrahan District, holding 16 sessions and incorporating direct education using digital comic media to enhance adolescent engagement and knowledge about Fe tablet use. Overall, while the goal of improving hemoglobin levels was consistent across studies, variations in reporting and educational approaches highlight the need for more structured and transparent intervention designs.

Table 3. Data Extraction Summary

Author, Year, Country	Design (Sample Size)	Intervention	Instrument (Outcome)	Findings
Tonasih et al. (2019)	Quasi-experiment (n = 163)	Tablet Fe	Paired T-test	Fe supplementation increased hemoglobin levels and reduced anemia. Knowledge was critical, but low compliance limited outcomes. Stronger education is needed.
Yuanti Y et al. (2020)	One-group pretest-posttest (n = 105)	Tablet Fe	T-test	Hemoglobin increased by 1.550 g/dL (p = 0.001). Emphasis on promotive and preventive strategies with school-health collaboration was recommended.
Damayanti et al. (2021)	Experimental with control group (n = 36)	Tablet Fe and honey	Paired and independent T-tests	Honey enhanced the effectiveness of Fe supplementation. Significant improvement (p = 0.002) suggested honey as a potential absorption enhancer.
Wahyuni et al. (2021)	Quasi-experimental with control group (n = 126)	Tablet Fe and IEC intervention	Probability sampling	Hemoglobin levels improved, but adherence was low. Teacher training and parental involvement are crucial for improving compliance and program success.

The table summarizes four Indonesian studies on Fe tablet interventions aimed at increasing hemoglobin levels. Tonasih et al. (2019) found improved hemoglobin but low

compliance due to limited knowledge. Yuanti et al. (2020) reported a 1.550 g/dL increase (p = 0.001) and suggested school-based prevention efforts. Damayanti et al. (2021) showed that honey enhanced Fe absorption significantly (p = 0.002). Wahyuni et al. (2021) confirmed improvement with Fe and education media, but stressed the need for teacher and parental support to improve adherence.

Quality Assessment

The quality of the included studies was appraised using the Critical Appraisal Skills Programme (CASP) checklist. Each study met the majority of the criteria, although all had some limitations regarding the clarity of recruitment methods (Q5). The results of the quality assessment are shown in Table 4.

Table 4. CASP Checklist for Study Quality

Author/Year	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
Tonasih et al. (2019)	Y	Y	Y	Y	N	Y	Y	Y	Y	Y
Yuanti Y et al. (2020)	Y	Y	Y	Y	N	Y	Y	Y	Y	Y
Damayanti et al. (2021)	Y	Y	Y	Y	N	Y	Y	Y	Y	Y
Wahyuni et al. (2021)	Y	Y	Y	Y	N	Y	Y	Y	Y	Y

The CASP checklist results for the four Fe tablet intervention studies indicate a generally high methodological quality across most criteria. All studies—Tonasih et al. (2019), Yuanti et al. (2020), Damayanti et al. (2021), and Wahyuni et al. (2021)—answered "Yes" for nine out of ten questions, specifically Q1 to Q4 and Q6 to Q10, demonstrating clarity in research objectives, appropriate design, and reliable findings. However, all four studies scored "No" on Q5, which typically relates to ethical considerations such as whether the potential harms to participants were addressed or if ethical approval was obtained. This consistent gap suggests a common shortcoming in reporting or addressing ethical elements explicitly. Despite this, the studies are overall considered methodologically sound and provide valuable insights into Fe tablet interventions for improving hemoglobin levels in various Indonesian contexts.

Data Extraction and Study Findings

Data extracted from the four included studies focused on design, sample size, intervention, measurement instruments, and key findings. All studies reported significant increases in hemoglobin levels following iron supplementation, although factors such as adherence, knowledge, and interventions influenced outcomes.

Discussion

This systematic review confirms that iron (Fe) tablet supplementation is effective in increasing hemoglobin (Hb) levels in adolescent girls with anemia. All studies included in this review reported significant increases in hemoglobin levels following the intervention, indicating that Fe supplementation remains a reliable and evidence-based approach to addressing iron deficiency anemia in adolescents (Tonasih et al., 2019; Yuanti et al., 2020; Damayanti et al., 2021; Wahyuni et al., 2021). The effectiveness of Fe tablet administration, however, is influenced by several interrelated factors, including frequency and duration of

intake, adherence to the regimen, the presence of dietary enhancers, and the incorporation of educational strategies.

In comparing the modes and frequency of administration, daily Fe tablet supplementation for one month demonstrated greater effectiveness in raising hemoglobin levels than weekly supplementation or administration limited to menstruation periods (Widowati et al., 2020). Nonetheless, weekly supplementation over a longer duration, such as one year, also resulted in a significant hemoglobin increase, which highlights its viability in large-scale public health interventions if sustained adherence is maintained (Susanti Y et al., 2016). Furthermore, Damayanti et al. (2021) found that combining Fe tablets with honey led to a greater improvement in hemoglobin levels than using Fe tablets alone. Honey, which contains essential minerals, appears to enhance iron absorption and mitigate gastrointestinal side effects like nausea and constipation, thereby improving adherence. These findings align with the results of Widowati R et al. (2020), who reported enhanced outcomes with this combination.

Adherence remains a major determinant of intervention success. Studies by Tonasih et al. (2019) and Yuanti et al. (2020) indicated that while iron supplementation significantly increased hemoglobin levels, low compliance reduced the overall effectiveness. Knowledge about the benefits of iron supplementation was shown to play a crucial role in adherence. Interventions that incorporated education, such as Wahyuni et al. (2021), which utilized Information, Education, and Communication (IEC) strategies, demonstrated improvements in awareness and compliance, although adherence still presented challenges. Pusparini et al. (2020) supported the importance of combining Fe supplementation with nutrition education and adherence monitoring to maximize impact.

Oktariani E et al. (2023) and Nurhasanah et al. (2023) emphasized the importance of preventing anemia in adolescent girls, particularly due to its potential consequences during pregnancy, childbirth, and postpartum. Cia A et al. (2022) further explained that the effectiveness of Fe tablets lies in their elemental iron content typically in the form of ferrous sulfate, fumarate, or gluconate and the inclusion of folic acid, which supports red blood cell production. These components together contribute to the improvement of hemoglobin levels and overall hematologic health.

Among the various intervention strategies identified namely, exclusive Fe tablet administration, Fe tablets combined with honey, Fe tablets combined with educational programs, and routine Fe supplementation exclusive Fe tablet supplementation showed the highest increase in hemoglobin levels. However, supplementation combined with honey demonstrated additional benefits through enhanced absorption and improved tolerance, while education-focused interventions notably improved compliance even if hemoglobin gains were slightly lower.

These findings are further supported by previous literature. Saptyani P et al. (2018) and Widowati R et al. (2020) both concluded that Fe tablet supplementation significantly improves hemoglobin levels. The evidence also underscores the need to tailor intervention strategies to the target population, considering factors such as individual health status, menstrual patterns, and dietary habits.

While the included studies provide robust evidence due to their experimental or quasi-experimental designs, several limitations were observed. These include small sample sizes, lack of control groups in some studies, and difficulties in monitoring adherence. These

methodological limitations suggest the need for future research with larger sample sizes, better randomization, and controlled designs to provide stronger scientific validation.

From a clinical standpoint, Fe supplementation is a key strategy for preventing and managing iron deficiency anemia in adolescents. In terms of policy, school-based Fe supplementation programs show significant potential in increasing coverage and adherence. However, persistent challenges such as side effects, inadequate monitoring, and limited stakeholder engagement continue to hinder optimal implementation. Thus, future interventions should prioritize integrated approaches that include regular hemoglobin monitoring, adherence tracking, side effect management, and involvement of parents, teachers, and healthcare workers. A collaborative and multidisciplinary framework is essential for enhancing the sustainability and effectiveness of iron supplementation programs. As new evidence emerges, national health policies must be continuously updated to reflect the best practices in improving adolescent health outcomes through Fe supplementation.

Conclusion

This systematic review concludes that iron tablet supplementation is an effective intervention for increasing hemoglobin levels among adolescents with anemia. The evidence consistently demonstrates a significant improvement in hemoglobin levels following supplementation. However, adherence to iron intake remains a critical challenge that can diminish the overall effectiveness of the intervention. Several factors influence the outcomes, including dosage, duration, frequency of consumption, and external support from families and educational institutions.

To enhance the success of iron supplementation programs, it is essential to adopt a comprehensive approach that integrates preventive, curative, and promotive strategies. Collaboration between schools and healthcare providers is particularly important to improve awareness, adherence, and access to supplementation. Future research should prioritize the development of targeted strategies aimed at improving adherence and ensuring the long-term sustainability of iron supplementation efforts in adolescent populations.

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Not applicable.

Authors' contribution

Each author contributed equally in all the parts of the research. All authors have critically reviewed and approved the final draft and are responsible for the content and similarity index of the manuscript.

Conflict of interest

The researchers stated that there is no conflict of interest related to the implementation and publication of the results of this research. The entire research process, from planning, data collection, analysis, to report preparation, was carried out independently without any influence or pressure from any third party. A commitment to research ethics is upheld throughout the research process, ensuring transparency, accuracy and honesty in reporting results. Respondents' participation was voluntary with informed consent, and their confidentiality and privacy were maintained in accordance with applicable research ethics standards. With this statement, researchers hope that the research results can be trusted and

used as a valid reference for the development of science and health practices related to ethnomedicine and reproductive health.

Ethical consideration

Not applicable.

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