



Effectiveness of Health Education on Iron Supplement Adherence Among Adolescent Girls: A Scoping Review

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Abstract

Anemia in adolescent girls affects cognitive performance, physical and mental health, social development, and increases the risk of anemia during pregnancy. Health education programs have been implemented to improve adherence with iron supplementation, yet evidence comparing the effectiveness of different approaches remains limited. This study aimed to map and synthesize evidence on the effectiveness of health education interventions in improving adherence to iron supplementation among adolescent girls. A scoping review was conducted following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR) and the Joanna Briggs Institute (JBI) scoping review framework with PCC criteria: adolescent girls (Population); health education (Concept); adherence with iron supplementation (Context). Articles with no date restriction were retrieved from Scopus, PubMed, and EBSCO using predefined keywords. Data extraction included country, design, findings, and study limitations. Seven articles were included following title, abstract, and full-text screening. Thematic analysis was applied, and results were presented in tables and narrative form. Studies were conducted in India (n=4) and Indonesia (n=3), published between 2008 and 2025, involving samples ranging from 70 to 150,700 adolescent girls. All included studies reported a positive association between health education and improved adherence to iron supplementation, with adherence rates ranging from 26.5% in WhatsApp-based reminder interventions to 97.1% in teacher-supervised, directly observed treatment. Health education combined with direct supervision, family support, and digital reminders can effectively improve adolescent girls' adherence to iron supplementation. Subsequent studies should use standardized adherence indicators and longer follow-up periods to enhance comparability and generalizability.

Keywords

Adherence, Adolescent girls, Anemia, Health education, Iron supplementation

1. BACKGROUND

The World Health Organization (WHO) has designated anemia as a key indicator of nutritional status and health. At the global level, the prevalence of anemia in pregnant women (35.5%) is higher than that in non-pregnant women (30.5%) (WHO, 2023). Anemia in adolescent girls can not only affect cognition, but also affect physical, mental, and social health (WHO, 2012). Adolescent girls with anemia are 1.73 times more likely to experience cognitive impairment than teenage girls without anemia (Bahrami et al., 2020; Musfira & Hadju, 2025). The long-term impact of anemia in adolescent girls is the risk of developing anemia during pregnancy, which will negatively affect fetal growth and development and increase the risk of complications during childbirth, including premature birth, low birth weight, and the risk of stunting later in life (Feriyanthi et al., 2022).

Prevention and control strategies for anemia in adolescent girls and women of childbearing age focus on ensuring adequate food intake through balanced nutrition, iron supplementation, increased fortification of foodstuffs with iron and folic acid, and treatment of concomitant diseases. Various studies were conducted to see the impact of iron and folic acid (IFA) supplementation on biological

indicators such as ferritin, hemoglobin levels, and clinical outcomes, as well as to examine distribution methods, such as whether it is administered in schools or health (Meilani & Setiyawati, 2023; Setiawati et al., 2022). Adherence to iron and folic acid supplementation is essential to prevent anemia (Abby et al., 2023). Adherence to iron tablet consumption among adolescent girls is influenced by various factors that can generally be categorized as personal, social, environmental, and regimen-related. Previous studies show that knowledge, attitudes, peer support, and iron tablet distribution significantly influence adherence rates (Ansari et al., 2021; Hidayanty et al., 2025; Silitonga et al., 2025; Tando et al., 2024).

Health education is a significant factor in adherence to iron tablets among adolescent girls. Theoretical frameworks such as the Health Belief Model (HBM) and the Theory of Planned Behavior (TPB) can be used to explain how health education influences individual adherence. According to HBM, a person will be more motivated to implement health behaviors, including taking iron supplements, if he or she feels at risk of developing health problems, understands that the condition can have serious impacts, and believes that the benefits of the recommended actions

outweigh the obstacles that may be faced (Rosenstock, 1974). Similarly, the TPB suggests that behavioral intentions, shaped by attitudes, subjective norms, and perceived behavioral control, are the most proximal determinants of health behavior (Ajzen, 1991). Based on this theoretical framework, health education interventions targeting cognitive and social factors have the potential to be an effective approach for improving adherence to iron supplementation among adolescent girls.

The combination of health education and iron supplementation led to significant improvements in hemoglobin and hematocrit levels (Rajkumar et al., 2018). The results also showed that health education delivered through various media, such as print, audiovisual, social media, and peer groups, can significantly increase self-awareness and adherence to iron supplementation among adolescent girls (Septiana et al., 2025). Most systematic reviews have assessed changes in Hb or anemia as indicators of success. However, few have specifically examined the effectiveness of health education as a component of interventions to improve adherence among adolescent girls. This scoping review mapped the available evidence on the effectiveness of health education in improving adolescent girls' adherence to iron supplementation. It

classified the types of educational interventions used (materials and methods). This review not only provides a comprehensive picture of how effective health education is in improving adherence but also provides an empirical basis for developing more sustainable, standardized, and contextually relevant intervention methods.

2. METHODS

This scope review was conducted by following the methodological guidelines set by the Joanna Briggs Institute (JBI) for scoping reviews (Peters et al., 2020) and presented in accordance with the PRISMA-ScR (Preferred Reporting Items for Systematic Reviews and Meta-Analyses Extension for Scoping Reviews) reporting standards (Tricco et al., 2018). This review followed the PRISMA flow diagram. It followed the PCC format: Population = adolescent girls; Concept = health education; Context = adherence to iron supplement consumption.

A systematic search was conducted in August 2025 across three electronic databases: PubMed, Scopus, and EBSCO. No publication year restriction was applied, given the limited number of studies specifically addressing health education interventions to improve adherence to iron supplementation among

adolescent girls; imposing a date restriction would risk excluding relevant evidence and undermine the comprehensive mapping purpose of this scoping review. The following Boolean search string was used across all databases: ("adolescent girls" OR "female adolescent") AND ("health education") AND ("iron supplementation" OR 'iron folic acid' OR 'IFA' OR "tablet tambah darah").

Inclusion criteria were: (1) study population of adolescent girls aged 10-19 years; (2) interventions defined as health education in any form; (3) outcome related to adherence to iron supplementation; (4) full-text articles in English; and (5) observational and experimental study designs. Exclusion criteria included: (1) non-full-text articles; (2) studies involving populations other than adolescent girls (e.g., children, pregnant women, and postpartum women, adolescent boys); (3) review articles; and (4) qualitative studies.

Operational definition applied in this review were as follows: (1) Adolescent girls were defined as girls aged 10–18 years; (2) Health education was defined as a planned learning process to influence individuals, groups, or communities to improve their knowledge, attitudes, and skills related to health by using various media, both digital and traditional; (3) Adherence to iron supplementation was defined as the level

of adherence among adolescent girls in taking iron tablets or iron supplements according to the recommended usage, dosage, and frequency to prevent and treat anemia.

The study selection process consisted of two stages: title and abstract screening using inclusion and exclusion criteria, followed by full-text article eligibility assessment. A single reviewer performed screening and data extraction. This methodological limitation may increase the risk of selection bias because it lacks independent review by multiple reviewers. The extracted data included the author and year of publication, country of study, journal, study design, study population, form of health education provided, key findings, adherence assessment method, and study limitations. The article selection process is presented using a PRISMA-ScR diagram (Figure 1).

Based on searches across the three databases, 83 articles were retrieved prior to screening. Following the removal of 4 duplicate records and 5 articles automatically flagged as ineligible by the reference management system (Mendeley), 74 records proceeded to title and abstract screening. of these, 48 articles were excluded at the screening stage, leaving 26 articles sought for full-text retrieval. Seven articles could not be retrieved in full text,

leaving 19 articles assessed for eligibility. Following full-text review, 11 articles were excluded due to irrelevant outcomes (n=5), irrelevant study design (n=3), and inappropriate study population (n=3). A total of 7 articles met the inclusion criteria and were included in the final thematic analysis. The complete article selection process is illustrated in Figure 1.

3. RESULTS

Based on searches across three databases, 83 articles were retrieved in total (Scopus, n=62; PubMed, n=17; EBSCO, n=4). Following the removal of duplicates (n=4) and records automatically flagged as

ineligible by the reference management system (n=5), 74 records underwent title and abstract screening. After excluding 48 records at the screening stage, 26 articles were sought for full-text retrieval, of which 7 could not be accessed. The remaining 19 articles were assessed for full-text eligibility, and 11 were subsequently excluded due to irrelevant outcomes (n=5), an irrelevant study design (n=3), or an inappropriate population (n=3). A total of 7 articles met the inclusion criteria and were included in the final thematic analysis. The complete selection process is presented in Figure 1.

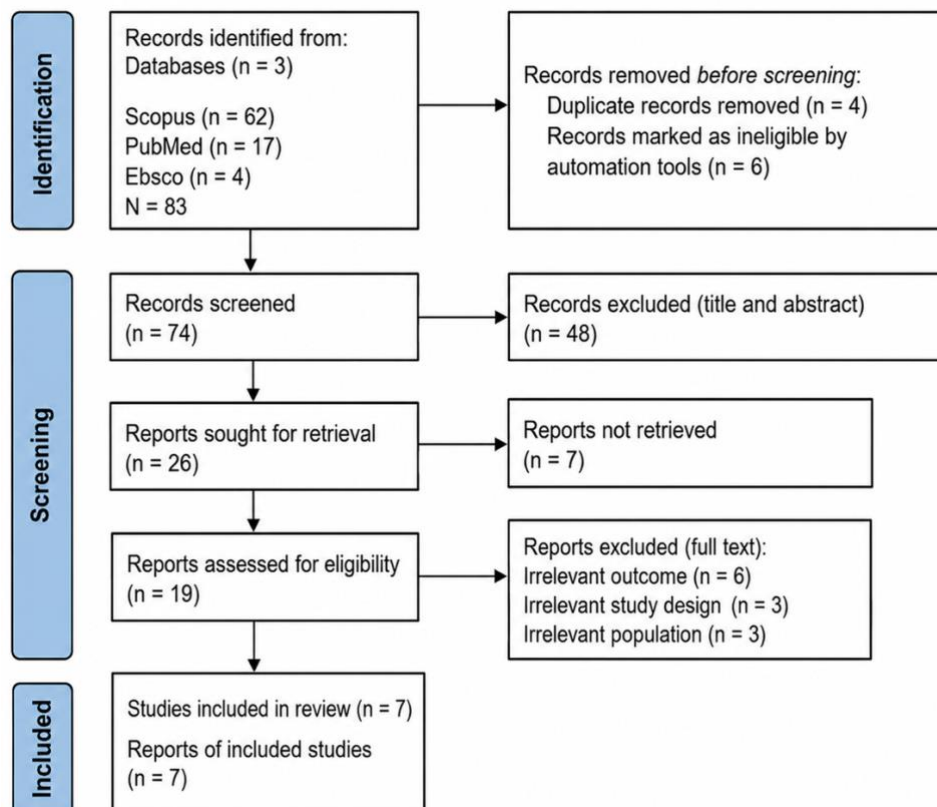


Figure 1. PRISMA 2020 flow diagram of The Effectiveness of Health Education in Increasing Adherence with Iron Supplement Consumption among Adolescent Girls

The seven included studies were published between 2008 and 2025 and represented two countries: India (n=4) and Indonesia (n=3). Sample sizes varied considerably, ranging from 70 adolescent girls in quasi-experimental school-based studies to 150,700 participants in a large-scale government effectiveness study, reflecting the diversity of intervention contexts and scales. The majority of studies employed quasi-experimental designs (n=4), while the remaining studies used

mixed-methods (n=1), community-based intervention (n=1), and large-scale operational program evaluation (n=1). Interventions were predominantly school-based (n=5), with two studies adopting community-based approaches. Follow-up durations ranged from four weeks (Laurence et al., 2025) to several (Chakma et al., 2013; Vir et al., 2008). A comprehensive summary of all included studies is presented in Table 1.

Table 1. Summary of Included Studies on the Effectiveness of Health Education Interventions on Iron Supplement Adherence Among Adolescent Girls (*Continue to page 254*)

Author (Year), Country, Journal	Design Study- Study Population	Health Education Intervention	Key Findings	Adherence Measurement	Study Limitation
Chakma et al. (2013), Madhya Pradesh, India, Public Health Nutrition	Community-based intervention; N=233 (of 274 enrolled) tribal adolescent girls aged 12–19 years	Community mobilization, group counseling, training for health workers, and teachers	Counseling significantly associated with adherence ($\chi^2=72.74$, $df=3$, $p<0.0001$)	Pill count every 10 days by teachers and anganwadi workers, cross-verified by the investigator	Initial exclusion of severe anemia cases was later reversed due to ethical concerns, potentially affecting the study design
Kotecha et al. (2009), Gujarat, India, Indian Journal of Medical Research	Large-scale program evaluation; N=69,000 in Grades 8–12 across 426 schools, Vadodara district	Nutrition education for girls & teachers using government IEC materials.	Health education is ineffective in changing dietary behavior and knowledge retention; adherence is managed via a separate structured monitoring system	Self-monitoring and multi-level supervision	No control group; entire district covered by program, making comparison impossible
Laurence et al. (2005), Maluku, Indonesia, Frontiers in Digital Health	Quasi-experimental (pre-post control group); N=91 (intervention: n=49, control: n=42)	WhatsApp-based reminders (3 times per week, 4 weeks): text & image messages on anemia, WIFAS, and IFA intake	Intervention group more likely to take WIFAS ($p<0.001$) and consume $\geq 75\%$ distributed tablets ($p=0.015$); adherence 26.5% vs. 7% (control)	Self-reported using a card	Low use of the reporting link hindered adherence monitoring; incomplete participation reduced sample size and generalizability.
Meilani & Setiyawati (2023), Yogyakarta, Indonesia,	Quasi-experimental; N=70 senior high school girls (35/group)	Directly Observed Treatment (DOT) by teachers vs. peer educators.	Adherence: teacher-observed 97.1% vs. peer-observed 68.6%	Self-reported using a card	The peer group showed no significant Hb improvement; peers were insufficient to

Author (Year), Country, Journal	Design Study- Study Population	Health Education Intervention	Key Findings	Adherence Measurement	Study Limitation
Jurnal Kesehatan Masyarakat		Treatment method.			replace teachers in ensuring adherence
Rusdin et al. (2021), Makassar, Indonesia, Macedonian Journal of Medical Sciences	Quasi- experimental (RCT pre-post test); N=70 (35/group)	PAKEM model: lecture, group discussion, problem- solving, game simulation (quiz, role-play, card matching); media: poster, leaflet, video, app.	Adherence score increased from 0.83 to 7.34 (intervention); mean difference vs. control: 2.91 (285%)	Self-reporting, along with proof of Fe tablet consumption in the form of photos or videos.	Scores declined at post-test 2 in the control group due to the absence of weekly monitoring
Vir et al. (2008), Uttar Pradesh, India, Food and Nutrition Bulletin	Large-scale effectiveness study; N=150,700 adolescent girls aged 10–19 years	Monthly family life education sessions covering adolescent health and development, integrated with weekly IFA plus deworming tablets	Health education and counseling significantly influenced IFA adherence	Register- based supply and consumption recording at ICDS center	Not designed as a long-term study; limited longitudinal evidence
Y et al. (2024), Karrul, India, Journal of Family Medicine and Primary Care	Mixed-method (sequential explanatory); community- based cross- sectional; N=972 adolescent girls aged 10–19 years and their parents	Counseling on IFA benefits and misconception clarification for non-adherent participants	Health education associated with higher adherence: parents (OR=2.76, p=0.002); girls (OR=3.07, p=0.000)	Self-reported using a card	Self-reported adherence; potential recall bias

Note.

RCT = Randomized Controlled Trial; IFA = Iron Folic Acid; WIFAS = Weekly Iron Folic Acid Supplementation; DOT = Directly Observed Treatment; PAKEM = Pembelajaran Aktif Kreatif Efektif dan Menyenangkan; ICDS = Integrated Child Development Services (ICDS), OR = Odds Ratio; Hb = Hemoglobin; N = number of participants; χ^2 = Chi-square; df = degrees of freedom; IEC = Information, Education, and Communication.

The health education interventions identified across the seven studies were diverse in their modalities and delivery mechanisms. These included: (1) school-based Directly Observed Treatment (DOT) supervised by teachers or peer educators (Meilani & Setiyawati, 2023) (2) the PAKEM (Participatory, Active, Creative, Effective, and Fun) active learning model, incorporating lectures, group discussions, problem-solving, role-play, quiz games,

and multimedia materials (Rusdin et al., 2021) (3) WhatsApp-based digital reminders delivered three times per week over four weeks (Laurence et al., 2025) (4) community-based group counseling combined with training for health workers and teachers (Chakma et al., 2013) (5) monthly family life education sessions integrated with weekly IFA supplementation and deworming (Vir et al., 2008) (6) government-led nutrition

education using information, education, and communication (IEC) materials delivered through schools (Kotecha et al., 2009) and (7) individual counseling targeting misconceptions about IFA supplementation, provided to both adolescent girls and their parents (Y et al., 2024).

Six of the seven included studies reported a positive association between health education and improved adherence to iron supplementation. The highest adherence rate was observed in the teacher-supervised DOT intervention, where adherence reached 97.1% compared to 68.6% in the peer-educator group (Meilani & Setiyawati, 2023). The PAKEM active learning intervention demonstrated a substantial increase in adherence scores, rising from 0.83 to 7.34 in the intervention group, representing a mean difference of 2.91 (285%) compared to the control group (Rusdin et al., 2021). WhatsApp-based reminders resulted in adherence of 26.5% in the intervention group compared to 7% in the control group, with participants in the intervention group significantly more likely to consume $\geq 75\%$ of the distributed tablets ($p=0.015$) (Laurence et al., 2025). Community-based counseling interventions in India similarly demonstrated that repeated counseling and family involvement were significantly

associated with higher adherence (Chakma et al., 2013; Vir et al., 2008). Parental involvement was found to increase the likelihood of adherence by 2.76 times among the general population and 3.07 times among adolescent girls (Y et al., 2024). One operational study, however, noted that structured monitoring systems rather than health education alone were the primary driver of adherence outcomes (Kotecha et al., 2009).

Adherence was operationalized in various ways across the included studies. Self-reported adherence using monitoring cards was the most commonly employed method ($n=4$). In contrast, other studies used pill counts verified by teachers or health workers (Chakma et al., 2013), register-based recording of supply and consumption at integrated child development service centers (Vir et al., 2008), and photographic or video evidence of tablet consumption (Rusdin et al., 2021). The heterogeneity of measurement approaches limits direct comparability across studies and represents a key methodological challenge for synthesizing evidence in this field.

4. DISCUSSION

This scoping review identified seven studies examining the effectiveness of health education interventions on

adherence to iron supplementation among adolescent girls, all conducted exclusively in Indonesia and India. The geographic concentration of evidence reflects the high burden of iron deficiency anemia in South and Southeast Asia, where adolescent girls remain a particularly vulnerable population. National data from Indonesia indicate that adherence rates to iron-folic acid supplementation programs among adolescent girls have been persistently low, at 1.4% in 2018 and 3.0% in 2023 (Kementerian Kesehatan RI, 2023), attributed to factors such as lack of awareness, inadequate health education, and cultural beliefs about supplementation. The interventions reviewed in this study can serve as an alternative approach to address public health problems that require follow-up (Cramer et al., 2008).

A critical appraisal of the methodological quality of included studies reveals several important limitations that affect the interpretability and generalizability of findings. The majority of studies employed quasi-experimental designs without randomization ($n=4$), limiting causal inference. Only one study used a randomized controlled trial (RCT) design (Rusdin et al., 2021), while others relied on large-scale program evaluations or mixed-methods approaches that were

not designed to isolate the effect of health education specifically. The absence of control groups in some studies — most notably the large-scale Gujarat program (Kotecha et al., 2009) — further limits the ability to attribute observed outcomes solely to health education interventions. Additionally, most studies relied on self-reported adherence measures, which are susceptible to recall and social desirability (Meilani & Setiyawati, 2023; Y et al., 2024). Follow-up durations were generally short, ranging from four weeks to several months, making it difficult to assess the sustainability of behavioral change. These methodological heterogeneities collectively limit the strength of conclusions that can be drawn from the available evidence base.

Among the identified intervention types, school-based directly observed treatment (DOT) supervised by teachers demonstrated the highest adherence rates. Studies evaluating directly observed treatment (DOT) in high schools show that teacher-supervised interventions achieve very high adherence, exceeding 97% in the teacher group compared to 77% in the peer-educator group (Meilani & Setiyawati, 2023). This finding underscores the critical role of authority figures and structured accountability mechanisms in sustaining adherence behavior. From a theoretical perspective, Social Cognitive Theory

(SCT) explains this through the concepts of observational learning and reinforcement, in which teachers' authority serves as a more credible behavioral model than peers'. Adherence with the consumption of blood tablets is influenced by the social environment, which provides reminders and information, including from teachers, parents, peers, and health workers (Silitonga et al., 2023). Distributing IFA supervision responsibilities across multiple teachers and streamlining monitoring processes may reduce the burden at the school level while maintaining high adherence outcomes (Gosdin et al., 2020). From a policy perspective, integrating DOT into existing school health programs is a structurally feasible and cost-effective strategy to scale up supervised supplementation.

The PAKEM (Participatory, Active, Creative, Effective, and Fun) method, evaluated in Makassar, Indonesia, demonstrated a significant increase in adherence-related knowledge, attitudes, and motivation, with mean adherence scores rising from 0.83 to 7.34 in the intervention group (Rusdin et al., 2021). This multi-strategy approach, incorporating lectures, group discussions, problem-solving, role-play, quiz games, and multimedia materials, reflects principles of constructivist education, wherein learners

actively construct knowledge through engagement rather than passive reception. From the perspective of the Health Belief Model (HBM), PAKEM increases perceived benefits and self-efficacy by providing a more immersive and engaging learning experience, thereby reducing perceived barriers to supplementation. However, a notable methodological limitation of the PAKEM study was the observed decline in adherence scores from post-test 1 to post-test 2 in the control group, attributed to the absence of weekly reinforcement. This finding suggests that gains from active learning interventions can decay without sustained follow-up, carrying important implications for program design specifically, the need for periodic reinforcement sessions to maintain behavioral change over time (Haile et al., 2024). Perceptions of vulnerability, severity, benefits, and barriers influence health behaviors. By providing a more in-depth learning experience, PAKEM increases perceived benefits and self-efficacy. Similar results were found in community-based counseling interventions.

Community-based counseling interventions in Madhya Pradesh and Uttar Pradesh demonstrated that repeated counseling and family involvement were significantly associated with higher

adherence to supplementation programs (Chakma et al., 2013; Vir et al., 2008). These findings confirm that education-based approaches and social support contribute meaningfully to the success of supplementation programs. The Theory of Planned Behavior (TPB) provides a useful theoretical lens here: counseling interventions targeting attitudes toward supplementation, subjective norms from family and community members, and perceived behavioral control can collectively strengthen behavioral intentions and, ultimately, adherence behavior (Ajzen, 1991). However, the challenge of community-based implementation lies in the substantial human resource requirements for conducting repeated counseling sessions and maintaining participant motivation over time. This practical constraint must be addressed in program planning and resource allocation.

Research in Madhya Pradesh found that repeated counseling and family involvement correlated with greater adherence to supplementation programs (Chakma et al., 2013). Similarly, a large-scale study in Uttar Pradesh found that weekly counseling with supplementation effectively reduced the prevalence of anemia among adolescent girls (Vir et al., 2008). This study confirms that an

education-based approach and social support contribute significantly to the success of supplementation programs. However, the challenge of implementation in a community context is the need for sufficient human resources to conduct repeated counseling and maintain participant motivation.

A government program in Gujarat that distributed IFA through secondary schools highlights the limitations of education-only approaches at scale (Kotecha et al., 2009). Although information, education, and communication campaigns were implemented, the results indicated that health education alone was insufficient to overcome behavioral barriers without robust monitoring mechanisms. While the program achieved broad population coverage, its effectiveness in influencing dietary behavior and knowledge retention was limited. This finding raises an important programmatic concern: large-scale implementation without rigorous monitoring and sustained educational reinforcement may be insufficient to drive meaningful behavioral change, even when structural access to supplements is ensured. The absence of a control group, a critical design limitation acknowledged by the authors, further constrains the interpretability of these findings.

Population-level policies addressing adolescent iron deficiency anemia must therefore emphasize a combination of supplement provision, intensive education, and continuous monitoring rather than relying on any single component (Septiana et al., 2025).

A mixed-methods study in Tamil Nadu found that health education provided to parents was associated with a 2.76-fold higher likelihood of adherence among the general population and a 3.07-fold higher likelihood among adolescent girls (Y et al., 2024). This finding highlights the household environment as a powerful mediator of adolescent health behaviors. Parental involvement transforms iron supplementation from an individual health behavior into a family-supported practice, reinforcing motivation and reducing the social barriers adolescents may face when taking supplements without family encouragement. This dynamic is particularly relevant in collectivist cultural contexts, as found in both Indonesia and India, where family influences on adolescent behavior are substantial. From a programmatic standpoint, health education curricula targeting parents delivered through school meetings, community health posts (posyandu), or digital platforms may represent a high-

leverage strategy for improving population-level adherence.

A quasi-experimental study conducted in Maluku, Indonesia, found that adolescent girls receiving WhatsApp-based reminders three times per week for four weeks were significantly more likely to have consumed WIFAS in the week before the endline survey ($p < 0.001$) and to have consumed at least 75% of distributed tablets ($p = 0.015$), with adherence reaching 26.5% compared to 7% in the control group (Laurence et al., 2025). This intervention modality reflects the growing global interest in mobile health (mHealth) strategies for chronic disease management and adherence to supplementation. WhatsApp's potential as a health communication platform lies in its capacity to deliver structured, consistent messages rapidly to large audiences (Kamel Boulos et al., 2016), thereby reinforcing health education content and increasing adolescents' awareness between formal educational encounters (Lestari et al., 2024). These findings demonstrate significant potential for digital technology to support public health programs, particularly given high smartphone penetration among adolescents in both Indonesia and India. However, the study's reliance on self-reported adherence and low utilization of the digital reporting link

represent important methodological limitations that temper the strength of these conclusions.

A critical cross-cutting finding of this scoping review is the substantial heterogeneity in study designs, sample sizes, intervention durations, and adherence measurement methods across the included studies. Adherence was operationalized in various ways, including self-report monitoring cards, direct observation, photographic evidence, programmatic records, and pill counts each with distinct levels of reliability and susceptibility to bias. Self-reported adherence in particular has been identified as potentially unreliable due to recall and social desirability biases. Follow-up durations ranged from four weeks to several months, making direct comparisons between short-term and sustained behavioral outcomes methodologically inappropriate. This heterogeneity precludes quantitative synthesis and limits the generalizability of findings across contexts. Future research should prioritize the adoption of standardized adherence measurement tools that combine subjective and objective methods, and consistent follow-up periods of at least 6 months to enable meaningful cross-study synthesis and support evidence-based policy development.

The collective evidence from this scoping review supports a multicomponent approach to health education to improve adherence to iron supplementation among adolescent girls. No single intervention modality demonstrated universal effectiveness across all contexts; rather, the most successful programs combined structured supervision (DOT), engaging educational content (PAKEM), social support (family involvement and counseling), and technological reinforcement (digital reminders). School-based programs with teacher involvement represent the most consistently effective platform, given schools' existing reach, authority structures, and monitoring capacity. Policymakers in Indonesia and India, and potentially in other high-burden settings, should consider integrating multicomponent health education frameworks into national supplementation programs, with explicit attention to monitoring mechanisms, family engagement strategies, and digital health tools. Standardization of adherence measurement instruments across programs would also facilitate the accumulation of evidence and program evaluation over time.

5. CONCLUSION

This scoping review maps the empirical evidence on the effectiveness of health education interventions for adherence to iron supplementation among adolescent girls by examining seven relevant studies from Indonesia and India. Data synthesis shows that health education interventions achieve optimal outcomes when synergized with structured surveillance, domestic support, and digital-based reinforcement. In particular, the strategy based on direct teacher supervision recorded the highest levels of adherence. In addition, other modalities, such as participatory active learning, community counseling, parental involvement, and digital reminders (WhatsApp), have been shown to make significant contributions to facilitating behavioral change in their respective contexts.

Given the nature of the scoping review, the main focus of this study is to map the breadth and characteristics of the intervention modality, rather than to measure the magnitude of the causal effect. Our analysis identifies the geographical centralization of scientific evidence in South and Southeast Asia, as well as high methodological heterogeneity, particularly in study designs and adherence measurement instruments. Therefore,

standardizing output indicators and extending the follow-up period are crucial for improving comparability across studies. To expand the generalization and scalability of global adolescent anemia reduction programs, future research should prioritize multicomponent interventions, geographic diversification of settings, and the use of hybrid adherence measurement methods that rigorously combine objective and subjective approaches.

AUTHOR CONTRIBUTIONS

HS, contributed to the conceptualization, methodology, and report writing. AK and SBM, contributed to investigation, data curation, and report writing. AS, contributes to the supervision, validation, and administration of research. All authors have read and agreed to all the contents of the published manuscript.

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CONFLICT OF INTEREST

The authors declare no conflict of interest. The funder had no role in the design of the study, the collection, analysis, or interpretation of data, the writing of the manuscript, or the decision to publish the results. The entire research process is carried out without any intervention from funders, from determining the research design through collecting and analyzing data, data interpretation, manuscript writing, and publication of research results.

DATA AVAILABILITY STATEMENT

The data the findings of this research are available from the corresponding author upon reasonable request.

REFERENCES

Abby, S. O., Arini, F. A., Sufyan, D. L., & Ilmi, I. M. B. (2023). The relationship between the compliance of TTD consumption, nutrition intake, and nutrition status on the incidence of anemia in adolescent girls at SMPN 1 Gunungsari. *Amerta Nutrition*, 7(2 SP), 213–223. <https://doi.org/10.20473/amnt.v7i2SP.2023.213-223>

Ajzen, I. (1991). The theory of planned behavior. *Organizational Behavior and Human Decision Processes*, 50(2), 179–211. [https://doi.org/10.1016/0749-5978\(91\)90020-T](https://doi.org/10.1016/0749-5978(91)90020-T)

Ansari, M. R., Istiti Kandarina, B. J., Kusmayanti, N., Destriyani, D., Masfufah, M., & Fikrinnisa, R. (2021). The acceptability of weekly iron-folic acid supplementation and its influencing factors among adolescent school girls in Yogyakarta city: A mix-methods study. *Malaysian Journal of Nutrition*, 27(1), 53–66. <https://doi.org/10.31246/MJN-2020-0019>

Bahrami, A., Khorasanchi, Z., Tayefi, M., Avan, A., Seifi, N., Tavakoly Sany, S. B., Ferns, G. A., Bahrami-Taghanaki, H., & Ghayour-Mobarhan, M. (2020). Anemia is associated with cognitive impairment in adolescent girls: A cross-sectional survey. *Applied Neuropsychology: Child*, 9(2), 165–171. <https://doi.org/10.1080/21622965.2018.1550405>

Chakma, T., Rao, P. V., & Meshram, P. K. (2013). Factors associated with high compliance/feasibility during iron and folic acid supplementation in a tribal area of Madhya Pradesh, India. *Public Health Nutrition*, 16(2), 377–380.

- <https://doi.org/10.1017/S1368980012002704>
- Cramer, J. A., Roy, A., Burrell, A., Fairchild, C. J., Fuldeore, M. J., Ollendorf, D. A., & Wong, P. K. (2008). Medication compliance and persistence: Terminology and definitions. *Value in Health*, 11(1), 44–47. <https://doi.org/10.1111/j.1524-4733.2007.00213.x>
- Feriyanti, A., Deviatin, N. S., Nurmala, I., Widati, S., & Atmaka, D. R. (2022). Determinant of adherence to iron supplementation in adolescent girl in specific intervention for stunting prevention: Systematic review. *Media Gizi Indonesia*, 17(1SP), 90–96. <https://doi.org/10.20473/mgi.v17i1SP.90-96>
- Gosdin, L., Sharma, A. J., Tripp, K., Amoafu, E. F., Mahama, A. B., Selenje, L., Jefferds, M. E., Ramakrishnan, U., Martorell, R., & Addo, O. Y. (2020). Barriers to and facilitators of iron and folic acid supplementation within a school-based integrated nutrition and health promotion program among Ghanaian adolescent girls. *Current Developments in Nutrition*, 4(9), nzaa135. <https://doi.org/10.1093/cdn/nzaa135>
- Haile, B., Oumer, A., Negese, T., Temesgen, M., Kebede, A., Abdurahman, D., Motuma, A., & Roba, K. T. (2024). Factors associated with compliance with weekly iron and folic acid supplementation among school adolescent girls in Debub Achefer district, northwest Ethiopia: School-based cross-sectional study. *Scientific Reports*, 14(1), 1–9. <https://doi.org/10.1038/s41598-024-60800-5>
- Hidayanty, H., Nurzakiah, N., Irmayanti, I., Yuliana, Y., Helmizar, H., & Yahya, Y. (2025). Perceived barriers and enablers for taking iron–folic acid supplementation regularly among adolescent girls in Indonesia: A pilot study. *International Journal of Environmental Research and Public Health*, 22(2), 1–17. <https://doi.org/10.3390/ijerph22020209>
- Kamel Boulos, M., Giustini, D., & Wheeler, S. (2016). Instagram and WhatsApp in health and healthcare: An overview. *Future Internet*, 8(3), 37. <https://doi.org/10.3390/fi8030037>
- Kementerian Kesehatan RI. (2023). Survei Kesehatan Indonesia (SKI) dalam angka. Badan Kebijakan Pembangunan Kesehatan, Kementerian Kesehatan RI. <https://kesmas.kemkes.go.id/asset>

- s/uploads/documents/SKI 2023 Dalam Angka.pdf
- Kotecha, P. V., Nirupam, S., & Karkar, P. D. (2009). Adolescent girls' anaemia control programme, Gujarat, India. *The Indian Journal of Medical Research*, 130(5), 584–589. <https://pubmed.ncbi.nlm.nih.gov/20090111/>
- Laurence, M. C., Titaley, C. R., Tahitu, R., Asmin, E., Kailola, N. E., Istia, S. S., Tando, Y. D., Pasamba, L. A., & Sara, L. S. (2025). The effect of WhatsApp-based reminders on enhancing knowledge and adherence to weekly iron-folic acid supplementation among adolescent girls in Maluku, Indonesia. *Frontiers in Digital Health*, 7, Article 1542006. <https://doi.org/10.3389/fdgth.2025.1542006>
- Lestari, L., Heryani, H., & Ariani, D. (2024). WhatsApp-based anemia e-leaflet for young women as a media for adolescent health promotion. *Journal of Education and Health Promotion*, 12(1), 448. https://doi.org/10.4103/jehp.jehp_186_23
- Meilani, N., & Setiyawati, N. (2023). Directly observed treatment for iron tablet supplements consumption among female senior high school students. *Kemas*, 18(3), 375–382. <https://doi.org/10.15294/kemas.v18i3.38594>
- Musfira, & Hadju, V. (2025). The relationship of chronic malnutrition to adolescent girls' cognition in Indonesia: A systematic review. *Nutricion Clinica y Dietetica Hospitalaria*, 45(1), 334–345. <https://doi.org/10.12873/45lmusfira>
- Peters, M. D. J., Marnie, C., Tricco, A. C., Pollock, D., Munn, Z., Alexander, L., McInerney, P., Godfrey, C. M., & Khalil, H. (2020). Updated methodological guidance for the conduct of scoping reviews. *JBIE Evidence Synthesis*, 18(10), 2119–2126. <https://doi.org/10.11124/JBIES-20-00167>
- Rajkumar, D. J., Manikandan, R., Mathuf, M. A., Aakash, K. S., Pajapath, D. K., Ashok Kumar, T. R., Sarumathy, S., & Logaraj, M. (2018). Effect of health education and iron supplementation on haemoglobin levels in adolescent girls. *Research Journal of Pharmacy and Technology*, 11(7), 2761–2764. <https://doi.org/10.5958/0974-360X.2018.00510.3>

- Rosenstock, I. M. (1974). Historical origins of the health belief model. *Health Education Monographs*, 2(4), 328–335. <https://doi.org/10.1177/109019817400200403>
- Rusdin, R., Abdullah, A. Z., Wahiduddin, W., Ansariadi, A., Suriah, S., & Hidayanty, H. (2021). Educational model of PAKEM in compliance with fe tablet consumption of adolescent girls. *Open Access Macedonian Journal of Medical Sciences*, 9, 710–716. <https://doi.org/10.3889/oamjms.2021.6576>
- Septiana, K. S., Adnani, Q. E. S., Susiarno, H., Tarawan, V. M., Arya, I. F. D., & Anwar, R. (2025). The influence of anemia education media on increasing self-awareness and compliance in consuming iron supplements in adolescent girls: A systematic review. *International Journal of Women's Health*, 17, 2277–2289. <https://doi.org/10.2147/IJWH.S532950>
- Setiawati, D., Ulfa, L., & Kridawati, A. (2022). Pengaruh pendidikan kesehatan terhadap sikap remaja tentang kesehatan reproduksi. *Jurnal Ilmu Kesehatan Masyarakat*, 11(4), 322–328. <https://journals.stikim.ac.id/index.php/jikm/article/view/1453>
- Silitonga, H. T. H., Salim, L. A., Nurmala, I., Hargono, R., Notobroto, H. B., Hartini, N., & Purwandini, S. (2023). The role of social support and interpersonal trust to improve compliance of iron supplementation amongst adolescent girls. *Nigerian Postgraduate Medical Journal*, 30(1), 75–80. https://doi.org/10.4103/npmj.npmj_277_22
- Silitonga, H. T. H., Salim, L. A., Nurmala, I., Wartiningsih, M., & Raga, A. D. (2025). The association between social support with compliance of IFA supplement intake among adolescent girls in Sidoarjo, Indonesia. *Nutrition and Health*, 31(2), 625–632. <https://doi.org/10.1177/02601060231206310>
- Tando, Y. D., Titaley, C. R., Tahitu, R., Asmin, E., & Sara, L. S. (2024). Anemia and adherence to weekly iron-folic acid supplementation among adolescent girls in a stunting locus of Ambon City, Indonesia. *Journal of Health Research*, 38(6), 467–479. <https://doi.org/10.56808/2586-940X.1103>
- Tricco, A. C., Lillie, E., Zarin, W., O'Brien, K. K., Colquhoun, H., Levac, D., Moher, D., Peters, M. D. J., Horsley, T., Weeks, L., Hempel, S., Akl, E. A., Chang, C., McGowan, J., Stewart, L., Hartling, L.,

Aldcroft, A., Wilson, M. G., Garritty, C., ... Straus, S. E. (2018). PRISMA extension for scoping reviews (PRISMA-ScR): Checklist and explanation. *Annals of Internal Medicine*, 169(7), 467–473. <https://doi.org/10.7326/M18-0850>

Vir, S. C., Singh, N., Nigam, A. K., & Jain, R. (2008). Weekly iron and folic acid supplementation with counseling reduces anemia in adolescent girls: A large-scale effectiveness study in Uttar Pradesh, India. *Food and Nutrition Bulletin*, 29(3), 186–194. <https://doi.org/10.1177/156482650802900304>

World Health Organization. (2012). Anaemia policy brief. https://www.who.int/iris/bitstream/10665/148556/1/WHO_NMH_NHD_14.4_eng.pdf

World Health Organization. (2023). WHO global anaemia estimates, 2025 edition. https://www.who.int/data/gho/data/themes/topics/anaemia_in_women_and_children