

SYSTEMATIC REVIEW

Factors Of Compliance To Iron Supplementation On Adolescent Girls With Anemia In Asia: A Systematic Review

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ABSTRACT

Introduction: Iron deficiency anemia (IDA) remains a critical global health challenge, particularly among adolescent girls, with a worldwide prevalence of 29.4%. While iron supplementation is a proven intervention, adherence rates remain suboptimal (32.7%-44.3%), undermining anemia control efforts. This systematic review synthesizes evidence on factors affecting adherence to iron supplementation in adolescent girls. **Methods:** This study followed the PRISMA guidelines, with searches conducted in five databases for studies published between 2020 and 2025. Of the 309 articles identified, 13 met the inclusion criteria and were analyzed thematically. **Results:** Key findings reveal that individual, social, and systemic factors influence adherence. Personal factors influencing adherence include low knowledge, negative attitudes, and low awareness of the consequences of anemia, which hinder adherence. Meanwhile, social factors include maternal support and peer influence, which significantly influence adherence behavior. Barriers related to supplements, such as unpleasant taste and gastrointestinal side effects, are often reported, along with forgetfulness as a major challenge. The systemic factors include school-based policies and the quality of program implementation, which also shape adherence. Context-specific interventions such as nutrition and monitoring can demonstrate improved adherence, highlighting the importance of locally tailored strategies. **Conclusion:** Adherence to iron supplementation is multifactorial, requiring integrated approaches. Recommendations include: (1) targeted education campaigns to enhance knowledge and attitudes, (2) optimizing supplement formulations to minimize side effects, (3) strengthening school and community-based distribution systems, and (4) engaging families and peers to foster supportive environments. Future programs should prioritize contextual adjustments to maximize compliance and reduce IDA among vulnerable groups.

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INTRODUCTION

Iron deficiency anemia is a significant global public health problem, especially among adolescent girls. According to the latest data from the World Health Organization (WHO), about 29.4% of adolescent girls worldwide suffer from anemia, with the highest prevalence in low- and middle-income countries (1). Anemia in adolescent girls has serious health consequences, including decreased cognitive function, decreased working capacity, increased risk of infection, and complications of future pregnancies. This condition also has far-reaching socio-economic impacts, including a decrease in school productivity, attendance, and overall quality of life. In adolescence, iron requirements increase significantly due to rapid growth, muscle mass formation, and, especially in adolescent girls, menstrual

blood loss. This puts adolescent girls at a very high risk of developing iron deficiency. Iron supplementation is an effective strategy for addressing iron deficiency anemia in adolescent girls. Several national supplementation programs have been implemented in various countries, focusing on weekly or daily iron supplementation. However, despite the availability of these programs, iron supplementation adherence rates among adolescent girls are often low. Research conducted (2) found that only 44.3% of adolescent girls adhered to a weekly iron supplementation program. Other studies in India (3) show a lower level of adherence, which is around 32.7%. This low level of adherence is a major barrier to the effectiveness of iron supplementation programs and is a significant challenge in overcoming anemia in the adolescent female population. This is attributed to various factors such as side effects, lack of knowledge, and minimal social support. Therefore, it is crucial to gain a deeper knowledge of the factors influencing adolescent girls' adherence to iron supplementation to enhance the effectiveness of anemia prevention interventions in this population. Adolescent girls who

adhere to iron supplementation can increase their hemoglobin levels, thereby preventing anemia (4) (5).

In addition to individual and social factors, health system factors also play an important role in iron supplementation adherence. Access to health services, supplement availability, quality of distribution programs, and effective communication from healthcare providers are all crucial aspects that affect adherence. Knowledge adherence to iron supplementation among adolescent girls is critical in addressing the global health burden of anemia. While the provision of iron supplements is a necessary step, it is adherence that determines the actual effectiveness of these interventions (6). Adolescent girls, due to their unique physiological and developmental needs, represent a high-risk group where even a small lapse in adherence can significantly undermine the intended health benefits. Without a clear knowledge of the behavioral, social, and systemic factors that influence adherence, large-scale public health efforts may fail to produce meaningful reductions in anemia prevalence. Thus, improving our knowledge of adherence patterns and barriers is essential for optimizing intervention strategies, informing policy, and ultimately achieving global targets for anemia reduction, as outlined by the World Health Organization. Research in Ghana identified that young women who have easy access to health facilities and receive adequate counselling from health workers have higher levels of adherence. Other research (7) showed that the integration of iron supplementation programs with existing adolescent health programs and using a school-based approach can improve adherence. The factors associated with the characteristics of the supplement itself also affect adherence. The type of supplement (tablets, capsules, or syrup), dosage, frequency of administration, and duration of treatment can all affect a young woman's willingness to take iron supplements regularly. Some studies suggest that a low-dose and weekly frequency regimen may improve adherence compared to high doses and daily frequency. For example, a study conducted (8) through a Cochrane Review found that intermittent iron supplementation had a higher level of adherence compared to daily supplementation. Interventions targeting factors affecting iron supplementation adherence have shown promising results. Approaches such as health education, reminders through mobile technology, school and family involvement, and taste enhancement and reduction of supplement side effects have been tested in a variety of contexts. Research (9) in China evaluated the effectiveness of school-based programs that combine health education, peer support, and digital reminders, finding a 37% increase in adherence compared to conventional approaches. Technology-based approaches, such as the use of mobile apps and text messaging, have also shown positive results in improving adherence.

Although some interventions have shown promising

results, there is still a gap in the literature regarding the relative effectiveness of different strategies for improving iron supplementation adherence among adolescent girls. Many existing studies have methodological limitations, including small sample sizes, short follow-up periods, and non-standard adherence measures. In addition, the majority of studies were conducted in specific geographic locations, which limited the generalization of findings to different contexts. This systematic review is important to do for several reasons. First, although iron deficiency anemia is a significant health problem among adolescent girls, there is still limited knowledge of the factors that affect iron supplementation adherence in this population. Second, iron supplementation programs have been implemented in various countries, but low adherence rates continue to be a major challenge. Knowledge the factors that affect adherence can help in the development of more effective interventions. Third, the majority of existing research focuses on the pregnant female population, with relatively limited attention to adolescent girls. Given the differences in demographic characteristics, social context, and health needs between these two populations, a better knowledge of the specific factors that influence adherence among adolescent girls is needed.

This systematic review aimed to identify, synthesize, and evaluate the current evidence regarding factors influencing iron supplementation adherence among adolescent girls. Specifically, this review aims to: (1) identify various individual, social, and health system factors that affect iron supplementation adherence in adolescent girls; (2) evaluate the strength of the relationship between these factors and supplementation adherence; (3) explore variations in factors influencing adherence based on geographical, socio-economic, and cultural contexts; (4) identify gaps in the literature and directions for future research; and (5) provide recommendations to improve iron supplementation adherence among adolescent girls. Achieving these goals, this systematic review is expected to make a significant contribution to the development of more effective strategies and interventions to improve iron supplementation adherence and, ultimately, reduce the prevalence of iron deficiency anemia among adolescent girls.

METHODOLOGY

Research Design

This study uses the systematic literature review (SLR) method as the main methodological approach. The SLR process in this study adopts the framework proposed (10) with updated PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines. SLR in this study is carried out through a series of well-structured and documented stages, including the formulation of research questions, the determination of literature search strategies, the determination of inclusion

and exclusion criteria, data extraction, methodological quality assessment, and synthesis of findings.

Search and Study Selection

The search and selection process of studies is carried out systematically using a predetermined search protocol. Literature searches were conducted on major electronic databases, including Scopus, Web of Science, IEEE Xplore, Science Direct, and PubMed, as shown in Table I.

Table I: Searches the electronic database. Literature searches were conducted on major electronic databases

Electronic databases	Searches
Scopus	Adolescent "OR Anemia "OR "Adherence Iron supplementation," OR "iron intake" OR "iron therapy Anemia" OR "iron deficiency anemia ("iron supplementation" OR "iron intake") AND (adherence OR adherence) AND (adolescents OR teenagers) AND (anemia)
Web of Science	"anemia" OR "iron deficiency anemia" "monitoring and evaluation" OR "program evaluation" OR "health program monitoring" ("iron supplementation" OR "iron therapy") AND (adherence OR adherence) AND (adolescents) AND (anemia)
IEEE Xplore	"iron supplementation" OR "iron intake" "adherence" OR "adherence" ("iron supplementation" OR "iron intake") AND ("monitoring app" OR "mHealth" OR "mobile health") AND (adherence OR adherence) AND (adolescents)
Science Direct	("iron supplementation" OR "iron therapy") AND (adherence OR adherence) AND (adolescents OR teenagers) AND ("monitoring app" OR "mHealth" OR "digital health") AND ("iron deficiency anemia")
PubMed	("iron supplementation" OR "iron intake") AND ("adherence" OR "adherence" OR "medication adherence") AND ("adolescents" OR "teenagers") AND ("iron deficiency anemia") AND ("mobile health" OR "monitoring app" OR "mHealth" OR "telemedicine")

The search period is limited to publications published between January 2020 and February 2025 to ensure relevance and up-to-date findings. The selection of studies was carried out through two screening stages: (1) screening of titles and abstracts and (2) assessment of the full text. The entire search and selection process was documented using the PRISMA 2020 flowchart to ensure transparency and openness of the process (11).

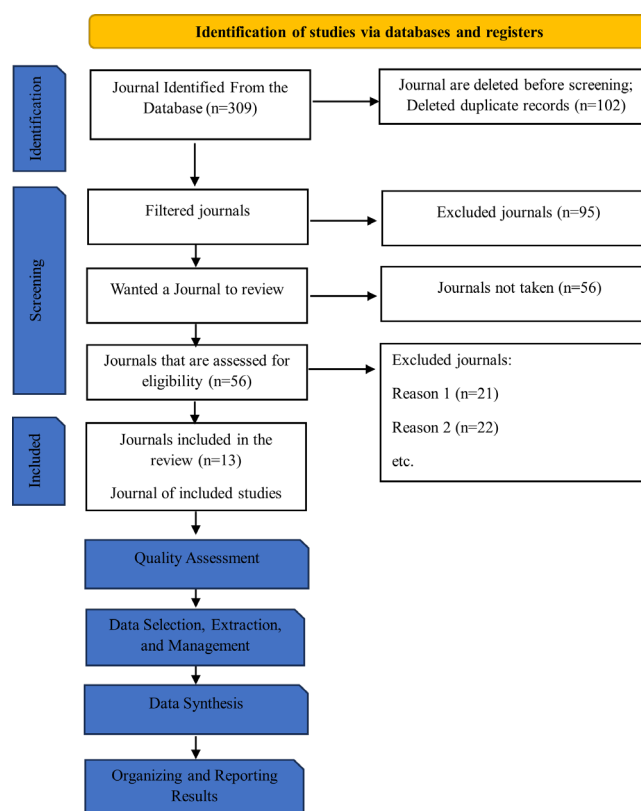


Fig. 1: Prisma Flowchart. Flow chart to summarise the selection of potent articles for the review

Inclusion and Exclusion Criteria

To ensure the quality and relevance of the evidence analyzed in this study, clear inclusion and exclusion criteria were established. These criteria were developed to maintain methodological rigor, reduce bias, and ensure that the articles selected were relevant to the study objectives, as shown in Table II.

Table II: Inclusion and Exclusion Criteria

Inclusion Criteria	Exclusion Criteria
Research articles published in peer-reviewed journals	Opinion articles, editorials, book reviews, systematic reviews, review articles, conference papers
Female Adolescent	Pregnant women
Aged 10-22 years	Age Child 0-10 years
Research published between 2020 and 2025	Article published in 2020

Methodological Quality (Risk of Bias) Assessment

Two independent reviewers reviewed the articles separately to reduce the potential for selection bias. Methodological quality and bias risk assessments were conducted using instruments tailored to the research design of the included studies. For quantitative research, we use the modified Critical Appraisal Skills Programme (CASP), while for qualitative research, we employ the Consolidated Criteria for Reporting Qualitative Research (COREQ) instrument. Research with mixed methods is assessed using the 2018 version of the Mixed Methods Appraisal Tool (MMAT) as recommended (12). The quality assessment was carried out by two independent researchers, and disagreements were resolved through discussions with a third researcher. The results of the quality assessment are documented in the methodological quality summary table (Table 1) and are used to inform the interpretation of the findings and the strength of the evidence. Studies with a high risk of bias are not automatically excluded from the review, but their methodological limitations are considered in the synthesis and interpretation of the results.

Data Selection, Extraction, and Management

The data extraction process uses a standardized and pre-tested data extraction form to ensure consistency in data collection. The extracted data includes (1) publication information (author, year, journal); (2) research characteristics (design, method, sample size); (3) the context of the research; (4) key findings; and (5) implications. To ensure the reliability of the data extraction, two researchers performed the extraction independently and then compared their results. Inconsistencies or disagreements are resolved through discussion and consensus. The extracted data is organized and managed using Mendeley reference management software and structured spreadsheets. This approach is in line with the recommendations of the (13), which emphasizes the importance of consistency and transparency in the data extraction process for high-quality SLRs. The entire data extraction process is documented in detail to ensure openness and facilitate external checks.

RESULTS

Based on a systematic review of 13 journals on iron supplementation adherence factors in adolescent girls, research was conducted in various countries, including Indonesia (5 studies), India (2 studies), Ghana, Hong Kong, Thailand, Nepal, Ethiopia, and Vietnam. The research design varied, including cross-sectional (4 studies), mixed-methods (3 studies), experimental/RCT (2 studies), qualitative studies (2 studies), literature review (2 studies), and other approaches. The sample/population ranged from 40 to 1,856 adolescent girls with an age range of 10-18 years, the majority of whom came from the school environment. Based on a systematic review of 13 journals on factors influencing iron supplementation adherence among adolescent girls, studies were conducted in various countries, including Indonesia (5 studies), India (2 studies), Ghana, Hong Kong, Thailand, Nepal, Ethiopia, and Vietnam. The study designs varied, including cross-sectional studies (4 studies), mixed methods (3 studies), experimental/RCT (2 studies), qualitative studies (2 studies), literature reviews (2 studies), and other approaches. The sample/population ranged from 40 to 1,856 adolescent girls aged 10–18 years, mostly from school settings. Factors influencing adolescent girls' adherence to iron supplementation include knowledge, attitudes, and awareness. Various efforts have been made to address non-adherence through education and interventions. Some studies also involved teachers and parents to provide a more comprehensive perspective on the implementation of iron supplementation programs in various social and geographical contexts, as shown in Table 3. Some studies also involved teachers and parents to provide a more comprehensive perspective on the implementation of iron supplementation programs in various social and geographical contexts, this shown in Table III.

Table III. Study on Factors Influencing Adherence to Iron Supplementation in Adolescent Women. The implementation of iron supplementation programs in various social and geographical contexts.

Author (Year)	Study Design	Sample size/Population	Age (Years)	Location	Intervention	Finding
(Hameed et al., 2022)	Cross-sectional study	208 young women (104 from public schools, 104 from private schools)	13-16	India	Weekly Iron and Folic Acid Supplementation (WIFS)	WIFS program in government schools
(Choudhury & Chaudhary, 2024)	Experimental study	40 young women	17-19	India	250g millet biscuits for 45 days	Intervention with iron-rich millet biscuits
(Silitonga et al., 2023)	Mixed-method	202 students from 3 high schools in Sidoarjo	16-18	Indonesia	Iron Supplementation for one week, one tablet	Knowledge, attitudes, intentions, and program implementation
(Gosdin, Amoah, et al., 2021)	Qualitative analysis	16 schools with 1 district-level coordinator, 3 school-level educators, and 1 parent leader	13-18	Ghana	Iron and Folic Acid (IFA) in the GIFTS program	Limited training, IFA distribution challenges, lack of incentives, inconsistent health and nutrition education
(Gie, 2023)	Linear programming study	Young women	16-22	Vietnam	Food-based recommendations (FBRs)	Local food recommendations to increase iron and calcium intake
(Apriningsih et al., 2020)	Cross-sectional	274 subjects from 18 schools	14-16	Indonesia	Iron and folic acid supplementation	School organization, student age, knowledge, motivation, self-efficacy, previous Hb level checks, teacher education
(Ansari et al., 2021)	Mixed-methods	211 participants (cross-sectional survey) + FGD and in-depth interviews	12-18	Indonesia	Weekly Iron-Folic Acid Supplementation (WIFS)	Tablet taste, unpleasant tablet smell, forgetfulness, peer support, side effects, maternal support
(Khanal et al., 2024)	Cross-sectional	602 young women from grades 6-10	12-16	Nepal	Weekly Iron Folic Acid Supplementation (WIFAS)	Types of schools, father's education, food diversity
(Seminar et al., 2020)	Qualitative study	174 young women (FGD) + 20 young women (in-depth interview) + 66 parents (FGD) + 10 parents (in-depth interview)	15-19	Indonesia	Weekly Iron-Folic Acid Supplementation (WIFAS)	Awareness and knowledge of anemia and WIFAS, perception of low risk of anemia, influence of parental opinion
(Alfiah et al., 2020)	Cross-sectional	1,856 young women (934 in East Java and 922 in NTT) from 60 high schools in 20 districts	17	Indonesia	Weekly Iron Folic Acid (WIFA)	Forget, not consider necessary, afraid of side effects
(Handiso et al., 2021)	Randomized controlled trial	226 young women (113/group)	10-19	Ethiopia	Weekly Iron-Folic Acid Supplementation (WIFAS)	Community-based interventions
(Cheung et al., 2023)	Cross-sectional	340 girls	16-19	Hong Kong	iron supplementation	Poor dietary habits and adolescent girls who reported heavy menstrual bleeding had lower serum ferritin levels
(Karnpean et al., 2022)	Cross-sectional	18,000 individuals (252)	15-18	Thailand	Iron supplementation	Thalassemia Hemoglobinopathies are a highly prevalent and significant contributor to anemia in Thailand

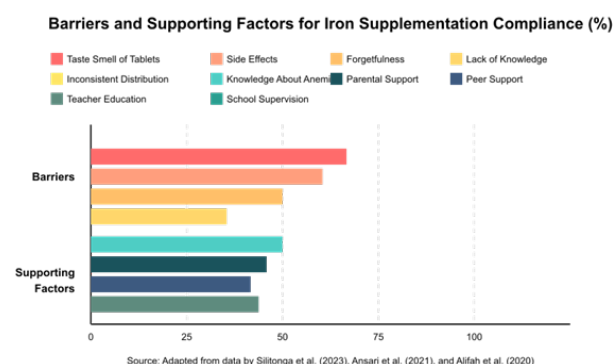


Fig. 2: Barriers and Supporting Factors for Iron Supplementation Adherence. The Strength of the Relationship between Factors and Supplementation Adherence

DISCUSSION

Factors Affecting Iron Supplementation Adherence

This systematic review analyzed 13 journals and identified various factors that affect adherence to iron supplementation in adolescent girls. Dominant individual factors include adolescents' knowledge, attitudes, and awareness about anemia and the importance of iron supplementation (14) and (15). Identify that knowledge and attitudes have an important role in supplementing consumption adherence. While (16) found that awareness and knowledge of anemia and low-risk perception affect adolescent adherence in Indonesia. Influential social factors mainly include family and peer support. (15) and (17) underline the importance of parental support, especially for mothers, as well as peer influence. (16) also emphasized that parental opinions have a significant influence on adolescent girls' adherence to taking iron supplements in East Java and NTT. Influential health system and program factors include school policies, school commitments, and the implementation of programs. (18) identified that limited training, distribution challenges, lack of incentives, and inconsistent health education were the main obstacles in the GIFTS program in Ghana. Meanwhile, (19) shows that school organizations and teacher education play an important role in adherence to the consumption of iron tablets in Indonesia.

The Strength of the Relationship between Factors and Supplementation Adherence

Based on this systematic review, the strength of the relationship between factors and adherence to supplementation varies. Knowledge and attitude factors showed a consistent and strong association with supplementation adherence, as reported (20) and (15).

Factors related to the characteristics of the supplement, such as the taste and smell of the tablets, as well as side effects, showed a strong negative relationship with adherence. (17) and (21) found that the taste of the tablets was unpleasant, unpleasant odors, and fear of side effects were the main factors of non-adherence in

adolescent girls in Indonesia. The "forgetfulness" factor also showed a strong correlation with non-adherence, as reported (21) and (17). Meanwhile, (22) and (23) reported that system factors such as school type and the ability to follow missed supplement distributions had a strong relationship with program adherence.

Variation of Adherence Factors Based on Context

This systematic review reveals variations in adherence factors based on geographical, socio-economic, and cultural contexts. In Indonesia, a study (24) (21) showed differences in adherence patterns between adolescent girls in East Java and NTT, reflecting socio-cultural variations. Meanwhile, in India, an intervention study (25) suggests that local culinary approaches, such as iron-rich millet biscuits, can increase adherence to certain cultural contexts (26) and (27). identify differences in adherence based on school type (government vs private) in India and Nepal, reflecting socio-economic factors. (22) also found variations in adherence between junior and senior schools in Ghana, which shows the influence of education level on adherence. In Vietnam, the local food recommendation approach (FBR) (28) highlighting the importance of cultural context in increasing iron intake. While community-based studies (29) in Ethiopia, demonstrated the effectiveness of community-based approaches adapted to the local social context.

Gaps in the Literature and Future Research Directions

Although there is a considerable amount of research on adherence factors related to iron supplementation, some important gaps remain. First, most studies focused on the population of adolescent girls in school, so there was limited data on adolescent girls who did not attend school. Second, the majority of studies use cross-sectional designs that limit causal inference, and there is a need for longitudinal studies such as those conducted (23). Third, there are still limited studies evaluating the effectiveness of specific interventions to improve adherence, with exceptions such as studies (25) and (29). Fourth, studies exploring the interaction between adherence factors and their effects on long-term health outcomes are lacking. Future research directions need to include: (1) studies with longitudinal designs to evaluate changes in adherence over time; (2) studies involving young women outside of school contexts; (3) randomized controlled trials to evaluate the effectiveness of specific interventions in improving adherence; and (4) more comprehensive mixed-methods studies to knowledge the socio-cultural context of supplementation adherence.

Theoretical Relationship with Behavioral Change

Knowledge, attitude, and awareness factors have a significant relationship with adolescent girls' adherence in consuming iron supplements. Based on the Health Belief Model (HBM) perspective, these results reinforce the role of perceived susceptibility (awareness of the risk of anemia) and perceived benefits (belief in the benefits of iron supplements) as the main drivers for

adolescent girls to change their health behavior (30). Adolescents who know the risks of anemia and the benefits of iron supplements tend to have positive attitudes and form adherence habits. The Theory of Planned Behavior (TPB) is also relevant in explaining patterns of behavioral change. Positive attitudes toward supplementation, social support from parents or peers (subjective norms), and perceived behavioral control (perceived behavioral control) together form a strong intention to take supplements regularly (31). This indicates that, consistent with findings that adolescents who feel they have control over their schedule and access to supplements are more consistent in their adherence. The interaction between personal factors (knowledge, beliefs), environmental factors (school/community support), and actual behavior (supplement intake habits) forms a reciprocal determinism that influences adherence, as described in Social Cognitive Theory (SCT) (32). Adolescents who receive information and supervision from teachers or peers will believe and comply, and receive positive feedback, will be more motivated to maintain adherence behavior.

Recommendations to Improve Supplementation Adherence

Based on the systematic review, several recommendations can be made to improve iron supplementation adherence among adolescent girls: First, developing a comprehensive educational program to increase knowledge and awareness about anemia and the importance of iron supplementation, as suggested (15) and (33). Second, improving the quality of iron supplements to reduce side effects and increase acceptability, as identified (34) and (24). Third, strengthen the distribution system and supervision of supplement consumption in schools, with adequate training for teachers and health workers, as recommended (23). Fourth, the active involvement of parents and peers in supplementation programs to increase social support, as suggested (28). Fifth, adaptation of supplementation programs based on local contexts, including cultural considerations and resource availability, such as the local food approach proposed (28)(19). Sixth, the integration of a regular hemoglobin screening program to increase motivation, as suggested (19). By implementing these recommendations, it is hoped that iron supplementation adherence in adolescent girls can be improved, thereby contributing to a decrease in the prevalence of anemia and an improvement in the overall health of adolescent girls. Collaboration and coordination among sectors are needed to conduct regular monitoring and evaluation to ensure that programs are implemented effectively and achieve optimal results in anemia prevention efforts.

CONCLUSION

Based on a systematic review of 13 journals on factors influencing iron supplementation adherence among adolescent girls, it can be concluded that adherence

is influenced by various interrelated factors. Dominant individual factors include adolescents' knowledge, attitudes, and awareness of anemia, while social factors include family support, especially from mothers, and peer influence. Characteristics of the supplement, such as taste, odor, and side effects, as well as the "forgetfulness" factor, consistently emerge as the main barriers to adherence across various contexts. Systemic factors, such as school policies, commitment, and program implementation, also play a significant role. Variations in adherence have been identified based on geographical, socio-economic, and cultural contexts, such as differences between public and private schools, and between regions with different cultural backgrounds. Context-based approaches, such as the use of millet biscuits in India and local food recommendations in Vietnam, have proven effective in improving adherence. To improve adherence, it is recommended to develop comprehensive education programs, improve the quality of supplements to reduce side effects, strengthen distribution and monitoring systems in schools, actively involve parents and peers, tailor programs to local contexts, and integrate regular hemoglobin checks. Effective monitoring and evaluation are needed using digitalization, such as applications that make it easier for adolescents to access the latest information and improve adherence. Additionally, there is a need for a community of adolescents who are aware and concerned about their health to prevent anemia. Although many studies have been conducted, there are still gaps in the literature, particularly regarding out-of-school girls, longitudinal studies, evaluations of specific interventions, and explorations of interactions between factors. This is due to limitations in the target population, as not all adolescent girls were included in the research sample, resulting in less than optimal outcomes. Therefore, broader and more specific research is needed on adolescent girls' adherence, starting with mapping the prevalence of adherence and its determinants.

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