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Review Article

Dietary intake, anemia, and iron status among adolescent girls in low- and middle-income countries: A systematic review

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Abstract

Background: Anemia and iron deficiency remain important public health problems among adolescent girls in low- and middle-income countries (LMICs). Dietary intake, including foods that may inhibit or enhance iron absorption, is one of several determinants of iron status, but evidence in this group remains fragmented.
Objective: To synthesize evidence on (1) associations between dietary intake factors, including foods that may inhibit or enhance iron absorption, and anemia, iron deficiency (ID), and iron deficiency anemia (IDA) among adolescent girls in LMICs; (2) the effects of food-based and nutrition education interventions on these outcomes; and (3) implications for community health nursing practice.
Methods: This review was conducted in accordance with the Cochrane Handbook for Systematic Reviews of Interventions and the JBI Manual for Evidence Synthesis, and is reported following PRISMA 2020. PubMed, Scopus, ScienceDirect, and ProQuest were searched on 6 May 2026 for English-language studies published in the preceding five years (2021 to the search date), supplemented by citation searching. Eligible studies were cross-sectional studies or randomized controlled trials of girls aged 10–19 years in LMICs that assessed dietary intake and measured hemoglobin or iron biomarkers. Two reviewers independently screened records in Rayyan (used only as a study-selection tool), extracted data, and appraised risk of bias using JBI checklists.
Results: Ten studies (4,030 girls; eight countries) were included: two randomized trials, eight cross-sectional; nine had low risk of bias. Anemia prevalence was 21.1%–44.4% and ferritin-confirmed IDA 6.1%–49.7%. Not consuming animal-source foods was associated with anemia (AOR 3.2; 95% CI 2.0–5.1); pulses ≥3 times/week (OR 0.51; 95% CI 0.28–0.90) and haem-iron intake were associated with better hemoglobin, though inconsistently. Tea with meals was significant only in unadjusted analyses. Iron-fortified lentils reduced the decline in serum ferritin rather than increasing ferritin in absolute terms; game-based nutrition education improved behaviour and slightly raised hemoglobin without changing ferritin.
Conclusion: Low intake of animal-source foods and protein was the most consistent dietary correlate of anemia, although not all studies confirmed it, and evidence on specific absorption inhibitors remains indirect. Because the evidence is predominantly cross-sectional and trials are few, causal inference is limited. Nutrition education and food-based strategies delivered with families and schools are plausible implications for community health nursing, but nurse-led interventions have not yet been tested in this population.

Background

Anemia, iron deficiency (ID), and iron deficiency anemia (IDA) are related but distinct conditions. Anemia is defined by a hemoglobin (Hb) concentration below the relevant threshold, which is <12 g/dL for nonpregnant adolescent girls aged ≥12 years (World Health Organization [WHO], 2024). ID refers to depleted iron stores, indicated by serum ferritin <15 µg/L after adjustment for inflammation, and may occur without anemia (WHO, 2020). IDA is anemia accompanied by ID. Because anemia may also result from infections, inflammation, other micronutrient deficiencies, and hemoglobinopathies, the prevalence of anemia should not be equated with that of IDA (Williams et al., 2023).

Adolescent girls are particularly vulnerable to ID because of rapid growth and menstrual blood loss (Aabdien et al., 2022). Iron deficiency has been associated with reduced physical capacity, cognitive function, and quality of life (Cheung et al., 2023).

Data from low- and middle-income countries (LMICs) generally report Hb-defined anemia rather than IDA (Anggaraini & Lestari, 2025; Effendi, 2026). The prevalence of anemia among adolescent girls has been reported as 18.1% in Uganda (Adokorach et al., 2024), 23.0% in Ethiopia (Habtegiorgis et al., 2022), and 29.4% in India (Shah et al., 2025). In Bangladesh, anemia affected 46.8% of children and adolescents aged 6 months to 19 years, whereas IDA affected only

13.6% (Kundu et al., 2023), demonstrating that not all anemia is attributable to ID.

Iron status is influenced by the quantity and bioavailability of dietary iron, menstruation, infections, inflammation, and growth requirements (Cohen & Powers, 2024). Mechanistically, nonheme iron absorption is inhibited by phytates and polyphenols and enhanced by ascorbic acid and the meat–fish–poultry factor (Piskin et al., 2022). Stable-isotope studies have shown that tea reduces iron bioavailability, whereas low-phytate millet improves it (Reddy et al., 2022). However, this evidence comes from short-term studies among adult women. Because iron absorption is also regulated by body iron stores, these effects may not necessarily translate into long-term changes in iron status and warrant direct investigation among adolescent girls (Aprita, 2024; Anurak & Chaow, 2025; Tuhalauruw, 2024).

Adolescents' dietary intake is shaped by family, school, and social environments (Wrottesley et al., 2022), including parental food literacy (Hoteit et al., 2022), gender norms, and food insecurity (Kimaryo et al., 2025). Weekly iron–folic acid supplementation reduces anemia (Gosdin et al., 2021), but implementation is hindered by supply constraints, adverse effects, school absenteeism, and insufficient family support (Kimaryo et al., 2025). Food fortification may complement supplementation because it has been shown to attenuate the decline in ferritin concentrations among adolescent girls (Yunus et al., 2024).

Previous reviews have focused on anemia risk factors while limiting dietary exposures to dietary diversity (Habtegiorgis et al., 2022), on general adolescent nutritional status, or on nutritional strategies discussed narratively (Cohen & Powers, 2024). The present review addresses the need to distinguish direct measurements of dietary intake from proxy indicators, Hb-defined anemia from biomarker-defined ID/IDA, and observational evidence from intervention evidence. Its objectives were to synthesize associations between dietary intake, anemia, and iron status among adolescent girls aged 10–19 years in LMICs; the effects of food-based and nutrition education interventions on iron biomarkers; and implications for community health nursing.

Methods

Study Design

This systematic review narratively synthesized observational and intervention studies. The review process—including question formulation, searching, selection, data extraction, risk-of-bias assessment, and synthesis—was informed by the Cochrane Handbook for Systematic Reviews of Interventions (Higgins et al., 2024) for intervention effectiveness and the JBI Manual for Evidence Synthesis chapter on systematic reviews of etiology and risk (Aromataris et al., 2024) for observational questions. Rayyan supported deduplication and study selection. Reporting followed PRISMA 2020 and the Synthesis Without Meta-analysis (SWiM) guideline.

The review team prepared a written protocol in May 2026 before initiating the search. It specified the research questions, eligibility criteria, information sources, study selection and extraction procedures, and synthesis plan. The protocol was not prospectively registered in PROSPERO or another registry and was not published. Three changes were made during the review: (1) the publication period was narrowed from 2016–2026 to 1 January 2021 through the search date to focus on the preceding five years; (2) the exposure criterion was broadened from studies specifically quantifying the intake of iron-absorption inhibitors or enhancers to studies assessing dietary intake by any method, including proxy indicators, because only some studies assessed at full text quantified these substances; and (3) study protocols without results were excluded.

Research Questions

Two research questions guided the review. The first was observational and framed using PECO: "What is the association between dietary intake—including nutrient intake, inhibitors and enhancers of iron absorption, food groups, and eating habits—and anemia and iron status among adolescent girls aged 10–19 years in LMICs?"

The second addressed effectiveness and was framed using PICO: "What are the effects of food-based or nutrition education interventions intended to improve dietary intake on hemoglobin concentration, anemia, and iron-status biomarkers among adolescent girls aged 10–19 years in LMICs?"

Inclusion and Exclusion Criteria

Eligibility criteria were defined using PECO for the first question and PICO for the second, as follows.

Nonpregnant adolescent girls aged 10–19 years (WHO definition) living in LMICs. Studies of mixed samples (male and female participants or wider age ranges) were eligible if (i) data for girls aged 10–19 years were reported separately for at least one outcome or (ii) at least 80% of participants were girls aged 10–19 years. When an association between intake and an outcome was available only for the combined sample, it was still extracted, identified in Table 1, and assigned less interpretive weight in the synthesis.

LMICs comprised low-, lower-middle-, and upper-middle-income countries according to the World Bank income classification for fiscal year 2026 (1 July 2025–30 June 2026), which was applicable at the time of the review. Country eligibility was determined using this classification. All eight countries represented in the included studies met the criterion.

For question 1, studies could assess dietary intake by any method, including direct measurement (24-hour recall, food records, or semiquantitative food-frequency questionnaires) or proxy measures (food-group consumption frequency, dietary diversity scores, or eating habits). Relevant exposures included nutrient intake; foods containing iron-absorption inhibitors (phytates, tannins/polyphenols, tea or coffee, calcium, and fiber); and enhancers (vitamin C and animal-source foods). Measurement approaches were recorded and synthesized separately. For question 2, eligible interventions were food-based strategies (fortification, biofortification, dietary modification, or food provision) or nutrition education intended to modify dietary intake, compared with no intervention, usual care, or another intervention.

At least one of the following: hemoglobin concentration or anemia status; serum ferritin; soluble transferrin receptor; total body iron; total iron-binding capacity (TIBC); transferrin saturation; ID; or IDA. Definitions and thresholds used by each primary study, including any adjustment for inflammation, were recorded.

Cross-sectional studies were eligible for question 1, and individually or cluster-randomized controlled trials (RCTs) for question 2. Cross-sectional studies were selected because they commonly measured dietary intake and iron biomarkers concurrently in this population, whereas RCTs provide intervention-effect estimates with comparatively less confounding. Cohort, case–control, and quasi-experimental studies were excluded to maintain consistency in risk-of-bias appraisal and feasibility within the team's resources. This restriction is acknowledged as a limitation.

Language, period, and publication status. Only English-language articles were eligible because the team lacked the capacity to translate other languages reliably. Publication was restricted to 1 January 2021 through the search date for the reason described under Protocol and Registration. Only peer-reviewed original research articles reporting results were included. Study protocols, conference abstracts, theses, and preprints were excluded; when a protocol was identified, the corresponding results report was sought separately.

Studies were excluded if participants were pregnant or breastfeeding, or had chronic diseases or conditions affecting iron metabolism (e.g., thalassemia, chronic kidney disease, or malabsorption syndromes) without separate data for healthy participants; if they evaluated iron or other micronutrient supplementation without a food or nutrition education component and without dietary-intake data; or if they were reviews, editorials, or commentaries. Reference lists of relevant reviews were nevertheless searched.

Search Methods

Information sources. Searches were conducted on 6 May 2026 in PubMed (including MEDLINE and other PubMed records; National Library of Medicine), Scopus (Elsevier), ScienceDirect (Elsevier), and ProQuest. Clinical trial registries, organizational websites, and gray literature were not searched, and experts were not contacted to identify additional studies.

Four concept blocks were used: population (adolescent girls), exposure or intervention (dietary intake, inhibitors and enhancers of iron absorption, food groups, fortification, and nutrition education), outcomes (anemia, iron status, and related biomarkers), and setting (LMICs). Synonyms within each block were combined with OR, and blocks were combined with AND. In PubMed, free-text search terms were combined with the Medical Subject Headings (MeSH) "Adolescent" and "Anemia, Iron-

Deficiency." Scopus and ScienceDirect do not use MeSH; therefore, free-text searches targeted titles, abstracts, and keywords. Because ScienceDirect does not support truncation, complete word forms were used. Where supported, both "anemia" and "anaemia" were included. Filters were applied for English language, publication years 2021–2026, and article document type.

Because relevant publications might name specific countries without using "LMIC" or "developing countries," the sensitivity of the setting block was assessed by rerunning the PubMed strategy without this block on 6 May 2026.

Study Selection

Records from each database were exported in RIS format and imported into Rayyan, a web application used to support deduplication and study screening (Ouzzani et al., 2016). Potential duplicates were identified using Rayyan's duplicate-detection function, and each flagged pair was checked and resolved manually. Two reviewers independently screened titles and abstracts and then full texts, comparing their decisions at each stage. Each excluded report was assigned one primary exclusion reason using Rayyan labels in the following order: population, setting, design, exposure or intervention, outcome, and publication type. Disagreements at either stage were resolved through discussion, with a third reviewer making the final decision if consensus could not be reached. Record counts at each stage were calculated from Rayyan exports and documented in the screening log.

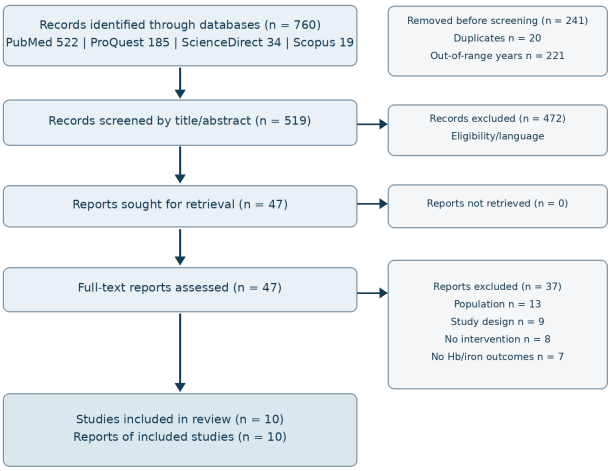


Figure 1. PRISMA Flow Instagram

Quality Assessment

Two reviewers independently assessed risk of bias in each included study using the Joanna Briggs Institute (JBI) critical appraisal checklist appropriate for its design (RCT or cross-sectional study). Differences were resolved through discussion; when consensus could not be reached, a third reviewer was consulted. Studies were classified according to the number of "Yes" responses. Low risk of bias was assigned to RCTs with 10 "Yes" responses or cross-sectional studies with 6–8 "Yes" responses; moderate risk of bias was assigned to RCTs with 7 "Yes" responses.

Data Extraction and Synthesis

Because Rayyan was used only for screening, data were extracted using a Microsoft Excel form piloted on two studies. Two reviewers independently extracted each study into separate copies of the form. Variables included author, year, country, setting, study design, sample size (recruited and analyzed), participant characteristics, dietary measurement methods and instruments (direct or proxy), exposures or interventions and comparators, follow-up duration, outcomes and thresholds (including inflammation adjustment), adjustment covariates, and effect estimates (OR/AOR, coefficients, or mean differences) with 95% confidence intervals or p values. The two forms were compared cell by cell. Discrepancies were checked against the original article, resolved by discussion, and referred to a third reviewer if necessary. When data were missing or unclear (e.g., outcomes were not sex-disaggregated or the definition of IDA was unreported), corresponding authors were contacted by email up to twice over two weeks. If no response was received, the data were recorded as "not reported" and were not imputed. Multiple reports from the same study were identified using the study name, setting, data collection period, and authorship team, and were consolidated as one study using the most complete report to prevent double counting of participants. Extracted data are provided in Table 1.

Synthesis Methods

Data were tabulated and synthesized narratively according to SWiM because measures of dietary intake (1–7-day recalls, food-group consumption frequencies, and dietary diversity scores) and biochemical indicators differed substantially

across studies, precluding a meaningful meta-analysis. Studies were grouped by (1) research question (observational or intervention), (2) dietary-intake assessment (direct or proxy), and (3) outcome type (Hb-defined anemia or biomarker-defined ID/IDA). Within each group, effect estimates were presented as reported, prioritizing adjusted estimates, and the direction of effects was summarized. Studies at moderate risk of bias and those reporting associations only for mixed samples received less interpretive weight.

Reporting bias was not formally assessed because fewer than 10 studies contributed to each outcome and no meta-analysis was undertaken. Certainty of evidence was not evaluated using GRADE because the exposure and outcome measures were too heterogeneous to support a single summary estimate; this is acknowledged as a limitation

Results

Database searches yielded 760 records (PubMed, 522; ProQuest, 185; ScienceDirect, 34; Scopus, 19). Before screening, 241 records were removed, comprising 20 duplicates and 221 records published in 2016–2020 that were excluded after the publication period was narrowed (see Protocol and Registration). Of the 519 records screened by title and abstract, 472 were excluded because they failed to meet eligibility criteria or were not published in English. All 47 reports sought for retrieval were obtained. Following full-text assessment, 37 reports were excluded for ineligible populations (n = 13), ineligible designs (n = 9), absence of an intervention (n = 8), or failure to report Hb or iron biomarkers (n = 7). Thus, 10 studies represented by 10 reports were included (Figure 1). Published between 2021 and 2025, these comprised two RCTs—one cluster RCT (Yunus et al., 2024) and one individually randomized trial (Sabet et al., 2023)—and eight cross-sectional studies, with 4,030 adolescent girls recruited or randomized in total. Nine studies were rated at low risk of bias and one at moderate risk.

Study Characteristics and Prevalence of Anemia and Iron Deficiency Anemia

All included studies focused on adolescent girls within the age range of 10–19 years, a period of rapid linear growth and menarche. The studies were conducted across Asia and Africa. Asian settings included Bangladesh, southern Jordan, India, Iran, Yemen, and Indonesia, whereas African settings included Ethiopia and Ghana. The prevalence of anemia among adolescent girls ranged from 21.1% in Jatinangor, Indonesia (Sari et al., 2022), to 44.4% in Hodeida, Yemen (Al-Jermmy et al., 2022). Ferritin-confirmed IDA was reported in three studies: 6.1% in Bangladesh (Yunus et al., 2024), 21.5% in southern Jordan (Khamaiseh, 2025), and 49.7% among adolescent girls in Kumasi, Ghana (Yeboah et al., 2024). Two Indonesian studies described IDA without measuring ferritin: 21.1% in Jatinangor, based on Hb alone (Sari et al., 2022), and 22.2% in Islamic boarding schools in Tasikmalaya, based on erythrocyte indices (Rahfiludin et al., 2021). These two figures are therefore more appropriately interpreted as anemia prevalence than as confirmed IDA.

Factors Potentially Inhibiting Iron Absorption

Four studies assessed nutrient intake quantitatively using 24-hour, 7-day, or 3-day dietary recalls. The remaining six used proxy indicators. Khamaiseh (2025) described collecting a 24-hour dietary recall, but the analysis used food-group frequency questions. Other proxies included food-group consumption frequency (Shah et al., 2025), dietary diversity scores and meal regularity (Handiso, 2022), and questionnaires about eating habits (Al-Jermmy et al., 2022; Yeboah et al., 2024). None of the studies quantified phytate, tannin, polyphenol, or vitamin C intake, and none directly measured iron absorption. Accordingly, the synthesis reports associations between dietary indicators and iron status rather than changes in absorption.

Factors Potentially Enhancing Iron Absorption

Two studies quantified dietary factors thought to enhance iron absorption, and neither found a relationship with hematological status for those factors (Rahfiludin et al., 2021; Sari et al., 2022), even though intake was very low among girls attending Islamic boarding schools in Tasikmalaya. Directly measured heme iron and meat–fish–poultry (MFP) iron intake correlated positively with Hb and hematocrit (Rahfiludin et al., 2021). Adequate protein intake was associated with lower odds of anemia (OR 0.25; 95% CI 0.11–0.58), but this estimate was derived from a combined sample of adolescent girls and adult

women (Sari et al., 2022). Findings based on proxy indicators were inconsistent. Not consuming animal-source foods was associated with anemia (AOR 3.2; 95% CI 2.0–5.1) (Kedir et al., 2024), whereas frequency of meat or fish consumption was not associated with Hb or anemia in Jordan or India (Shah et al., 2025). Protein intake did not differ by anemia status (Sari et al., 2022). Adverse effects of tablets and nonadherence are barriers to supplementation programs rather than dietary inhibitors of absorption and were therefore not synthesized alongside dietary factors.

Social Determinants and Family Factors Affecting Iron Status

Socioeconomic conditions, including household income and parental education, influence access to nutritious foods, dietary diversification, and anemia risk among adolescent girls across LMIC settings (Handiso, 2022). Household food security, wealth status, and families' social and employment circumstances also shape consumption of iron-rich foods and access to nutrition services (Kedir et al., 2024).

The following implications were developed by the authors by linking the review findings to the roles of community health nurses as educators, screeners, collaborators, and advocates. They are organized into three domains:

Domain 1: Technology-Based Nutrition Education and Behavior Modification

Digital game-based nutrition education improved knowledge, attitudes, and practices, but its effect on Hb was small and its effect on ferritin was not significant (Sabet et al., 2023). School nurses could adapt this approach using evidence-informed messages encouraging consumption of affordable animal-source foods and protein. However, changes in behavior should not be treated as equivalent to improved iron status.

Domain 2: Early Detection and Community-Based Screening

Field measurement of capillary Hb using HemoCue is feasible in school and community settings; thus, Hb screening is preferable to relying on symptoms alone (Al-Jermmy et al., 2022).

Domain 3: Local Food-Based Policy Recommendations (Staple Food Fortification)

Fortified staple foods, such as lentils, may complement supplementation. In the cluster RCT conducted in Bangladesh, ferritin concentrations declined in all groups during the 85-day feeding period, but the decline was smaller among girls receiving iron-fortified lentils than among controls. Fortification therefore attenuated the decline in ferritin rather than increasing ferritin in absolute terms. Nurses could support distribution through adolescent groups and family engagement. All three proposed approaches require evaluation in nurse-led intervention trials (Yunus et al., 2024).

Table 1. Characteristics and findings of included studies

Author, year	Country/setting	Design	Sample	Dietary exposure/intervention; measure	Main findings	Risk of bias (JBI)
Yunus et al., 2024	Bangladesh (Mymensingh); 48 rural BRAC adolescent clubs	Cluster RCT	n = 1,195; girls aged 10–17 years	Intervention: iron-fortified lentils vs regular lentils vs control; lentil consumption measured by 7-day recall	At baseline: subclinical ID 25.9%; IDA 6.1%. Day 85: ferritin +5.7 µg/L and total body iron +0.8 mg/kg vs control; ID OR 0.4	Low (10/13)
Khamaiseh, 2025	Southern Jordan (Al-Karak); 8 public secondary schools	Cross-sectional	n = 284 girls; eligibility 10–17 years (sample aged 13–17)	Proxy: meal and food-group frequency (red meat, fish, fruits, vegetables, grains, dairy)	Anemia 26.8%; ferritin <12 ng/mL 35.3%; IDA 21.5%. Red meat, fish, fruits, vegetables, and meal frequency were not associated with Hb; grains p = 0.001; low income associated with lower Hb (p = 0.001)	Low (6/8)
Shah et al., 2025	India (Osmanabad, Maharashtra); rural	Cross-sectional	n = 401 analyzed (679 invited);	Proxy: food-group frequency (7-day recall)	Anemia 29.42%; pulses ≥3 times/week	Low (8/8)

Author, year	Country/setting	Design	Sample	Dietary exposure/intervention; measure	Main findings	Risk of bias (JBI)
			unmarried girls aged 10–19		OR 0.51 (95% CI 0.28–0.90)	
Handiso, 2022	Southern Ethiopia (Wolaita, Hadiya); agrarian communities	Cross-sectional	n = 820 (response rate 97.3%); girls aged 10–19	Proxy: dietary diversity score and meal skipping (questionnaire)	Anemia 37.2%; meal skipping and family income associated with anemia	Low (8/8)
Sabet et al., 2023	Iran (Saravan, Sistan-Baluchestan); schools	Individual RCT	n = 176 randomized; 160 analyzed; girls aged 10–19 with the lowest Hb in an earlier survey	Intervention: digital game-based nutrition education vs presentations and pamphlets; 3-day dietary recall[1] and KAP	ΔHb +0.42 vs +0.22 g/dL (p = 0.03); Δferritin +2.22 vs +1.71 ng/mL (p = 0.16); KAP improved (p < 0.001)	Moderate (7/13)
Sari et al., 2022	Indonesia (Jatinangor); 7 villages	Cross-sectional	n = 95 girls aged 10–19	Direct: adequacy of energy and protein intake (24-hour recall)	Hb-defined anemia (<12 g/dL) 21.1% (20/95), termed IDA by the authors without ferritin; adequate protein OR 0.25 (0.11–0.58) for the mixed sample	Low (8/8)
Rahfiludin et al., 2021	Indonesia (Tasikmalaya); 7 Islamic boarding schools	Cross-sectional	n = 176 Sundanese adolescent girls	Direct: heme iron and MFP iron (mg/day; three 24-hour recalls); raw vegetables and tea	Erythrocyte index–based IDA (without ferritin) 22.2%; heme and MFP iron correlated positively with Hb and hematocrit; plant-based diet per se was not associated with IDA	Low (8/8)
Kedir et al., 2024	Central Ethiopia (Silti); schools	Cross-sectional	n = 516 school-going adolescent girls	Proxy: animal-source food consumption (yes/no questionnaire)	Anemia 29% (95% CI 25.2–33.3); 51.1% did not consume animal-source foods; nonconsumption AOR 3.2 (2.0–5.1)	Low (8/8)
Al-Jermmy et al., 2022	Yemen (Hodeida); public/private secondary schools, conflict setting	Cross-sectional	n = 224 girls aged 15–19	Proxy: khat use, tea timing, meal frequency, breakfast, snacks, vegetables (questionnaire). Trial: iron + deworming with/without four nutrition education sessions	Anemia 37.8% (girls 44.4%); khat AOR 9.7; tea significant only in bivariate analysis; snacks protective. Trial: Hb 12.9 vs 11.3 g/dL	Low (8/8)
Yeboah et al., 2024	Ghana (Kumasi, Ashanti); secondary schools	Cross-sectional	n = 143 girls aged 16–19	Proxy: fruit, vegetable, dairy, protein, and carbohydrate consumption (questionnaire); TONI-4	Whole sample: anemia 42%; IDA 30.4%. Adolescent girls: IDA 49.7% (71/143); dietary analysis based on the full mixed sample	Low (8/8)

Discussion

Iron status among adolescent girls in LMICs is influenced by interactions between iron-absorption enhancers and inhibitors. Phytic acid is a major inhibitor in cereal- and legume-based diets because it reduces nonheme iron bioavailability (Handiso, 2022). In Indonesia, tea and certain plant-based foods may inhibit absorption, whereas animal-source foods provide more bioavailable heme iron (Rahfiludin et al., 2021). Recommendations to reduce inhibitors therefore still rely largely on mechanistic evidence. By contrast, recommendations to improve access to animal-source and fortified foods—shown to attenuate ferritin decline even without increasing absolute ferritin

concentrations—have somewhat more direct support in this population (Yunus et al., 2024).

Household economic conditions affect access to nutritious foods and contribute to anemia risk. Preventing IDA therefore requires more than individual education; structural factors and food access must also be considered (Handiso, 2022; Kedir et al., 2024; Khamaiseh, 2025; Yeboah et al., 2024). Families should be treated as units of intervention because they influence food provision, dietary behavior, and support for anemia prevention.

National supplementation programs do not always produce optimal improvements because effectiveness depends on adherence, adverse effects, absence from distribution sessions, and local social and food conditions. These challenges underscore the need to integrate supplementation with education, family support, improvements in the food environment, and locally appropriate food-based strategies (Shah et al., 2025).

The findings suggest three complementary approaches: technology-based education, early detection, and local food fortification as an adjunct to supplementation. Digital education can improve knowledge, attitudes, and practices related to IDA prevention, whereas combining education with supplementation and deworming represents a more comprehensive multimodal approach (Sabet et al., 2023; Al-Jermmy et al., 2022). Community health nurses may therefore bring together adolescents, families, schools, and communities in their roles as educators, coordinators, and advocates to support context-sensitive and sustainable anemia prevention (Shah et al., 2025).

Limitations

This review has several limitations. First, the protocol was not prospectively registered, and changes to the publication period and exposure criteria were made during the review, introducing potential reporting and selection biases. Second, restrictions to English-language articles, the 2021–2026 publication period, and cross-sectional studies or RCTs may have excluded relevant evidence from other language regions or from cohort and quasi-experimental studies. Third, despite expanding the setting block to include country names, studies not indexed in the four searched sources may have been missed. Fourth, most studies used proxy indicators of dietary intake, and none quantified absorption inhibitors; thus, the synthesis could not determine the contributions of phytates, tannins, or vitamin C. Fifth, several studies reported associations for mixed samples including boys or adult women, limiting the direct applicability of those findings to adolescent girls.

Conclusion and Recommendation

Iron status among adolescent girls in LMICs is associated with dietary intake and socioeconomic and family factors, but evidence on specific dietary inhibitors and enhancers remains limited. Because most studies were cross-sectional, the findings are associative rather than causal. Heme iron, animal-source foods, and pulses tended to be associated with better hematological status; however, the effects of phytates, tea, and vitamin C cannot be established because none of the included studies quantified these components and the association with tea was significant only in unadjusted analyses. Local food fortification attenuated ferritin decline rather than raising ferritin in absolute terms, while digital nutrition education improved behavior without improving ferritin. Community health nurses can advocate for fortified foods, access to animal-source foods, and Hb and ferritin screening. Future studies should quantify dietary exposures and test multicomponent interventions with biomarker-based outcomes.

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Declaration on the Use of AI
An AI-based tool (Chat GPT) was used for language editing and to improve the clarity of the manuscript. All content has been reviewed and validated by the authors.

Data Availability Statement
Data sharing is not applicable to this article.

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