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Nurses Led Interventions to Combat Female Adolescents' Anemia: A Systematic Review

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ABSTRACT

Background Anemia, which is mainly because of iron deficiency is a common social problem affecting millions of female adolescents all around the world with severe effects on cognitive development, educational attainment and long-term health. Multi-modal interventions such as supplementation, dietary diversification, and education are advised in accordance with the international targets to curb anemia. School and community nurses are key to the provision of such interventions. This system review will integrate the evidence on the efficacy of nurse-led interventions in preventing and managing anemia among female teenagers.

Methods A systematic review has been conducted in accordance with the Cochrane Handbook of Systematic Reviews of Interventions, utilizing PRISMA guidelines. The investigation was performed on PubMed, Scopus, Cochrane Library, Web of Science, CINAHL, and ProQuest from May 2021 to December 2025. Randomized controlled trials, quasi-experimental studies, and mixed-method research were incorporated in the investigations undertaken on female Adolescents aged 10 to 19 years. Quality assessment was conducted with techniques from the Joanna Briggs Institute.

Results: 6905 records identified, nine records were included. Structured health education, nutrition counseling, iron-folic acid supplementation, digital educational tools (e.g., mobile apps, games), and school-based programs were the most common interventions and are mostly implemented or overseen by nurses. The findings suggested that there were high levels of improvements in anemia-related knowledge, attitude, dietary habits, and adherence to supplementations. Some of the studies also showed beneficial impacts on hemoglobin levels and decreased prevalence of anemia.

Conclusion: Nurse-based interventions can be used to improve hematological outcomes, promote positive health behavior, and knowledge in teenage girls. To provide sustainable anemia prevention and control, it is important to integrate nurses into the school and community health programs. It is advisable that further studies should be conducted using rigor design, follow up, and well-articulated nursing roles to enhance the evidence base and implement policies.

KEYWORDS: Adolescents, Anemia, Health education, Iron deficiency.

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INTRODUCTION

Anemia is the most common disease that happens because of iron deficiency and it can impact hundreds of millions of women and adolescent girls across the globe and has been a significant healthcare issue (Saju, and Mohammed, 2025). Adolescence is a time of peak growth and initiation of the menstrual cycle, anemia caused by iron deficiency is more frequent, and poor diets, inadequate nutrition, and insufficient iron intake pose a danger to cognitive abilities, performance in educational institutions, and adult productivity, and impaired immunity, and poor maternal outcomes (Kebede et al., 2025).

Anemia is a major challenge to the health of the population worldwide with 1.62 billion people suffering the condition mainly in the low and middle-income countries (LMICs). It is approximate that the prevalence of anemia among nonpregnant and school-going people is 30% and 25% and 35% is believed to be dispersed in the low and middle-income nations (Rahman et al., 2023). The international community targets adolescent girls as one of the priority groups to reduce the prevalence of anemia and recommends multi-modal interventions like iron-folic acid supplements (daily or weekly), food fortification, diet diversification, and infection control, all of which should be delivered through school and community interventions(Marisa et al., 2025).

The focus of these strategies is primarily on nurses, especially school, and community health nurses, by means of screening, counselling, health education, direct or supervised provision of iron/IFA tablets, and continued behavioural support (Saju and

Mohammed, 2025). A number of recent reviews and primary studies have discussed interventions concerning anemia in adolescents, some of which have been concerned with health education or diet-education-supplementation models. Nonetheless, the synthesis of interventions with nurses (as opposed to teachers or other cadres) at the core of designing or delivering anemia prevention and control efforts has little synthesis (Siregar et al., 2025).

BACKGROUND

Iron deficiency anemia (IDA) is a universally prevalent nutritional disorder and it is disproportionately common in teenage girls and young women. According to (Gardner et al., 2023) Global Burden of Disease estimates suggest anemia is still the disease with a significant number of years lived with disability, and that dietary iron deficiency has been a primary cause in most areas. Adolescent girls are especially susceptible in low- and middle-income nations where rapid growth, menstrual bleeding, dietary sources of bioavailable iron, and recurrent infections interact to result in iron deficiency (Wiafe, Ayenu, and Eli-Cophie, 2023).

Leveraging the results of young women between 15 and 24 years old, it is still consistently observed that the prevalence of anemia in most low- and middle-income contexts is out of tune, which indicates that the world is not on the right path to global nutrition and Sustainable Development Goals (Merid et al., 2023). In addition to hematologic abnormalities, IDA during adolescence has been associated with cognitive impairment, poor school performance, low physical working capacity, and bad maternal and peri-natal outcomes later in life (Suprapti et al., 2025).

Developing countries risk-factor reviews indicate that among adolescents, food-intake habits, menstruation, parasitism, low educational and socioeconomic status are the leading causes of IDA (Wiafe, Ayenu, and Eli-Cophie, 2023; Ocktariyana et al., 2024). Asian and African cross-sectional surveys have been recording high levels of anemia and identifying poor dietary diversity and incomplete iron-folic acid intake as powerful predictors of anemia in school-going adolescent girls (Ghimire, Bhandari, and Rajbanshi, 2024; Sari et al., 2022). Indicatively, a study conducted recently in Nepal established that a lack of anemia education and anemia-related factors (incomplete iron-folic acid supplementation and low dietary diversity) were all significantly linked with increased anemia in schoolgirls. These data demonstrate the necessity of interventions that take into account both biomedical and behavioral factors of anemia in this age group (Ghimire, Bhandari, and Rajbanshi, 2024).
It is approximated that over 30 percent of all women of reproductive age across the globe are anaemic. This burden of anaemia is attributed to iron deficiency, at least half of it. Women of reproductive age are also extremely susceptible to iron deficiency as they lose iron during menstruation and their diets simply do not provide sufficient iron (WHO, 2023). The global recommendations focus on the combined approach, i.e. iron folic acid supplement, mass food fortification, dietary enhancement, and lifetime infection control (da Silva Lopes et al., 2021).

In spite of evident biological efficacy, according to most of the programs, the adolescent girl adherence to weekly iron- folic acid tablets is suboptimal, with only 64.1% consuming WIFA tablets and most (97.3) of them having fewer than 24 tablets in 6 months. The most frequent side effects were nausea (70.7%) and dizziness (66.3%) (Khomsan et al., 2025). It was discovered that poor knowledge, availability of SBCC materials, a de-motivating home environment, knowledge and school absenteeism were associated with non-compliance with weekly Iron Folic Acid Supplementation (IFAS). It can also be enhanced through more availability of health education resources, the ability to make supplementation more flexible, and stakeholder participation (Haile et al., 2024).

METHODS

Aims

This review is about the effectiveness of a nurse-led and health worker-led intervention in the prevention as well as control of female adolescent anemia. The major focus is on the interventions that have included health education, dietary counselling, iron or iron–folic acid supplementation and multimedia or eHealth components conducted either with schools or communities. The additional goals to describe the role of nurses in these programs and to determine which intervention parameters are leading to hemoglobin enhancement, anemia alleviation, and positive changes in knowledge, attitudes and practices are also there.

Design

A comprehensive evaluation was carried out in accordance with the procedures and data extraction form outlined in the most recent edition of the Cochrane Handbook for Systematic Reviews of Interventions (6.0). Page et al. (2021) noted that the PRISMA statement served as the guiding principle for this evaluation, and that it was filed in PROSPERO with the ID: CRD42021262081. We set out to answer the following question: Can adolescent girls' anemia be effectively treated through nurse-led interventions?

Search methods

Searches for relevant literature were carried out from May 2021 to December 2025 using the following keywords on PubMed, Scopus, Cochrane Library, Web of Science, CINAHL, and ProQuest: Just type in "adolescent anemia" and "nursing interventions" to find that information. (and) teenage females Language filters: English (human). Full text free. Articles that may have been pertinent were located by searching the reference lists of published works. Included as well were theses and grey literature. Notably, the writers sought the advice of a medical librarian in order to broaden the scope of their search

Table 1.

Table 1: Literature search strategy

Database	Date Searched	Results	Query
PubMed	8/12/2025	662	Search (Nursing Interventions) AND (adolescent anemia). AND (adolescent girls) Filters: full text free – Human Languages: English.
Web of Science	8/12/2025	3329	Search (Nursing Interventions) AND (adolescent anemia). AND (adolescent girls) Filters: full text free – Human Languages: English.
Embase	9/12/2025	1559	Search (Nursing Interventions) AND (adolescent anemia). AND (adolescent girls) Filters: full text free – Human Languages: English.
Cochrane Library	9/12/2025	819	Search (Nursing Interventions) AND (adolescent anemia). AND (adolescent girls) Filters: full text free – Human Languages: English.
CINAHL	10/12/2025	36	Search (Nursing Interventions) AND (adolescent anemia). AND (adolescent girls) Filters: full text free – Human Languages: English.

Inclusion criteria and study selection

This review identified all relevant studies by considering the following study designs, populations, interventions, and outcomes:
Study design: Randomized Controlled trials, quasi-experimental studies and Mixed methods.
Population: female adolescents aged 10–19 years, with or without diagnosed anemia, combined with younger children and adults.
Interventions encompass any forms of telehealth or telephonic technologies implemented by nurses, including mobile health (M-health), telehealth, telemonitoring, virtual interventions, e-coaching, and panel monitoring.

- Delivered structured health education or counselling about iron deficiency anemia, menstruation, diet, and preventive practices.
- Provided or supervised oral iron or iron–folic acid supplementation (daily or weekly).
- Offered nutrition counselling focused on iron-rich foods and enhancers of iron absorption.
- Implemented or guided eHealth or media-based education (such as mobile applications, SMS, online sessions, or educational videos).

Outcomes: changes in hemoglobin levels and anemia prevalence or severity among female adolescents following the intervention.

Exclusion criteria

Review articles, editorials, book chapters, procedures, and prospective observational studies were eliminated. Articles on telehealth interventions conducted by professionals other than nurses were excluded.

Search outcomes

Three writers (1,3,and 7) individually extracted data according to the inclusion and exclusion criteria, and then they checked and compared their work. The collected data was assembled using Microsoft Excel (version 16.0).

The following criteria were utilized to collect data from each study: names of authors, country, participants, sample size, intervention/control groups, follow-up duration, measurement instruments, and outcomes. The data extraction form was standardized. The articles utilized in this evaluation were organized and managed using Rayyan software.
With this search approach, 6905 articles were located (Fig. 1) In the initial step, we evaluated each article's abstract and title to weed out duplicates and ones that didn't align with our study's purpose. The remaining 239 publications were culled for 230 reasons: 101 for a lack of data, 13 for not being applicable to a home setting, 110 for inconsistent phenomena of interest, and 6 for not being relevant to a patient group. Hence, nine articles were considered for this evaluation.

Quality appraisal and data extraction

According to Lockwood et al. (2020), the Joanna Briggs Institute's critical analysis techniques were utilized for quality assessment. We opted for these resources since the checklists provided detailed instructions on how to answer each question. Research in the field of nursing can benefit from this instrument because of its high level of evaluation and comparison to similar ones (Jbi-global-wiki, 2024).

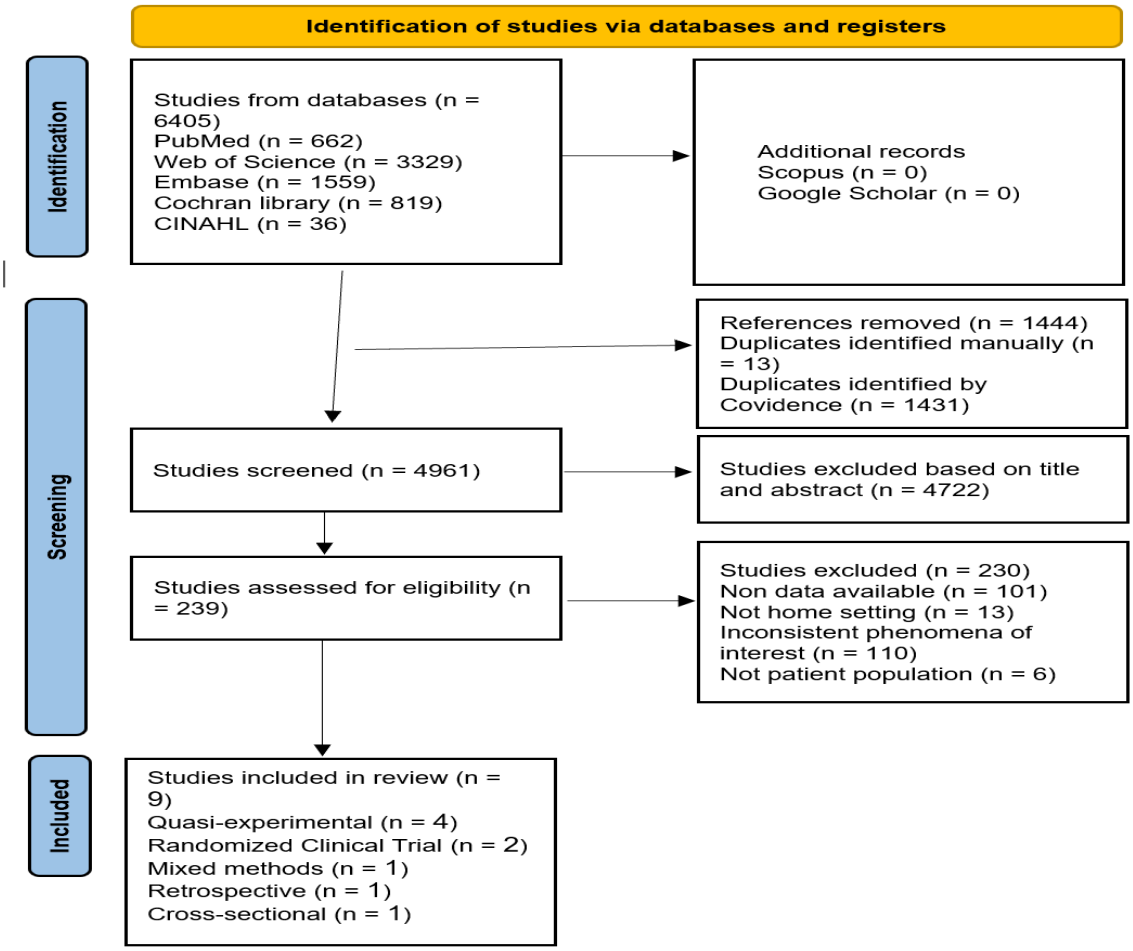

Fig. 1 PRISMA article selection flowchart

Synthesis

The data from the included studies was transcribed into table2 (Review Matrix) containing the following items: authors, research purpose, population, design, length, intervention, outcomes, and findings. Despite the comparability of the population and study outcomes, significant variability among the therapies rendered a meta-analysis unfeasible. Consequently, the results are conveyed in narrative format.

Results

Following the selection procedure, nine studies were recognized that fulfilled the criteria for inclusion and consequently, were incorporated in this review. These research works were comprised of varied designs such as randomized clinical trials, quasi-experimental pre–post designs, a mixed-methods intervention, a theory-based educational trial, and a pilot exploratory program, which were carried out in India, Iran, Indonesia, Bangladesh, Nepal, Saudi Arabia, and the sickle-cell cohort(Rakhshani et al., 2025; Khani Jeihooni et al., 2021; Ghadam et al., 2023; Salam et al., 2023; Sari et al., 2022; Rahman et al., 2023; Khanal et al., 2024; Zuair, 2025; Patel et al., 2025) In these studies, the majority of the subjects were adolescent girls studying in secondary schools or universities with the age range of approximately 13–19 years, and the sample sizes varied from small pilot groups to a few hundred participants in large school-based interventions(Rakhshani et al., 2025; Salam et al., 2023; Sari et al., 2022; Khanal et al., 2024; Zuair, 2025)

The greater part of the interventions was conducted in schools, and the programs were thought of as education-oriented or integrated nutrition initiatives carried out or overseen by nurses or health professionals(Salam et al., 2023; Sari et al., 2022; Zuair, 2025; Patel et al., 2025) Two Iranian works of the studies incorporated behavioral or planning frameworks (Theory of Planned Behavior and PRECEDE model) to organize multi-session nutrition and anemia-prevention education for female students, focusing on the factors affecting the attitudes, subjective norms, perceived behavioral control, and enabling factors (Rakhshani et al., 2025; Khani Jeihooni et al., 2021).

The remaining interventions adopted digital and eHealth modes to disseminate the messages, for instance, a digital game-based nutrition education program, a mobile health application (WANTER), and an eHealth education package consisting of online group counseling and mobile follow-up(Ghadam et al., 2023; Sari et al., 2022; Rahman et al., 2023).

Table2: Literature Review Matrix

Author (Year) / Country	Purpose	Participants	Design	Duration	Control Intervention	Intervention	Outcomes	Findings
Patel et al(2025) / India	To assess the efficacy of nurse-led interventions in enhancing knowledge and health promotion behaviors in adolescents with Sickle Cell Anemia (SCA).	200 adolescents (aged 10–18 years) diagnosed with Sickle Cell Anemia (SCA) receiving care at two tertiary hospitals in Vadodara, India. Participants were equally divided into experimental (n=100) and control (n=100) groups using simple random sampling.	Quasi-experimental research design with control and experimental groups.	Six weeks.	Routine care without additional intervention.	A six-week organized nurse-led intervention with weekly sessions of 45–60 minutes that include: 1. Educational presentations on disease pathology, symptoms, nutrition, hydration, medication compliance, and crisis prevention. 2. Individual and group counseling focused on psychological support, coping mechanisms, and family involvement. 3. Lifestyle initiatives advocating physical activity, stress reduction, and personal cleanliness practices. Administered by qualified nursing experts through lectures, conversations, visual aids, and interactive exercises.	Knowledge of SCA, symptoms, and management practices (measured by Structured Knowledge Questionnaire) and Health Behavior Promotion (self-care practices, preventive behaviors, and lifestyle adherence, measured by Health Behaviour Promotion Scale (HBPS)).	Demographic characteristics, including age, sex, household structure, and paternal occupation, had strong correlations with baseline scores. The conclusion is that nurse-directed treatments significantly improved knowledge and health-promoting behaviors among adolescents with SCA. Customizing these approaches according to demographic variables may enhance patient results.
Rakhshani et al(2025) / Iran	To evaluate the efficacy of an educational intervention grounded in the Theory of Planned Behavior (TPB) for the prevention of iron deficiency anemia (IDA) among female high school students.	160 female high school students (aged 14-19 years) in Shiraz, Iran, not suffering from IDA, were randomly allocated to two groups (experimental and control) of 80 each.	Quasi-experimental study with random allocation to experimental and control groups.	Four months for the educational program delivery in the experimental group, with data collected pre-intervention and four months post-intervention.	The control group received no specific intervention beyond pre- and post-intervention questionnaire completion, implying usual care.	The experimental group participated in an educational program grounded in the Theory of Planned Behavior (TPB) throughout six sessions of 50 to 60 minutes each, performed over a four-month period. Instructional approaches encompassed lectures, question-and-answer sessions, and group discussions. Content aimed at	Attitude, subjective norms, perceived behavioral control, behavioral intention, and behavior (actual dietary and supplementation behaviors) related to IDA prevention.	The current study demonstrates that education grounded in the Theory of Planned Behavior (TPB) can effectively influence nutritional practices to avoid iron deficiency anemia (IDA) in females aged 14 to 19 years. The findings of this research

Author (Year) / Country	Purpose	Participants	Design	Duration	Control Intervention	Intervention	Outcomes	Findings
						TPB constructs: attitude, subjective norms, perceived behavioral control, and behavioral purpose about IDA prevention.		may be utilized by students and their families, offering insights for the development and implementation of interventions aimed at preventing this disease among students, accessible to subordinate entities such as educational institutions, medical universities, health centers, and nutrition clinics.
Khani Jeihooni et al(2021) / Iran	To assess the efficacy of the PRECEDE model nutrition education in addressing iron deficiency anemia among female students in Fasa City, Fars Province, Iran.	160 female students (80 experimental and 80 control groups) from 7th and 8th grades in Fasa City, Fars Province, Iran. Mean age was 13.85 1.72 years in the experimental group and 13.60 1.81 years in the control group.	Quasi-experimental study using a random sampling method.	4 months after intervention (total measurement at two times: before and 4 months after intervention).	The control group received an education session at the end of the study for ethical concerns. No specific intervention during the study period.	The educational intervention comprised six sessions, each lasting 45 or 50 minutes, structured according to the PRECEDE concept. Sessions addressed the function of red blood cells and iron, the symptoms and prevalence of iron deficiency anemia (IDA), the significance of a nutritious diet, the supportive roles of parents, educators, school officials, and healthcare personnel, resource accessibility, and nutritional practices. Participants were organized into groups of eight for the reinforcing factors construct and into ten groups of eight for the instructional	PRECEDE constructs (knowledge, attitude, self-efficacy, reinforcing factors, enabling factors), nutritional behaviors preventing iron deficiency anemia, hemoglobin, hematocrit, and ferritin blood levels.	The nutrition intervention education based on the PRECEDE model positively influences the enhancement of iron deficiency anemia preventative behaviors among female students.

Author (Year) / Country	Purpose	Participants	Design	Duration	Control Intervention	Intervention	Outcomes	Findings
						program. The materials comprised small group conversations, question and answer sessions, practical demonstrations, movies, PowerPoint presentations, and publications. A WhatsApp group was established for parents to share information and receive instructional and motivational messages.		
Ghadam et al(2022) / Iran	To assess the effect of nutrition education via a digital game on indicators of iron-deficiency anemia in adolescent females.	176 adolescent girls	Randomized Clinical Trial (RCT)	14 weeks	Basic nutritional education is provided through PowerPoint presentations and pamphlets.	Digital game-based nutrition education is delivered via a digital game over a duration of 14 weeks. The game comprised seven phases, released biweekly, offering insights on high-risk populations, etiologies, symptoms, iron needs, and iron-dense meals. Participants were permitted to engage in play for a maximum duration of 45 minutes per session, followed by a 3-hour lockout period following each session.	Knowledge, attitude, and practice scores; hemoglobin (Hb), ferritin, serum transferrin, serum iron, transferrin saturation, total iron binding capacity (TIBC), hematocrit, mean corpuscular volume (MCV), mean corpuscular hemoglobin (MCH), mean corpuscular hemoglobin concentration (MCHC), and dietary intake of nutrients (energy, protein, carbohydrate, fat, fiber, cholesterol, calcium, phosphorus, iron, potassium, vitamin A, vitamin C, vitamin D, vitamin E).	The findings of this study demonstrated the beneficial effect of nutrition education utilizing a digital game on knowledge, attitude, and practice scores, along with a notable difference in hemoglobin levels. It is advisable to develop instructional games for students in the future to enhance health and nutrition awareness.
Salam et	To assess the	455 students	Mixed-	Seven half-	Not	A pedagogical	Knowledge	Educational

Author (Year) / Country	Purpose	Participants	Design	Duration	Control Intervention	Intervention	Outcomes	Findings
al(2023) / India	degree to which adolescent awareness of anemia and its prevention can be altered by nutritional messaging disseminated in educational settings.	(grade six and seven, 11-14 years old, 56% girls) and 7 teachers (30-45 years old) from three government schools in rural Karnataka, India.	methods pre-post intervention study.	hour educational sessions delivered over 7 weeks; pre- and post-intervention tests conducted ~1-2 weeks after the last session.	applicable; pre-post intervention design with participants serving as their own control.	intervention collaboratively designed by educators and nutrition specialists utilizing contextually tailored resources (lectures, role-playing, practical demonstrations). The program, conducted by school teachers, comprised seven half-hour sessions over seven weeks, addressing balanced diets, the significance of anemia during pregnancy, iron-rich foods, IFA supplementation (myths, facts, dos and don'ts), healthy behaviors, and adolescent health.	score related to anaemia.	interventions implemented by instructors in schools for adolescents are beneficial in enhancing awareness and attitudes regarding anemia and its prevention.
Sari et al(2022) / Indonesia	To evaluate the impact of health education using the WANTER mobile application on enhancing knowledge, attitudes, and practices (KAP) concerning anemia among female students.	277 adolescent girls (15–18 years old, high school students) from Soreang District, Bandung Regency, Indonesia (162 in intervention group, 115 in control group).	Quasi-experimental with a pretest-posttest design.	Three months.	Health education delivered via an educational booklet on anemia in adolescent girls.	Health education provided through the WANTER mobile application, featuring films on iron deficiency anemia, a BMI calculator, balanced diet guidance, and a consultation menu.	Knowledge, Attitude, and Practice (KAP) regarding anemia prevention.	No substantial difference in Knowledge, Attitude, and Practice (KAP) was seen between the control and intervention groups. Furthermore, there was no enhancement in practice observed in either the control or intervention groups. Knowledge, attitudes, and actions for the prevention of anemia require ongoing enhancement. Health education via suitable media for teenagers is crucial for

Author (Year) / Country	Purpose	Participants	Design	Duration	Control Intervention	Intervention	Outcomes	Findings
								enhancing the efficacy of interventions.
Rahman et al(2023) / Bangladesh	To analyze the efficacy of eHealth education in diminishing anemia prevalence among school-aged adolescent girls in rural Bangladesh and to evaluate alterations in their knowledge, attitudes, and practices concerning anemia.	138 school-going anemic adolescent girls (69 intervention, 69 control) from rural Bangladesh, aged 10-19 years, diagnosed with mild (10-11.9 g/dl) or moderate (7.0-9.9 g/dl) anemia, with a cell phone in their family, and guardian consent.	School-based two-arm (1:1) randomized controlled trial.	8 months (May 2022 to February 2023).	Participants received usual care and were under follow-up without health education.	The intervention group participated in two online group counseling sessions (1.5 hours each) conducted by a public health physician, along with 8 months of eHealth education delivered by mobile phone calls (5 minutes, four times per month, subsequently three times per month, and finally two times per month) and weekly short messaging service (SMS) from community health workers. The education encompassed the causes, effects, prevention, recovery, iron-rich foods, dietary recommendations, eating habits, healthy lifestyle, and personal cleanliness related to anemia. Health education materials (notebook) and a compilation of local iron-rich foods were also supplied.	Primary: Anemia level (hemoglobin screening for mild, moderate, severe anemia). Secondary: Changes in knowledge, attitude, and practice (KAP) regarding anemia; improvements in body mass index (BMI), hip-waist circumference, and mid-upper arm circumference (MUAC); total count of White blood cell (WBC), Red blood cell (RBC), Platelets, Mean corpuscular volume (MCV), Packed cell volume (PCV); urinary albumin, protein, sugar, and RBCs.	Mean hemoglobin levels in the intervention and control groups, respectively. eHealth education is anticipated to effectively enhance knowledge and promote healthy behavioral changes, hence alleviating the anemia burden among adolescent females.
Khanal A. et al(2024) / Nepal	To evaluate the disparity in the prevalence of anemia and its related determinants among adolescent girls in schools with and without the implementation of Weekly Iron	602 adolescent girls aged 10–19 years from grade six to ten, equally divided into WIFAS implemented and non-implemented schools.	Cross-sectional survey.	Data collected from December 18, 2022, to January 25, 2023.	Adolescent girls in non-implemented schools (not receiving WIFAS).	Adolescent females at schools using WIFAS received Weekly Iron Folic Acid Supplementation (60 mg of elemental iron and 400 µg of folic acid) for three months, succeeded by	Prevalence of anemia (defined by WHO, 2011, based on hemoglobin level), age, type of family, father's and mother's education, father's and mother's	Factors like as school type, paternal education, and dietary diversity were identified as statistically significant in relation to anemia during multivariable

Author (Year) / Country	Purpose	Participants	Design	Duration	Control Intervention	Intervention	Outcomes	Findings
	Folic Acid Supplementation (WIFAS) in Tokha Municipality, Kathmandu.					three months without supplementation, totaling 26 IFA pills annually.	occupation, knowledge on anemia and WIFAS, and dietary diversity.	logistic regression analysis. Based on the findings of this research, it is recommended to provide appropriate counseling and promote the use of WIFAS to reduce the prevalence of anemia among adolescent females.
Zuair, (2025) Saudi Arabia	To examine the prevalence of iron-deficiency anemia (IDA), assess the effects of a low-intensity educational intervention on the knowledge, attitudes, and practices (KAP) of students with IDA, and create a logic model to inform future school health initiatives.	45 female secondary school students with IDA (mean age = 16.29 years) from Medina City, Saudi Arabia, who completed a KAP assessment (out of 153 total students screened).	Retrospective, pre-post exploratory pilot study utilizing secondary data, with a pre-post design to evaluate the intervention.	Two 45-minute educational sessions, with an online one-week post-test evaluation.	No separate control group; a pre-post design was used.	The 'Red-Apple Initiative' is a low-intensity educational intervention administered by community health nurses. The program comprised two 45-minute sessions that addressed the causes and risk factors of IDA, prevention strategies, healthy dietary behaviors, and the rectification of misconceptions through engaging presentations, interactive question-and-answer segments, and a practical exercise in menu planning.	IDA prevalence, IDA knowledge scores (0-8), IDA practice scores (0-3), IDA attitude scores (1-18), total IDA KAP scores (1-29), and relevant demographic factors.	Educational intervention effectively enhanced knowledge and practices around IDA, however attitudes did not alter. These findings underscore the efficacy of targeted, evidence-based school health interventions in addressing deficiencies in teenage nutrition knowledge and practices. Future research should explore more rigorous interventions to attain holistic enhancements across all dimensions of Knowledge, Attitudes, and Practices (KAP).

Effects of educational and behavior-change interventions on knowledge and health behaviors

All the six studies that administered education based intervention are similar in that female adolescents knowledge on anemia after nurse led or other health professional led interventions showed significant improvement. In Iran, the Theory of Planned Behavior-based educational intervention exerted a strong influence on the knowledge scores and attitudes and subjective norms and perceived behavioral control over iron-rich dietary behaviors, which were also reflected in self-reported practice of iron deficiency anemia prevention among high-school girls. A PRECEDE-based nutrition education intervention also reported similar outcomes in which notable gains in the level of knowledge, predisposing and enabling factors, and iron intake dietary habits were realized with positive changes in anemia status among female students(Khani Jeihooni et al., 2021).

A school-based nutrition education intervention in rural Karnataka, India, resulted in positive effects on knowledge and behaviors related to the same by increasing levels of knowledge and qualitative reporting of improved awareness among adolescent girls (Salam et al., 2023).The results of a randomized clinical trial of a digital game-based nutrition education programme revealed that there were large improvements in nutrition knowledge and health-related attitudes in the intervention group as compared to the control group. More participants in the intervention group had better nutrition knowledge and were more familiar with iron-rich foods and anemia prevention messages than the controls (Ghadam et al., 2023).Similarly, an m-Health education programme (WANTER) reported significant improvements in nutrition knowledge and health-related attitudes, and the participants showed more knowledge about anemia prevention messages and iron-rich foods compared to the controls (Sari et al., 2022).

Effects of interventions on hemoglobin and anemia indicators

Several studies have measured blood-related outcomes and have reported that the interventions had a positive effect on anemia indicators. A nutrition education study based on the PRECEDE model, besides the knowledge and behaviors that were improved, it also found that there were significant increases in hemoglobin levels and decreases in the prevalence of iron deficiency anemia among female students after the intervention period(Khani Jeihooni et al., 2021) The trial of nutrition education through a digital game recorded a variety of changes to anemia-related indicators in adolescent girls, among these, increased hemoglobin and improved iron-status markers as compared to the control participants who received only conventional education(Ghadam et al., 2023) The authors of the school-based nutrition education study in India, whose main emphasis was on knowledge, reported that such interventions are a necessary step for the improvement of iron intake and, if combined with supplementation, may lead to the reduction of anemia in the future(Salam et al., 2023).

Mobile-health and eHealth interventions were also part of the strategy to target anemia outcomes, either by direct means or through diet and supplement adherence changes. The WANTER m-Health program, in which the main focus was on knowledge, attitude, and practice, was actually a behavior support program that aims to improve hemoglobin levels and ultimately, to prevent anemia(Sari et al., 2022)An eHealth education trial in rural Bangladesh was designed to assess if structured online counselling and mobile follow-up could lead to knowledge, dietary behaviors, and iron-folic acid adherence so that anemia levels would decrease in school-going adolescent girls; the protocol describes hemoglobin and anemia status as main endpoints, thereby highlighting the increasing engagement of digital nurse-supported strategies in anemia control(Rahman et al., 2023)The Saudi nursing-led school program was said to be a viable and effective means of bringing about changes in anemia-related indicators, although comprehensive hematologic data are scant in the pilot exploratory report(Zuair, 2025).

Contextual evidence from Nepal indicates that a significant number of girls continue to be anemic even after the implementation of the Weekly Iron–Folic Acid Supplementation (WIFAS) programs. Additionally, factors such as adherence to the program, dietary practices, and the quality of program implementation have emerged as the main determinants of anemia prevalence(Khanal et al., 2024) These outcomes, thus, highlight the indispensability of nurse-led education, counselling, and adherence support as the main components of the supplementation regime. The same is supported by the majority of interventions included in this review(Khani Jeihooni et al., 2021; Ghadam et al., 2023; Sari et al., 2022; Rahman et al., 2023; Zuair, 2025).

DISCUSSION

The evidence from this systematic review suggests that nurse- and health-professional-led interventions may have a significant influence on the improvement of anemia-related knowledge, health behaviors, and in some cases, hematologic outcomes, of female adolescents. Several modes of intervention, such as theory-driven classroom education, school-based nutrition programs, digital game-based learning, mobile-health applications, and nursing-led school initiatives, were reported to be associated with significant post-intervention gains in knowledge as well as more positive attitudes and behaviors towards diet, iron intake, and anemia prevention(Rakhshani et al., 2025; Khani Jeihooni et al., 2021; Ghadam et al., 2023; Salam et al., 2023; Sari et al., 2022; Zuair, 2025; Patel et al., 2025) In these studies where hemoglobin and anemia status were measured, integrated interventions that combined structured education with nutrition counseling and iron-related strategies led to significant improvements in anemia indicators(Khani Jeihooni et al., 2021; Ghadam et al., 2023) The findings align with broader evidence that the control of anemia is most effective when both the biological and behavioral determinants are targeted at the same time.

One of the major points across the included studies is the additional benefit of theory-based and structured educational approaches. Educational programs guided by the Theory of Planned Behavior and the PRECEDE model not only increased knowledge but also changed the determinants such as attitudes, subjective norms, perceived behavioral control, and enabling factors, which, in turn, resulted in better dietary practices and decrease in iron deficiency anemia(Rakhshani et al., 2025; Khani Jeihooni et al., 2021) In the same way, digital game-based learning and m-Health instruments such as the WANTER app were able to attract adolescents and thus translate their exposure to educational content into improved knowledge, more positive attitudes, and self-reported behavior change(Ghadam et al., 2023; Sari et al., 2022) The results of this study indicate that nurse-led interventions yield the highest results when they employ clear behavior-change models, methods that are interactive or technology-enabled, and have repeated contacts rather than providing a one-time information session.

The review also emphasizes the significance of the environment, the quality of the implementation, and the adherence. Information from Nepal demonstrates that even if there are Weekly Iron–Folic Acid Supplementation programs, it does not necessarily mean low anemia prevalence as adherence, dietary habits, and program coverage are still the most important factors that determine the impact(Khanal et al., 2024) Similarly, the nursing school-based program in Saudi Arabia and the eHealth education trial in Bangladesh indicate that the main points are feasibility and acceptability; however, they also show that continued engagement, support from the family and school, and follow-up are required to attain and sustain hematologic benefits(Rahman et al., 2023; Zuair, 2025) All these findings taken together suggest that nurse-led interventions should be integrated into the wider

health and education systems with a focus on reinforcement, supervision of supplement intake, and addressing compliance-related issues.

However, it is necessary to acknowledge several limitations of the present evidence base at the same time. Firstly, the number of studies that explicitly mention "nurse-led" models is still limited and in some instances, the role of nurses is combined with other health professionals making it hard to identify the single contribution of nursing practice alone(Zuair, 2025; Patel et al., 2025) Secondly, the differences in study design, intervention components, outcome measures, and follow-up periods make it hard to directly compare the results and perform a pooled quantitative synthesis. Thirdly, many studies have mainly concentrated on short-term knowledge and self-reported behaviors with only a few providing long-term follow-up data on hemoglobin or anemia prevalence. Lastly, some interventions were implemented as pilots or in single schools or regions, thus the results may not be applicable to a wider population.

Implications for nursing

The review evidence indicates the crucial role of nurses in the prevention and management of anemia in female adolescents using school- and community-based intervention programs. This indicates that nurses must be targeted and empowered as important agents in carrying out adolescent anemia programs in the framework of school health services, primary care, and community-based programs (Rakhshani et al., 2025; Khani Jeihooni et al., 2021; Ghadam et al., 2023; Salam et al., 2023; Zuair, 2025).

These results point to the necessity of improving the skills of the nurses in the clinical and community sector in areas such as adolescent nutrition, behavior change counseling, and using educational and digital tools.By learning and practicing the Theory of Planned Behavior and the PRECEDE model, nurses will be better able to create and implement interventions that go beyond just giving information and instead change participants' attitudes, social norms, perceived control, and facilitating resources (Rakhshani et al., 2025; Khani Jeihooni et al., 2021).Besides that, the use of cutting-edge modalities like digital game-based learning, mobile applications, and eHealth counseling in regular nursing practice may invigorate involvement and additionally broaden the target audience, particularly in resource-deficient or remote areas (Ghadam et al., 2023; Sari et al., 2022; Rahman et al., 2023).Also, nurses at school and in the community can keep track of compliance with iron or iron–folic acid supplementation, detect obstacles like side-effects or wrong beliefs, and collaborate with families and teachers to establish and maintain behavior change in the surroundings through support (Khanal et al., 2024; Zuair, 2025; Patel et al., 2025).

At policy and programmatic level, the findings can be used to promote the inclusion of nurse-led anemia interventions in the national strategies on adolescent health and school health policies. Staffing school and community nurses adequately, creating time and resources to conduct health education, and incorporating anaemia screening and counselling and follow up into regular services provided to the adolescent are important measures. It will be necessary to collaborate between nursing services, education sectors and public health authorities to scale up successful models that appeared in this review and also to implement them in various cultural and health-system contexts (Salam et al., 2023; Zuair, 2025).

LIMITATIONS

The present review has a number of limitations. First, the studies that specifically characterize the intervention of preventing or controlling anemia in female adolescents offered by nurses in particular were limited, and the studies included in this study were different in their design, setting, sample size, content of the interventions, and the period of follow up. The heterogeneity did not allow a direct comparison of the results between different studies and also it did not allow the meta analysis. Second, the role of nurses was not unequally identified over that of other health professionals or school workers in a number of interventions and this prevented the attribution of the effects that were observed to nursing practice alone. Third, most of the studies were short term studies on the changes in knowledge and self reported behaviors with very few having long term statistics of hemoglobin levels, anemia prevalence or long term behavior changes. Lastly, the majority of the interventions were implemented in single schools, districts or in certain national settings, and this might not be generalizable to other regions and health system organizations.

CONCLUSION

This systematic review findings indicate that nurse led and nurse coordinated interventions play a significant role in preventing and managing anemia in female adolescents. In various nations and contexts, structured health education, theory based behavior change interventions, nutrition counselling, digital game-based learning, mobile health applications and school-based nursing care were linked to knowledge, attitudes and health behaviors change with regard to iron deficiency anemia and some studies also indicated positive changes on hemoglobin and anemia status. These findings underscore the possible impact of school and community nurses as major agents of holistic adolescent anemia interventions, especially where interventions involve a combination of education and dietary interventions with iron supplementation. Prospective research ought to use strong designs and well-defined nursing roles, bigger and more varied samples as well as extended follow up to enhance the evidence base and to inform introduction of nurse led models in national adolescent health and school health policies.

Authors' contributions

Fares, and Amr collaborated on the study protocol. Reem completed the search strategy, reviewed by Amr and Jenan. Wajd and Abdullah handled screening, quality appraisal, and data extraction, supervised by Afrah and Jamela. Amr drafted the manuscript, with input from Reem, Afrah and Jenan. All authors approved the final manuscript.

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Availability of data and materials
The data that supports the results and findings of this systematic review can be found in either the main paper. Any other data from the current study are available from the corresponding author upon reasonable request.

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Ethics approval and consent to participate Not applicable. Consent for publication Not applicable.

Competing interests
The authors declare no competing interests.

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