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Educational and Behavioral Factors Associated with Iron Deficiency Anemia: A Systematic Review and Bibliometric Synthesis

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Abstract

Iron deficiency anemia remains a persistent public health concern worldwide, particularly among adolescents, women of reproductive age, and pregnant women, despite long-standing prevention efforts. While biomedical interventions such as iron supplementation and dietary diversification are well established, their effectiveness is strongly influenced by behavioral and contextual factors. This systematic review synthesized peer-reviewed evidence on knowledge, attitudes, and practices related to iron deficiency anemia to better understand these behavioral dimensions. Following PRISMA guidelines, a comprehensive search of Scopus and Web of Science identified 587 records, of which eleven studies met inclusion criteria for qualitative synthesis after de-duplication, screening, and eligibility assessment. The review integrated thematic analysis with bibliometric mapping to examine both conceptual patterns and intellectual structure of the literature. Findings revealed consistent gaps between general awareness of anemia and actionable knowledge required for effective prevention. Attitudes toward iron supplementation were frequently ambivalent, shaped by fear of side effects, social norms, and trust in health systems. Preventive practices were further constrained by socioeconomic conditions, food availability, household decision-making dynamics, and weaknesses in delivery systems. Educational and programmatic interventions improved knowledge but produced limited and inconsistent effects on sustained behavior when implemented in isolation. Bibliometric analyses corroborated these findings by demonstrating fragmentation between biomedical research, behavioral studies, and implementation-focused work. Overall, the evidence indicates that iron deficiency anemia persists not due to lack of awareness alone, but because of the complex interaction between knowledge, attitudes, structural constraints, and health system factors. Addressing anemia effectively therefore requires integrated strategies that combine practical education, supportive delivery mechanisms, and context-specific behavioral approaches.

Keywords: Iron Deficiency Anemia, Knowledge, Attitudes, and Practices, Health Education, Systematic Review, Bibliometric Analysis

Introduction

Iron deficiency anemia remains a significant public health concern across low-, middle-, and high-income countries, with substantial consequences for population health and human development (Bhutta et al., 2013). Evidence from the studies shortlisted through the PRISMA process indicates that iron deficiency anemia contributes to impaired cognitive development, reduced physical and work capacity, increased maternal and perinatal risks, and poorer overall quality of life, particularly among adolescents, women of reproductive age, and pregnant women (Gillespie et al., 2023). These population groups are consistently identified as being at elevated risk due to increased physiological iron requirements, gender-related vulnerabilities, and limited dietary diversity in many settings, as reported across multiple cross-sectional and intervention studies included in the review (Kaur, Kaur & Kaur, 2020).

The PRISMA-selected literature demonstrates that public health strategies to address iron deficiency anemia have historically emphasized biomedical interventions such as iron and folic acid supplementation, dietary diversification, food fortification, and routine screening in high-risk groups. While these approaches are supported by strong biological evidence and have shown efficacy under

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controlled conditions, the studies included in this review consistently report challenges in real-world implementation (Malay et al., 2018). Low adherence to iron supplementation, inconsistent adoption of dietary recommendations, and limited uptake of screening services were recurrent findings across adolescent, maternal, and community-based studies, indicating that biomedical effectiveness alone does not guarantee population-level impact. Knowledge-related findings reveal that while general awareness of anemia is common, detailed and actionable understanding of dietary iron sources, supplementation schedules, and absorption-related factors remains limited (Petry et al., 2016). Attitudinal analyses further show that perceptions of iron supplementation are frequently shaped by fear of side effects, social stigma, and varying levels of trust in health systems and health workers. Practice-related evidence demonstrates that preventive behaviors are often constrained by socioeconomic conditions, household decision-making dynamics, and weaknesses in delivery systems, particularly in low-resource settings. Attitudes were frequently influenced by prior negative experiences with supplementation, cultural beliefs, and inconsistent counseling, while practices were limited by food insecurity, irregular supplement supply, and inadequate follow-up within health and school systems (Petry et al., 2020).

Despite the growing volume of KAP-focused research, the systematic review identified a relative scarcity of comprehensive syntheses that integrate behavioral findings across population groups and settings. Existing reviews tend to prioritize prevalence estimates, clinical outcomes, or intervention efficacy, with limited attention to behavioral mechanisms and contextual constraints (Rohner et al., 2014). Moreover, the evidence base remains fragmented across adolescents, pregnant women, caregivers, and health workers, despite the interconnected nature of their roles in anemia prevention. In response to these gaps, the present review systematically synthesized KAP-related evidence on iron deficiency anemia using a merged Scopus–Web of Science dataset and a PRISMA-guided methodology. Through thematic analysis of the shortlisted studies, the review identified recurring behavioral patterns, structural barriers, and enabling factors that shape the prevention and management of iron deficiency anemia across diverse contexts. This integrated approach provides a stronger empirical foundation for designing education-focused, behaviorally informed, and system-sensitive strategies to improve anemia prevention and control.

Objective

The primary objective of this systematic review was to;

1. Synthesize peer-reviewed evidence on knowledge, attitudes, and practices related to iron deficiency anemia using a Scopus–Web of Science dataset through bibliometric and systematic review.

PRISMA Framework

A comprehensive search strategy was developed using Boolean operators to identify relevant studies (See Fig.1). The search combined key terms related to iron deficiency anemia, including “iron deficiency anemia,” “iron deficiency anaemia,” IDA, anemia, and anaemia, with terms capturing knowledge, attitude, and practice such as “knowledge attitude and practice,” KAP, awareness, and health knowledge. These were further linked with nutrition-related terms including nutritional deficiency, nutrition, micronutrients, and iron. The Boolean operators “OR” and “AND” were used systematically to broaden retrieval within concepts while ensuring that all core concepts were represented in the final search results. This systematic review was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses guidelines to ensure transparency, methodological rigor, and reproducibility. The PRISMA framework guided each stage of the review process, including identification, screening, eligibility assessment, and inclusion of studies. Records were identified from two major bibliographic databases: Scopus and Web of Science. The initial search yielded a total of 587 records, comprising 485 records from Scopus and 102 records from Web of Science. Duplicate records were identified primarily through digital object identifier matching, with supplementary title and year comparisons applied when necessary. This process resulted in the removal of 63 duplicate records, leaving 524 unique studies for screening. The screening stage involved review of titles, abstracts, and indexed keywords to assess relevance to iron deficiency anemia and KAP-related outcomes. Studies that focused exclusively on biomedical parameters without behavioral components or lacked an explicit focus on iron-related anemia were excluded. Full eligibility assessment was then conducted using available abstracts and full texts where accessible. Studies were included if they reported primary data or systematic synthesis related to

knowledge, attitudes, or practices concerning iron deficiency anemia or iron-related preventive behaviors. Following this process, eleven studies met the inclusion criteria and were retained for qualitative synthesis. The PRISMA flow diagram summarizes this process and visually represents the number of records identified, screened, excluded, and included at each stage. This structured approach enhances the credibility of the review and supports transparency in study selection.

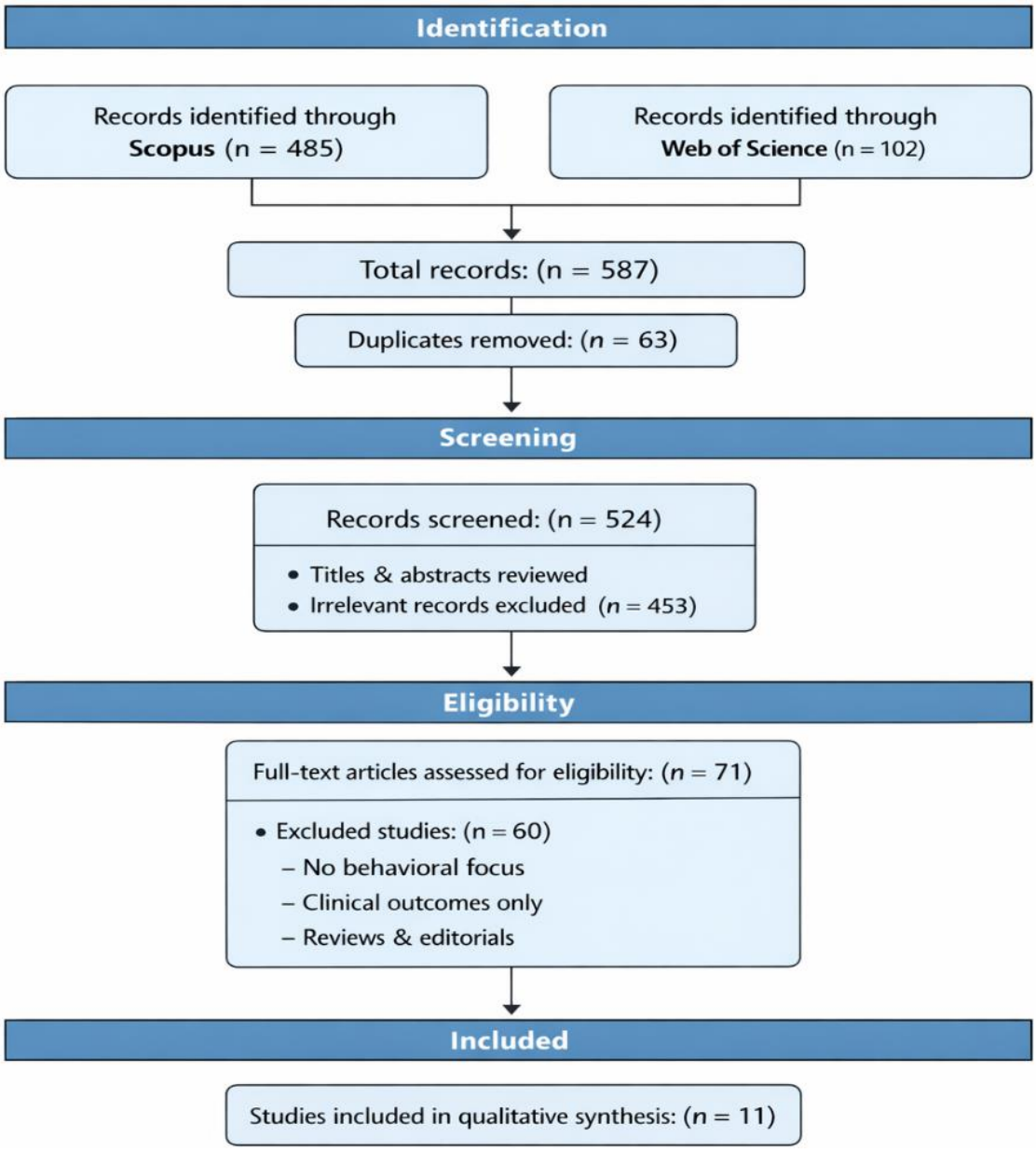

Fig. 1. PRISMA Framework

Research Methodology

Philosophical Stance:

This study was grounded in a **pragmatic epistemological stance,** recognizing that understanding iron deficiency anemia requires integration of both quantitative and qualitative forms of evidence. Pragmatism allows the use of multiple methodological approaches to address complex public health problems, emphasizing practical understanding over adherence to a single theoretical paradigm. In this context, bibliometric analysis was employed to map and quantify the structure of existing research, while a systematic review with thematic analysis was used to interpret behavioral and contextual dimensions of knowledge, attitudes, and practices related to iron deficiency anemia.

Research Design:

A **mixed-methods evidence synthesis design** was adopted, combining **bibliometric analysis** with a **PRISMA-guided systematic review.** The bibliometric component provided a quantitative overview of publication trends, thematic clustering, intellectual structure, and research networks within the iron

deficiency anemia literature. The systematic review component enabled in-depth qualitative synthesis of findings related to educational, behavioral, and system-level determinants. Together, these approaches offered complementary insights into both the scope and substance of the evidence base.

Population of the Study:

The population for this study comprised **peer-reviewed scholarly publications** addressing iron deficiency anemia, with specific reference to knowledge, attitudes, practices, education, nutrition, supplementation, and prevention strategies. These publications represented research conducted among diverse human populations, including adolescents, women of reproductive age, pregnant women, caregivers, and health workers, across low-, middle-, and high-income countries.

Sample and Sampling Technique:

The sample consisted of research articles retrieved from **Scopus and Web of Science,** selected through a **systematic, criterion-based sampling approach**. A comprehensive Boolean search strategy was applied to both databases, yielding an initial pool of 587 records. After de-duplication and screening, a final sample of **11 studies** was selected for qualitative synthesis in the systematic review, while **469 unique records** formed the basis of the bibliometric analysis. This purposive and systematic sampling approach ensured relevance, methodological rigor, and alignment with the study objectives.

Studies were included if they:

(1) were peer-reviewed journal articles;
(2) involved human participants;
(3) explicitly addressed iron deficiency anemia or iron-related anemia;
(4) examined knowledge, attitudes, practices, compliance, education, or behavioral outcomes
(5) employed quantitative, qualitative, or mixed-methods designs.

Studies were excluded if they:

(1) focused solely on clinical, biochemical, or laboratory outcomes without behavioral or educational components;
(2) lacked explicit relevance to iron deficiency anemia;
(3) were editorials, commentaries, guidelines, or opinion pieces;
(4) or provided insufficient methodological detail.

Data Collection Procedures:

Data collection occurred in two sequential phases. In the first phase, bibliographic data were extracted from Scopus and Web of Science using predefined Boolean search strings. Retrieved records were exported and merged, and duplicates were removed using digital object identifiers and title–year matching. Metadata fields including authorship, publication year, journal source, keywords, citations, and affiliations were retained for bibliometric analysis. In the second phase, full-text screening and data extraction were conducted for the systematic review. Information extracted included study design, population characteristics, educational components, KAP domains assessed, and key findings related to behavioral and contextual determinants of iron deficiency anemia.

Data Analysis:

Bibliometric analysis was conducted using descriptive indicators and network visualization techniques. Publication trends, citation patterns, keyword co-occurrence, and bibliographic coupling were analyzed to identify dominant themes, research clusters, and intellectual linkages within the literature. Visualization tools were used to map relationships among keywords, authors, and research domains, providing insight into how biomedical, behavioral, and educational strands of iron deficiency anemia research are structured. For the systematic review, **thematic analysis** was employed to synthesize qualitative and quantitative findings. An iterative coding process was applied, beginning with open coding of extracted findings related to knowledge, attitudes, practices, education, and system-level factors. Codes were subsequently organized into higher-order themes that reflected recurring behavioral patterns, barriers, and enabling factors across studies. This analytic process allowed integration of heterogeneous evidence into a coherent explanatory framework.

Bibliometric Analysis

The two VOSviewer visualizations provide a coherent and methodologically sound bibliometric complement to the systematic review and the merged Scopus–Web of Science dataset, and together they reinforce the thematic conclusions drawn in the review. The first image (Fig. 2.), based largely on index keywords, presents a dense, centrally organized network dominated by the term *human*,

surrounded by closely linked nodes such as *iron*, *iron deficiency*, *nutritional status*, *adult*, *infant*, and *cross-sectional study*. This centrality reflects the strong biomedical and population-based orientation of the literature captured in the merged dataset, which spans clinical, nutritional, and epidemiological research. The prominence of demographic terms (adult, infant, newborn) and study-design descriptors (cross-sectional study, epidemiology) aligns closely with the systematic review's finding that much of the evidence on iron deficiency anemia is observational and population focused, particularly among vulnerable life stages. At the same time, the presence of terms such as *social status*, *educational status*, *household*, *stunting*, and *wasting syndrome* supports the review's emphasis on socioeconomic and structural determinants that constrain preventive practices, indicating that the literature does not treat iron deficiency anemia purely as a biological condition but situates it within broader social and nutritional contexts. The clustering in the first map also reveals a relative separation between biomedical markers (e.g., *hematocrit*, *blood cell count*, *albumin*, *pathophysiology*) and public health–oriented constructs (e.g., *nutritional status*, *cross-sectional study*, *risk assessment*). This separation mirrors one of the core arguments of the systematic review: that while biomedical knowledge about iron deficiency anemia is extensive, translation into actionable, behavior-oriented prevention remains uneven. The visibility of micronutrient-related nodes such as *zinc*, *vitamin A*, and *cyanocobalamin* further reflects the multidimensional nutritional framing of anemia in the dataset, consistent with the review's observation that iron deficiency anemia is often discussed alongside other micronutrient deficiencies rather than in isolation.

The second visualization (Fig.3.), derived from terms in titles and abstracts, provides a more behaviorally and programmatically oriented perspective and aligns even more directly with the KAP-focused systematic review. Here, clusters centered on *knowledge*, *awareness*, *school*, *adolescent girl*, *participant*, and *pregnancy* clearly foreground the populations and constructs emphasized in the review. The strong linkage between *knowledge*, *school*, and *adolescent girl* reflects the substantial body of school-based and adolescent-focused studies identified in the systematic synthesis, particularly those examining educational interventions and awareness gaps. This supports the review's conclusion that general awareness is common but often insufficiently operational, as knowledge appears as a prominent but not fully integrated node with practice-oriented terms. At the same time, the second map shows distinct clusters around *supplementation*, *vitamin*, *folic acid*, and *fortification*, indicating that intervention research is a major pillar of the literature. However, these clusters are not fully merged with nodes related to *use*, *adherence*, or *practice*, which resonates with the review's critical finding that education and supplementation programs improve knowledge but do not always translate into sustained behavioral change. The presence of *patient*, *symptom*, *hospitalization*, and *disease* in a separate cluster further highlights the divide between clinical management and community-level prevention, reinforcing the review's argument that preventive practices are shaped as much by system design and access as by individual attitudes.

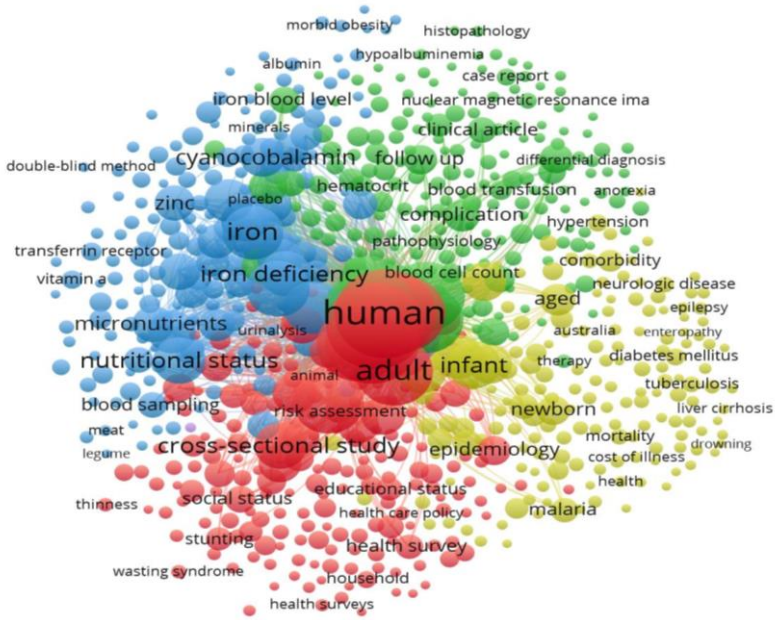

Fig.2. Index Keywords in Scopus data basis

Geographic and burden-related terms such as *India*, *country*, *burden*, *mortality*, *global burden*, and *cause* also feature prominently in the second visualization, reflecting the strong contribution of low- and middle-income country research within the merged dataset. This aligns with the systematic review's emphasis on contextual constraints, including resource limitations and health system capacity, which shape KAP outcomes. Importantly, the appearance of *KAP* as a distinct node connected to *knowledge* and *adolescent girl* validates the methodological relevance of the KAP framework used in the review and confirms that such studies form a recognizable subfield within the broader anemia literature.

Fig.4. represents a **bibliometric coupling network of authors,** generated using VOSviewer, and it visualizes how authors in the iron deficiency anemia literature are intellectually connected **through shared references** rather than through co-authorship or citation counts. At the most basic level, **each node represents an author,** and the **distance between nodes reflects the degree of bibliometric coupling** that is, how many references those authors' publications have in common. Authors who cite similar foundational literature (for example, the same epidemiological surveys, micronutrient trials, or WHO guidelines) appear closer together. The largely **uniform grey coloring** indicates that, overall, this field is characterized by a **broad but relatively diffuse intellectual structure,** with many authors drawing on overlapping but not tightly clustered reference bases. The **absence of large, dominant clusters** suggests that iron deficiency anemia research is **methodologically and thematically diverse**, rather than dominated by a few tightly knit schools of thought. Instead of strong, isolated research camps, the map shows a wide ring of moderately connected authors, indicating that many researchers engage with similar background literature but apply it across different contexts such as clinical nutrition, public health, epidemiology, supplementation trials, and KAP studies. This observation aligns well with your systematic review, which identified heterogeneity in study designs, populations, and outcomes, even when studies addressed similar research questions.

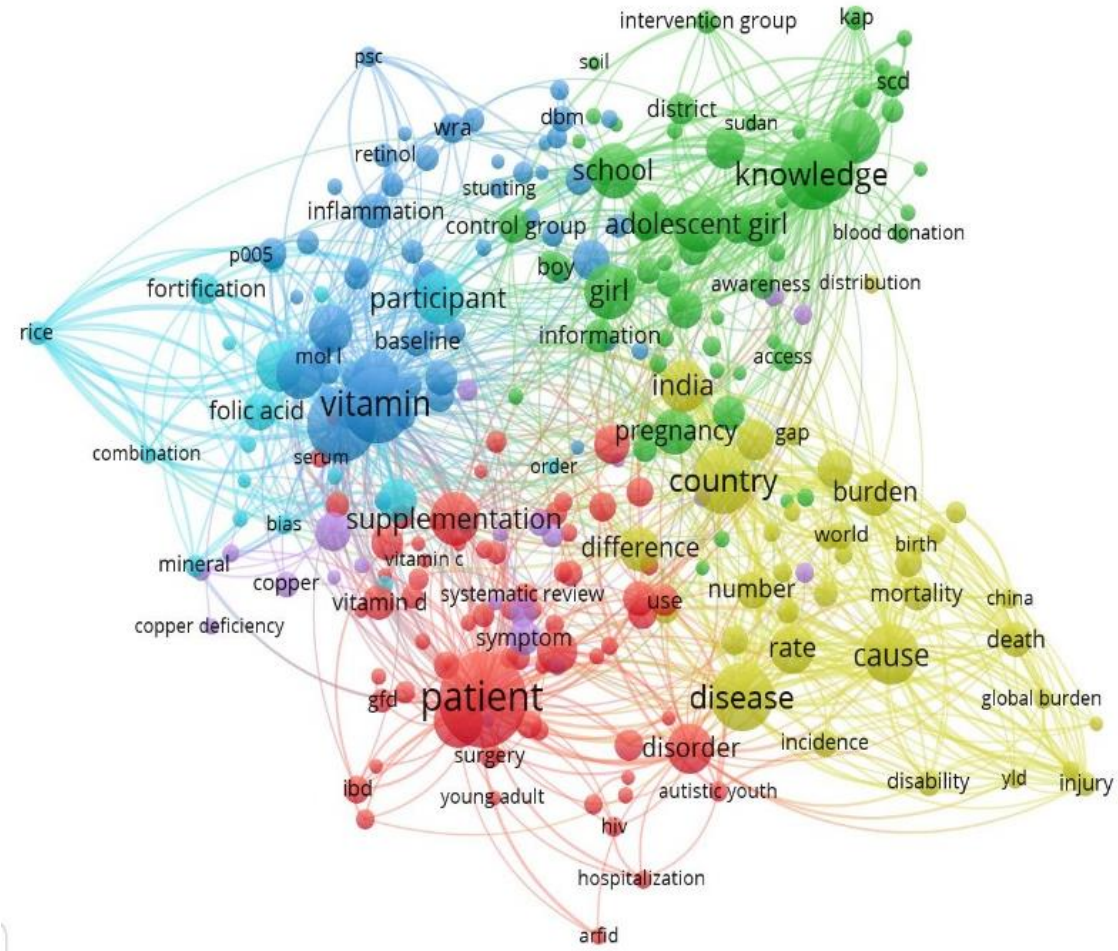

Fig.3. Key terms in Database

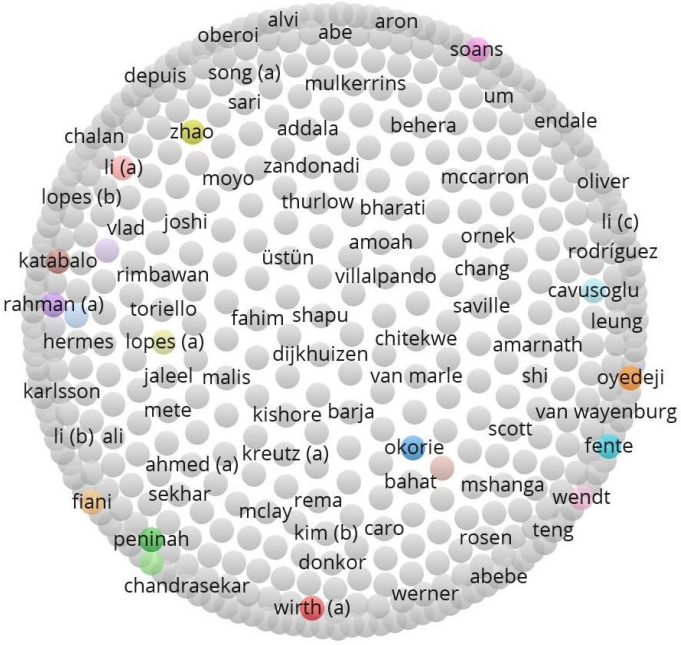

Fig.4. Bibliographic Coupling

The few **highlighted or colored nodes** (for example, authors such as *Peninnah*, *Zhao*, *Oeyedeji*, or *Fente*) represent authors with **relatively stronger coupling strength** or slightly more distinctive reference profiles. These authors likely contribute work that bridges subfields for instance, linking supplementation research with population surveys or connecting clinical studies with public health interventions. However, none of these nodes dominate the network, reinforcing the idea that the field lacks a single unifying theoretical or methodological anchor. The **circular, evenly distributed layout** is also meaningful. In bibliometric coupling maps, such a structure typically indicates that the research area has **expanded organically**, with many parallel contributions rather than a hierarchical development driven by a few seminal research groups. This supports your review's conclusion that iron deficiency anemia research has grown across multiple fronts biomedical, nutritional, behavioral, and policy-oriented without full integration into a consolidated research paradigm.

Systematic Review

The systematic synthesis (Fig.5.) of the included studies revealed several interrelated themes that collectively explain how knowledge, attitudes, and practices influence the prevention and management of iron deficiency anemia across different populations and settings. Although the included studies varied in design, geographic location, and target groups, strong thematic convergence was observed, allowing the development of a coherent explanatory framework. The themes identified include gaps between general awareness and actionable knowledge, the role of attitudes shaped by experience and trust, constraints on preventive practices imposed by socioeconomic and system-level factors, the influence of educational and programmatic interventions, cross-cutting determinants of KAP outcomes, and challenges related to measurement and assessment of KAP constructs (Fig.5.). A dominant theme across nearly all studies was the presence of general awareness of anemia without sufficient operational knowledge required for effective prevention. Many participants were aware that anemia exists and recognized it as a health problem; however, this awareness often lacked specificity. Knowledge of dietary iron sources was frequently incomplete, with participants unable to correctly identify locally available iron-rich foods or distinguish between heme and non-heme iron sources. Understanding of factors influencing iron absorption, such as the inhibitory effects of tea and coffee or the enhancing role of vitamin C, was particularly limited. In studies involving adolescents and pregnant women, participants often reported uncertainty regarding the correct dosage, frequency, and duration of iron supplementation. This lack of practical detail reduced confidence in preventive actions and contributed to inconsistent adherence. The evidence suggests that awareness-focused messaging alone does not equip individuals with the skills necessary to integrate iron-related practices into daily routines.

Attitudes toward iron deficiency anemia and its prevention constituted a second major theme and were shaped strongly by personal experience, perceived risks, and social context. Although many

participants expressed concern about anemia and acknowledged the importance of prevention, attitudes toward iron supplementation were frequently ambivalent. Fear of side effects such as gastrointestinal discomfort, nausea, or constipation was commonly reported and significantly influenced willingness to adhere to supplementation regimens. In several studies, negative past experiences with supplements outweighed perceived long-term benefits, leading to discontinuation even among individuals with adequate knowledge. Attitudinal responses were also influenced by trust in healthcare providers and public health systems. Where counseling was clear, consistent, and delivered by trusted personnel, attitudes toward supplementation tended to be more favorable. Conversely, inconsistent messaging or limited interaction with health professionals fostered skepticism and disengagement. Social norms and stigma further shaped attitudes, particularly among adolescents. In school-based settings, iron supplementation was sometimes perceived as a marker of illness or weakness, leading to embarrassment and reluctance to participate openly. Gender norms and misconceptions about body image also influenced attitudes toward dietary intake and supplement use. Among pregnant women, attitudes were closely linked to perceptions of fetal risk and the credibility of antenatal care services. When anemia was framed as a serious threat to maternal and fetal health, motivation to engage in preventive practices increased; however, when risks were minimized or poorly explained, preventive behaviors declined. These findings illustrate that attitudes toward IDA prevention are not static beliefs but dynamic responses shaped by lived experience and social meaning.

Preventive practices related to iron deficiency anemia formed a third major theme and were consistently constrained by structural and environmental factors. Dietary practices were influenced by food availability, affordability, and household decision-making authority. Even when participants possessed knowledge of iron-rich foods, economic limitations often prevented regular consumption. Adolescents and women frequently lacked control over household food choices, limiting their ability to implement dietary recommendations. Cultural food preferences and seasonal variability further constrained dietary diversification. These findings underscore the importance of considering food systems and household dynamics when designing nutrition education interventions. Iron supplementation practices were similarly shaped by system-level factors. Several studies reported inconsistent supply of iron tablets, limited follow-up, and lack of reminder mechanisms as barriers to sustained adherence. Where supplementation was integrated into routine structures, such as school-based weekly programs or antenatal care visits, adherence tended to improve. However, even in these settings, lack of supervision, inadequate explanation of side effects, and competing daily priorities reduced compliance. Qualitative evidence from caregiver and health worker perspectives highlighted confusion regarding administration schedules and uncertainty about how to manage adverse effects. These practice-level challenges demonstrate that adherence is not solely an individual responsibility but reflects the effectiveness of delivery systems.

Educational and programmatic interventions emerged as a fourth theme, highlighting their role in shaping KAP outcomes. Studies evaluating structured nutrition education interventions reported improvements in knowledge and, to a lesser extent, attitudes and practices. Educational sessions that were interactive, age-appropriate, and culturally tailored were more effective than one-time informational lectures. However, the impact of education alone was often modest and sometimes short-lived. Interventions that combined education with environmental or structural supports, such as provision of iron-rich meals or supervised supplementation, demonstrated more sustained improvements. School-based programs that normalized supplementation and reduced stigma were particularly effective in adolescent populations. These findings suggest that education is a necessary but insufficient condition for lasting behavior change. Cross-cutting determinants of KAP outcomes constituted another important theme. Higher educational attainment, greater socioeconomic resources, and regular contact with health services were consistently associated with better knowledge and more favorable attitudes. However, these advantages did not uniformly translate into optimal practices, indicating that structural barriers can override individual-level facilitators. Gender, age, and cultural context further influenced KAP patterns, with adolescents and women facing distinct challenges related to autonomy and social expectations. Health worker training and workload also affected the quality of counseling delivered, indirectly shaping patient knowledge and attitudes. These determinants highlight the multi-level nature of IDA prevention and the need for interventions that operate across individual, household, and system levels.

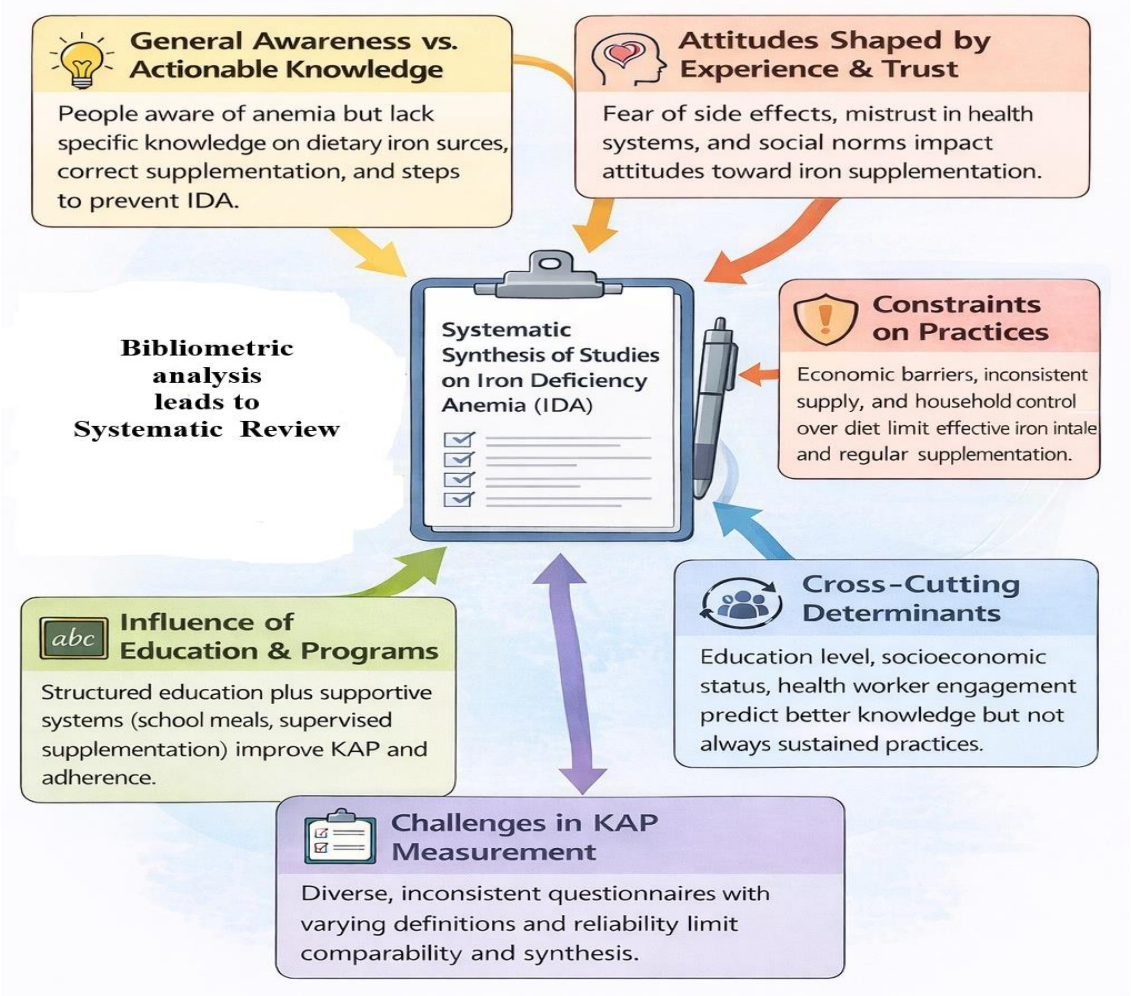

Fig.5. Systematic Review

A final theme concerned challenges related to measurement and assessment of KAP constructs. The included studies employed a wide range of questionnaires and scoring systems, limiting comparability across settings. Some studies used validated instruments with established reliability, while others relied on locally developed tools with limited psychometric testing. Definitions of "adequate knowledge" or "good practice" varied substantially, as did recall periods for dietary and supplementation behaviors. This inconsistency complicates synthesis and reduces the ability to draw quantitative conclusions. The emergence of validated KAP instruments in recent research represents a positive development, but wider adoption and standardization are needed to strengthen the evidence base. Taken together, the thematic synthesis demonstrates that prevention of iron deficiency anemia is influenced by interconnected cognitive, social, and structural factors. Knowledge deficits, attitudinal ambivalence, and practical constraints interact to shape behavior, explaining why high awareness does not consistently lead to improved outcomes. Effective strategies must therefore address multiple themes simultaneously rather than focusing narrowly on information provision.

Discussion

Bibliometric analysis demonstrates strong convergence between the bibliometric structure of the merged dataset and the thematic findings of the systematic review. Fig. 2 captures the breadth and biomedical grounding of iron deficiency anemia research, while the Fig. 3 highlights the behavioral, educational, and programmatic strands that are central to KAP analyses. Both visualizations also reveal fragmentation between knowledge generation, attitude formation, and practice implementation, visually substantiating the review's core conclusion that high awareness and extensive biomedical evidence have not consistently translated into effective, sustained preventive behaviors. In this sense, the bibliometric maps do not merely illustrate the literature; they critically corroborate the systematic review's interpretation of iron deficiency anemia as a condition shaped by intertwined biological, behavioral, and structural factors, as reflected in the merged Scopus–Web of Science corpus. In

relation to merged Scopus–Web of Science dataset, this map confirms that the literature base is **broad, mature, and interconnected at the reference level**, yet still fragmented in terms of conceptual integration. It visually substantiates why KAP studies, clinical trials, and epidemiological analyses often coexist without strong cross-fertilization, a gap your systematic review explicitly highlights. Overall, the bibliometric coupling map reinforces the need for integrative frameworks such as the KAP-based and system-oriented approaches you propose to better connect these parallel strands of research into a more cohesive body of evidence.

The combined bibliometric and thematic findings of this review provide a comprehensive explanation for the continued persistence of iron deficiency anemia despite decades of biomedical advancement. Bibliometric mapping of the merged Scopus–Web of Science dataset demonstrates that iron deficiency anemia research is extensive, mature, and multidisciplinary, with dominant contributions from clinical nutrition, epidemiology, and global health journals. Highly cited authors and journals within the dataset have generated robust evidence on iron metabolism, supplementation efficacy, and disease burden (Rohner et al., 2017). However, bibliographic coupling and keyword co-occurrence analyses reveal limited conceptual integration between biomedical research and studies focused on education, behavior, and implementation. This fragmentation mirrors the thematic findings of the systematic review, which show that strong physiological knowledge has not consistently translated into sustained preventive practices across populations.

Thematic synthesis of the PRISMA-shortlisted studies indicates that general awareness of anemia is widespread, yet actionable knowledge remains limited. Individuals frequently recognize anemia as a health problem but lack practical understanding of locally available iron-rich foods, appropriate supplementation schedules, and absorption-related factors such as the inhibitory role of tea consumption or the enhancing effect of vitamin C (Seminar et al., 2020). Similar patterns have been documented in multiple cross-sectional and intervention studies within the merged dataset, particularly among adolescents and women of reproductive age (Septiana et al., 2025). The bibliometric prominence of terms related to knowledge and awareness, contrasted with the weaker visibility of adherence and long-term practice terms, supports the conclusion that educational exposure alone does not ensure effective behavioral translation.

Attitudinal factors emerge as a critical mediator between knowledge and practice. Across the included studies, fear of side effects, mistrust in health systems, and social stigma surrounding iron supplementation consistently undermined adherence. These findings align with prior work demonstrating that gastrointestinal discomfort and negative perceptions of supplements remain key deterrents when counseling is inadequate or inconsistent (Waggiallah & Alzohairy, 2013). Bibliometric coupling further reinforces this interpretation by showing that behavioral and psychosocial studies often draw on reference bases distinct from clinical trials, indicating parallel rather than integrated knowledge development. This separation helps explain why program designs frequently underestimate the influence of trust, communication quality, and social norms on preventive behavior.

Structural and system-level constraints further limit the effectiveness of anemia prevention strategies. Dietary recommendations are often incompatible with economic realities, food availability, and household decision-making hierarchies, particularly in low-resource settings (Wieringa et al., 2018). Similarly, supplementation programs are constrained by inconsistent supply chains, limited follow-up mechanisms, and weak integration into routine health and school systems. These barriers are repeatedly highlighted in the PRISMA-shortlisted studies and are consistent with broader evidence showing that program coverage does not equate to consumption or adherence (Wieringa et al., 2019). Bibliometric clusters linking iron deficiency anemia with poverty, nutritional status, and global disease burden further emphasize that anemia prevention is embedded within wider social and health system contexts rather than being a purely nutritional issue.

Educational interventions were shown to improve knowledge and, in some cases, attitudes, particularly in school-based and adolescent-focused programs (WHO, 2016). However, their effects on sustained preventive practices were inconsistent. Studies within the merged dataset indicate that education produces more durable outcomes when combined with supportive delivery systems that normalize supplementation, reduce stigma, and minimize reliance on individual motivation (WHO, 2020). Bibliometric visualizations support this conclusion by showing education-related terms clustered closely with awareness constructs but weakly connected to adherence and long-term

outcomes. This pattern underscores the need for integrated approaches that align educational content with system-level support. The review also highlights methodological limitations within the KAP literature itself. Variability in measurement tools, inconsistent definitions of adequate knowledge or practice, and limited use of validated instruments restrict comparability across studies. The dispersion of KAP-related research across journals and disciplines observed in the bibliometric analysis reflects the absence of standardized conceptual and methodological frameworks. Addressing these limitations is essential for strengthening the evidence base and improving translation into policy and practice (Zimmermann & Hurrell, 2007).

Conclusion

The combined bibliometric and thematic evidence positions iron deficiency anemia as a complex behavioral and implementation challenge shaped by educational exposure, social norms, and system capacity rather than by biological factors alone. Effective prevention requires strategies that integrate biomedical interventions with behaviorally informed education and structurally supportive delivery mechanisms. This synthesis, grounded in PRISMA-selected evidence from the merged Scopus–Web of Science dataset, provides a stronger empirical foundation for designing context-sensitive and education-focused anemia control strategies. This systematic review demonstrates that knowledge, attitudes, and practices related to iron deficiency anemia are influenced by interrelated behavioral, social, and system-level factors. While awareness of anemia is widespread, actionable knowledge and sustained preventive practices remain inconsistent. Educational interventions are effective but insufficient when implemented in isolation. Integrating education with supportive delivery systems, reliable access to supplements, and culturally appropriate counseling is essential for improving anemia prevention outcomes. Strengthening KAP research through standardized measurement and improved reporting will further enhance evidence-based policy and practice.

Recommendations

1. Anemia prevention programs should move beyond standalone awareness campaigns and embed structured, behaviorally informed education within existing health and school systems. Educational content should emphasize actionable knowledge, including locally available iron-rich foods, appropriate supplementation schedules, and management of side effects, and should be delivered alongside routine supplementation and screening services. Integrating education with service delivery will reduce the gap between knowledge acquisition and sustained preventive practice by aligning information with real-world access and follow-up.
2. Health and nutrition programs should prioritize system-level supports that enable consistent practice, including reliable supply chains for iron supplements, routine monitoring and follow-up, and clear counseling protocols for managing side effects. Embedding supplementation into normalized settings such as schools, antenatal care services, and community health platforms can reduce stigma, improve adherence, and minimize reliance on individual motivation. Strengthened delivery systems are essential to ensure that biomedical interventions translate into long-term behavioral outcomes.

Declarations

Ethics approval and consent to participate: As this study was based exclusively on secondary analysis of published literature, it did not involve direct contact with human participants and therefore did not require ethical approval. Nevertheless, ethical principles of transparency, accurate representation, and appropriate citation were strictly adhered to throughout the research process. Artificial intelligence tools were used solely for language editing and formatting assistance; all intellectual content, analysis, and conclusions are the sole responsibility of the authors.

Consent for the Publications: Both authors (FF & AM) have read and approved the final manuscript and give their consent for its publication.

Availability of data and Materials: The data supporting the findings of this study are available from the corresponding author (FF) upon reasonable request.

Competing Interests: Not Applicable

Funding: Not Applicable

Authors' Contribution: Both authors (FF & AM) contributed equally to the study conception and design, data collection, analysis and interpretation, manuscript drafting, and final approval of the version to be published.

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