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EFFECT OF A STRUCTURED NUTRITION EDUCATION INTERVENTION ON NUTRITIONAL KNOWLEDGE AND IRON BIOAVAILABILITY AWARENESS AMONG ANAEMIC ADOLESCENT GIRLS

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Abstract

Background: Iron-deficiency anaemia remains a major public health concern among adolescent girls, with inadequate dietary practices and limited knowledge regarding iron-rich foods and factors influencing iron bioavailability contributing to the problem. This study evaluated the effectiveness of a nutrition education intervention in improving nutritional knowledge and awareness of iron bioavailability among anaemic adolescent girls.

Methods: A three-month multimodal nutrition education intervention was conducted among 243 anaemic adolescent girls aged 16–18 years from rural and urban colleges of Panchkula district, Haryana, India. The intervention comprised lectures, interactive discussions, booklets, posters, pamphlets, practical demonstrations and question–answer sessions. Nutritional knowledge was assessed before and after the intervention using an expert-reviewed and pre-tested structured questionnaire covering three domains: balanced diet; sources and conservation of nutrients; and therapeutic nutrition.

Results: The mean overall nutritional knowledge score increased significantly from 8.75 ± 2.42 at baseline to 21.52 ± 2.84 following the intervention, with a mean gain of 12.77 points (95% CI: 12.31–13.23; $p < 0.001$). Significant improvements were observed in balanced diet (3.68 ± 1.48 to 7.26 ± 1.22; gain 3.58), sources and conservation of nutrients (2.92 ± 1.34 to 7.49 ± 1.32; gain 4.57), and therapeutic nutrition (2.15 ± 1.15 to 6.77 ± 1.28; gain 4.62) (all $p < 0.001$). The normalized knowledge gain was 0.60. No significant differences in knowledge gain were observed according to socio-demographic characteristics. Greater absolute knowledge gain was observed among participants with lower baseline knowledge ($r = -0.637$, $p < 0.001$).

Conclusion: Structured multimodal nutrition education substantially improved nutritional knowledge among anaemic adolescent girls, particularly regarding therapeutic nutrition, nutrient sources and conservation, and dietary factors influencing iron bioavailability. Incorporating targeted nutrition education into adolescent health and anaemia-control programmes may strengthen dietary awareness and support appropriate food practices for improving iron nutrition.

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Introduction

Anaemia remains a major public health concern worldwide and disproportionately affects menstruating adolescent girls. Anaemia can result from multiple nutritional and non-nutritional causes, although iron deficiency is the most common nutritional cause (World Health Organization, 2021). Adolescence is a critical period of growth and development, accounting for nearly 15–20% of adult height and approximately 50% of adult body weight. The increased physiological demands during this stage, particularly for iron, folate, vitamin B12, protein, and vitamin C, necessitate the consumption of a balanced and nutrient-dense diet (Patton et al., 2022; UNICEF, 2023). Menstrual blood loss further increases iron requirements among adolescent girls, making them more vulnerable to iron deficiency and its associated health consequences, including impaired cognitive function, reduced immunity, and poor academic performance (World Health Organization, 2024). Despite these increased nutritional requirements, dietary inadequacies and unhealthy eating habits remain common among adolescents worldwide.

India bears a substantial burden of anaemia among adolescent girls. According to the National Family Health Survey-5 (NFHS-5; 2019–2021), 59.1% of girls aged 15–19 years were anaemic in India (International Institute for Population Sciences and ICF, 2021). A systematic review and meta-analysis of 35 studies involving 152,640 Indian adolescent girls reported a pooled anaemia prevalence of 65.7% (95% CI: 59.3–71.9%), highlighting the continuing magnitude of the problem (Daniel et al., 2023). More specifically, a recent systematic review of Indian adolescent girls reported a pooled anaemia prevalence of 65% in North India, with moderate anaemia accounting for 38% of cases, further emphasizing the need for regionally relevant preventive strategies (Kumari et al., 2025).

Although iron and folic acid supplementation is an important component of anaemia prevention and control, a comprehensive approach also requires attention to dietary practices and other determinants of anaemia. WHO recognizes adolescent girls and menstruating women as important target groups for iron interventions and emphasizes the need for integrated approaches to anaemia prevention and control (World Health Organization, 2023). In India, adolescent anaemia-control programmes also incorporate nutrition and health education alongside supplementation and other interventions (UNICEF, 2020).

The nutritional quality of a diet depends not only on the amount of iron consumed but also on its bioavailability. Haem and non-haem iron differ in their absorption, while dietary components such as ascorbic acid, phytate and polyphenols can enhance or inhibit non-haem iron absorption, respectively (Hurrell & Egli, 2010; Piskin et al., 2022). The composition of the overall meal therefore influences the amount of dietary iron available for absorption. Polyphenol-containing beverages, including tea and coffee, have also been shown to inhibit non-haem iron absorption, supporting the importance of appropriate dietary combinations and meal practices in nutrition education (Hurrell et al., 1999).

In addition to knowledge of iron sources and bioavailability, broader nutritional knowledge is important for promoting appropriate dietary practices during adolescence. Knowledge regarding balanced meals, food groups,

meal frequency, nutrient conservation and therapeutic dietary practices can help adolescents make informed food choices. Nutrition education provides an opportunity to address these aspects through structured and contextually appropriate educational approaches.

Previous intervention studies among adolescents have reported improvements in nutrition- and anaemia-related knowledge following nutrition education. For example, an intervention among adolescent girls in Assam evaluated nutrition education focused on iron-rich diets and reported changes in dietary behaviour following the intervention (Das and Goswami, 2023). However, evidence specifically evaluating knowledge gain among already anaemic adolescent girls across multiple nutrition domains, including balanced diet, sources and conservation of nutrients, iron bioavailability, and therapeutic nutrition, remains limited. Recent studies have reported a growing prevalence of meal skipping, frequent consumption of ultra-processed and fast foods, and excessive intake of sugar-sweetened beverages among adolescents (NCD Risk Factor Collaboration, 2022; Das et al., 2023). Inadequate consumption of fruits and vegetables, particularly vitamin C-rich foods, may compromise dietary iron absorption and is relevant to iron status among adolescent girls (Ghatpande et al., 2019; WHO, 2018).

Nutrition education has been recognized as an effective strategy for improving dietary knowledge, promoting healthy eating behaviours, and encouraging the adoption of appropriate food choices among adolescents (Contento, 2016). In the present study, nutritional knowledge was assessed using a structured questionnaire comprising three domains: balanced diet; sources and conservation of nutrients; and therapeutic nutrition. The intervention was designed as a structured, multimodal, three-month nutrition education programme incorporating lectures, interactive discussions, booklets, posters, pamphlets, practical demonstrations and question–answer sessions. The educational content specifically addressed balanced dietary practices, dietary sources of nutrients, factors influencing iron bioavailability, nutrient conservation, therapeutic nutrition and related lifestyle practices.

Therefore, the present study was undertaken to evaluate the effectiveness of a structured nutrition education intervention in improving nutritional knowledge among anaemic adolescent girls. Specifically, the study assessed changes in knowledge related to balanced diet, nutrient sources and conservation, and therapeutic nutrition following the intervention.

Materials and Methods

Study design

The present study employed a quantitative one-group pre-test–post-test quasi-experimental intervention design to assess the effectiveness of nutrition education in improving nutritional knowledge among anaemic adolescent girls. The questionnaire was developed based on previously published dietary assessment tools and modified according to the objectives of the study. The draft questionnaire was reviewed by a panel of experts for content relevance, clarity, and appropriateness. The questionnaire was subsequently pre-tested among 10 adolescent girls from the target population to assess the comprehensibility of the questions, appropriateness of language, sequence and flow, and ease of understanding. Based on their feedback, necessary modifications were

made before final administration. Baseline knowledge was assessed before the intervention, and post-intervention knowledge was evaluated after completion of the educational programme.

Study population and sample selection

The pre–post intervention study was conducted among 243 adolescent girls aged 16–18 years enrolled in educational institutions from rural and urban areas of Panchkula district, Haryana, India. Participants were selected using a purposive sampling technique following a health screening camp. Haemoglobin concentration was assessed as part of the screening process, and girls with haemoglobin levels <12.0 g/dL (classified as anaemic) and willing to participate in the study were included. Data were collected after obtaining informed consent from the participants.

The nutrition education programme was designed and implemented over a period of 03 months and comprised 06 structured educational sessions delivered through a combination of offline and online modes to facilitate participation and continuity of the intervention.

Sessions were conducted at approximately 15-day intervals, with each session lasting 60-90 minutes, depending on the educational activity and mode of delivery. The intervention provided repeated exposure to and reinforcement of key messages related to anaemia, iron-rich foods, iron bioavailability, balanced diet, nutrient conservation, and healthy dietary practices. To facilitate participation and continuity of learning, provision was made for respondents unable to attend a scheduled session to receive the educational content subsequently through an alternative interaction within the following few days.

Development of educational material

Educational material was developed after an extensive review of scientific literature, recommendations of the Indian Council of Medical Research–National Institute of Nutrition (ICMR–NIN, 2020), and nutrition and health guidelines related to anaemia, balanced diet, nutrient conservation, iron bioavailability, and therapeutic nutrition. The educational content was specifically designed according to the age, educational background, nutritional requirements, and learning abilities of adolescent girls.

Various teaching aids, including booklet, posters, pamphlets, PowerPoint presentations for lectures and recipe demonstration materials, were prepared to facilitate effective dissemination of nutritional information. The educational content covered the causes, symptoms, prevention, and management of anaemia; dietary sources of iron; enhancers and inhibitors of iron absorption; balanced diets; nutrient conservation during food preparation; therapeutic nutrition and lifestyle modifications for improving nutritional status. Particular emphasis was given to improving awareness regarding iron bioavailability by encouraging the consumption of vitamin C-rich foods along with iron-rich foods and discouraging the intake of tea and coffee with meals (Narwal et al., 2026).

Nutrition education intervention

Nutrition education was imparted to the participants over a period of three months with the objective of improving knowledge regarding anaemia, balanced diets, nutrient sources, nutrient enhancement and conservation, therapeutic nutrition, and healthy lifestyle practices. The intervention was implemented through lectures, interactive discussions, booklet, posters, pamphlets, demonstrations, and question–answer sessions.

Active participation of the participants was encouraged throughout the educational programme. Demonstrations of nutrient-rich recipes and discussions on healthy lifestyle practices were conducted to strengthen the practical understanding of nutrition concepts. The intervention was designed to enhance awareness regarding the importance of adequate nutrient intake during adolescence and to encourage the adoption of healthy dietary behaviours for the prevention and management of iron deficiency.

Assessment of nutritional knowledge

The effectiveness of the nutrition education programme was evaluated by assessing the nutritional knowledge of the participants before and after the intervention using a structured questionnaire developed by the investigator. The questionnaire consisted of statements related to balanced diet, nutrient sources and conservation, and therapeutic nutrition. The responses were recorded under two categories, namely "True" and "False".

For quantitative analysis, each correct response was assigned a score of one, whereas each incorrect response was assigned a score of zero. The responses were subsequently converted into numerical values, and the total knowledge score of each respondent was calculated by summing the scores obtained for all statements. The same questionnaire was administered before the commencement of the nutrition education programme and after the completion of the intervention. The difference between the pre-test and post-test scores was used to determine the gain in nutritional knowledge and to assess the effectiveness of the educational programme. or descriptive interpretation of individual knowledge gain, participants were categorized into low (<8), moderate (8–16), and high (>16) gain groups based on the predefined score intervals used in the present study.

Knowledge domains assessed

The questionnaire assessed nutritional knowledge under three domains, namely balanced diet, sources and conservation of nutrients, and therapeutic nutrition. The first domain, balanced diet, included questions related to meal patterns, food groups, factors affecting iron absorption, the role of vitamin C in enhancing iron absorption, ferritin storage, and the inhibitory effects of tea and coffee on iron bioavailability. The second domain, sources and conservation of nutrients, assessed participants' knowledge regarding major dietary sources of nutrients, including cereals and pulses; the nutritional significance of jaggery; vitamin C-rich foods such as amla and guava; nutrient losses during food preparation; and the role of fermentation and sprouting in improving nutrient availability and bioavailability. The domain also included knowledge relevant to dietary factors influencing iron nutrition. The third domain, therapeutic nutrition, included questions related to anaemia, heme and non-heme iron, folic acid deficiency, obesity indicators, lifestyle disorders, and pica. This domain also evaluated the participants' awareness regarding dietary practices associated with the prevention and management of nutritional disorders.

Data Management and Statistical Analysis

Data collected from the participants were coded, checked for completeness, cleaned, and entered into Microsoft Excel® 2019 and subsequently imported into IBM SPSS 23 for statistical analysis. Descriptive statistics, including frequencies, percentages, means, and standard deviations, were used to summarize the participants’ socio-demographic characteristics and knowledge scores. Pre-intervention and post-intervention

knowledge scores were compared to assess the effectiveness of the nutrition education intervention. The mean differences between pre- and post-intervention scores were assessed using a paired-samples t-test. The results were considered statistically significant at $p < 0.05$, with 95% confidence intervals reported for the estimated mean differences.

Normalized knowledge gain was calculated to quantify the proportion of the possible knowledge improvement achieved following the intervention using the formula:

Normalized gain (g) = (post-intervention score − pre-intervention score) / (maximum possible score − pre-intervention score).

Results

A marked improvement in knowledge scores after the educational intervention among the 243 participants was observed (Table 1). The overall mean knowledge score increased from 8.75 ± 2.42 before the intervention to 21.52 ± 2.84 after the intervention, indicating a substantial improvement in nutrition-related knowledge following the intervention.

Table 1: Comparison of Pre- and Post-Intervention Knowledge Scores and Normalized Knowledge Gain (n = 243)

Knowledge Component	Possible Score Range	Pre-intervention Mean ± SD	Pre Range	Post-intervention Mean ± SD	Post Range	Mean Improvement	Normalized gain
Balanced Diet Knowledge	0–10	3.68 ± 1.48	1–10	7.26 ± 1.22	4–10	+3.58	0.57
Sources and Conservation of Nutrients	0–10	2.92 ± 1.34	0–7	7.49 ± 1.32	4–10	+4.57	0.65
Therapeutic Nutrition Knowledge	0–10	2.15 ± 1.15	0–5	6.77 ± 1.28	4–10	+4.62	0.67
Total Knowledge Score	**0–30**	**8.75 ± 2.42**	**2–16**	**21.52 ± 2.84**	**15–30**	**+12.77**	**0.60**

SD: Standard Deviation

Among the three domains, the highest improvement was observed in therapeutic nutrition knowledge (+4.62 points) followed by sources and conservation knowledge (+4.57 points) and balanced diet knowledge (+3.58 points). The post-intervention scores showed a higher mean and reduced variation in the balanced diet domain (SD reduced from 1.48 to 1.22), suggesting that participants developed more consistent understanding after

education. Overall, the intervention was effective in enhancing knowledge across all nutrition domains. The normalized knowledge gain was 0.60, indicating that approximately 60% of the possible improvement beyond the baseline score was achieved

A paired sample t-test was performed to evaluate the effectiveness of the educational intervention on participants' total knowledge scores (Table 2). The mean knowledge score increased significantly from 8.75 ± 2.42 before intervention to 21.52 ± 2.84 after intervention. The mean improvement in knowledge score was 12.77 points (95% CI: 12.31–13.23). The obtained t-value ($t = 54.18$, $df = 242$) was highly significant ($p < 0.001$), indicating that the educational intervention produced a statistically significant improvement in overall knowledge among participants. This indicated that the nutrition education intervention was highly effective in improving the knowledge level of the participants.

Table 2: Effect of Educational Intervention on Total Knowledge Score (Paired t-test) (n = 243)

Pre-intervention Knowledge Score Mean ± SD	Post-intervention Knowledge Score Mean ± SD	Mean Improvement	95% CI of Difference	t-value	df	p-value
8.75 ± 2.42	21.52 ± 2.84	12.77	12.31 – 13.23	54.18	242	<0.001

Note: Values are presented as mean ± SD. CI, confidence interval; SD, standard deviation. Paired-samples t-test was used. $p < 0.05$ was considered statistically significant.

The domain-wise paired t-test revealed a highly significant improvement in all three knowledge domains following the educational intervention (Table 3). Balanced diet knowledge improved significantly from 3.68 ± 1.48 at pre-intervention to 7.26 ± 1.22 post-intervention, with a mean gain of 3.58 points ($t = 32.11$, $p < 0.001$). Knowledge regarding sources and conservation of nutrients increased from 2.92 ± 1.34 at pre-intervention to 7.49 ± 1.32 at post-intervention, showing a mean improvement of 4.57 points ($t = 39.36$, $p < 0.001$). Therapeutic nutrition knowledge showed the highest improvement, increasing from 2.15 ± 1.15 to 6.77 ± 1.28, with a mean gain of 4.62 points ($t = 44.49$, $p < 0.001$).

Table 3: Domain-wise Comparison of Knowledge Scores Before and After Educational Intervention (Paired t-test) (n = 243)

Knowledge Domain	Pre-intervention Mean ± SD	Post-intervention Mean ± SD	Mean Improvement	95% CI of Difference	t-value	df	p-value
Balanced diet knowledge	3.68 ± 1.48	7.26 ± 1.22	3.58	3.36 – 3.80	32.11	242	<0.001
Sources and	2.92 ± 1.34	7.49 ± 1.32	4.57	4.34 – 4.80	39.36	242	<0.001

Conservation of Nutrients							
Therapeutic nutrition knowledge	2.15 ± 1.15	6.77 ± 1.28	4.62	4.41 – 4.82	44.49	242	<0.001

Note: Values are presented as mean ± SD. CI, confidence interval; SD, standard deviation. Paired-samples t-test was used to compare pre- and post-intervention scores. $p < 0.05$ was considered statistically significant.

Thus, it can be concluded that the educational intervention was effective in significantly enhancing knowledge related to balanced diet, iron sources/conservation, and therapeutic nutrition among participants. The greatest improvement was observed in the therapeutic nutrition domain.

The distribution of knowledge gain scores revealed that the majority of participants (66.3%) achieved a moderate level of knowledge gain following the educational intervention (Table 4). About 27.2% participants showed a high level of knowledge gain, whereas only 6.6% had a low level of improvement. Overall, the findings indicated that the educational intervention resulted in a meaningful improvement in knowledge among participants, with 93.5% (227/243) participants demonstrating moderate to high knowledge gain after the intervention.

Table 4: Distribution of Participants According to Level of Knowledge Gain After Educational Intervention

Level of Knowledge Gain	Score Range	Frequency (n)	Percentage (%)
Low Knowledge Gain	<8	16	6.6
Moderate Knowledge Gain	8–16	161	66.3
High Knowledge Gain	>16	66	27.2
Total		**243**	**100.0**

A significant negative correlation was observed between pre-intervention knowledge score and knowledge gain score ($r = -0.637$, $p < 0.001$), indicating that participants with lower baseline knowledge showed greater improvement after the educational intervention (Table 5). A moderate-to-strong inverse association was observed between baseline knowledge and knowledge gain ($r = -0.637$, $p<0.001$), suggesting greater absolute improvement among participants with lower baseline scores. This finding should, however, be interpreted cautiously because gain scores are mathematically related to baseline scores.

Table 5: Correlation Between Pre-intervention Knowledge Score and Knowledge Gain Score (n = 243)

Variables	Pearson's r	p-value
Pre-intervention Knowledge Score vs Knowledge Gain Score	-0.637	<0.001

Note: Pearson's correlation coefficient (r) was used. $p < 0.05$ was considered statistically significant.

Discussion

The present study demonstrated a substantial improvement in nutritional knowledge following a three-month structured nutrition education intervention among anaemic adolescent girls. The findings of the present study

are relevant to the broader national efforts for prevention and control of anaemia among adolescents. The Government of India has implemented a life-cycle approach to anaemia control through programmes such as Weekly Iron and Folic Acid Supplementation (WIFS) incorporating iron and folic acid supplementation, deworming, screening and treatment, behaviour change communication, and promotion of appropriate dietary practices. The Anaemia Mukt Bharat (AMB) strategy further strengthened this integrated approach which was designed to operate through existing platforms including the National Iron Plus Initiative (NIPI) and WIFS. More recently, the Government of India has introduced the Anaemia Mukt Bharat Abhiyaan operational framework, which expands the earlier approach through a 7×7×7 framework with greater emphasis on testing, therapeutic management, dietary diversification, tracking, and community participation. Thus, the present study's focus on improving knowledge regarding balanced diets, iron-rich food sources, iron bioavailability, nutrient conservation, and therapeutic nutrition complements the educational and behaviour-change components of national anaemia-control strategies.

Nutrition education is also consistent with the objectives of POSHAN Abhiyaan and the subsequent Mission Saksham Anganwadi and POSHAN 2.0, which emphasize nutrition awareness, community engagement, behaviour change, dietary diversity, and promotion of locally available nutritious foods. Government initiatives under the POSHAN framework use Jan Andolan approaches, including awareness activities, community-based events, Poshan Maah and Poshan Pakhwada, to promote sustained improvements in nutrition-related practices. Such approaches reinforce the importance of moving beyond the provision of supplements towards improving individuals' understanding of appropriate food choices and dietary practices.

The substantial improvement in knowledge observed in the present study, with 93.5% (227/243) of participants demonstrating moderate to high knowledge gain, supports the potential role of structured nutrition education as a complementary component of these broader national initiatives. Despite the availability of supplementation and anaemia-control programmes, persistent anaemia among adolescent girls indicates that programme delivery needs to be accompanied by effective communication, counselling, dietary awareness, and reinforcement of appropriate food practices. The present intervention used lectures, interactive discussions, booklets, posters, pamphlets, practical demonstrations, and question-and-answer sessions, thereby providing repeated and multimodal exposure to nutrition messages. The present study identified significant improvement across the three knowledge domains, namely balanced diet, sources and conservation of nutrients, and therapeutic nutrition. The findings therefore, suggest that structured nutrition education delivered through educational institutions may complement existing adolescent health, anaemia-control, and IFA supplementation initiatives by strengthening the knowledge required for informed dietary choices.

The present findings also have implications for food-based approaches within anaemia-control programmes. Government guidance emphasizes dietary diversification and increased consumption of iron-rich foods, including the use of locally available resources. In the present study, education included practical information on iron-rich foods, factors enhancing and inhibiting iron absorption, nutrient conservation, and appropriate dietary combinations. Such context-specific education may help translate general programme messages into practical food choices that are feasible within local dietary patterns. Therefore, integrating structured nutrition

education with school- and college-based health activities, counselling, supplementation programmes, and locally acceptable food-based strategies may provide a more comprehensive approach to improving anaemia-related nutritional knowledge among adolescent girls.

The greater gain in therapeutic nutrition may reflect the relatively low baseline knowledge in this domain, leaving greater scope for improvement following structured education. The significant improvement in nutritional knowledge observed in the present study is consistent with findings from a school-based nutrition education intervention in rural Karnataka, where structured nutrition messages delivered through lectures, role play and practical demonstrations improved adolescents' awareness regarding anaemia and its prevention. The present study extends this evidence by focusing specifically on anaemic adolescent girls and by assessing multiple domains encompassing balanced diet, iron sources and bioavailability, nutrient conservation and therapeutic nutrition (Salam et al., 2023).

A randomized clinical trial among 176 adolescent girls evaluated a 14-week digital game-based nutrition education intervention. It assessed knowledge, attitudes, practices and biochemical markers, and reported significant improvements in knowledge and Hb (Ghadam et al., 2022). Evidence from controlled interventions also suggests that nutrition education can influence not only knowledge but potentially downstream nutritional outcomes. However, unlike studies incorporating biochemical endpoints, the present investigation was designed primarily to evaluate educational gain and therefore did not assess post-intervention haemoglobin or iron-status biomarkers.

Lutfiasari et al. (2024) reviewed communication methods for anaemia prevention in adolescents and concluded that well-planned communication strategies can support dietary modification and iron-folic acid use. Similarly in the present study, the interventions used were posters, pamphlets, lectures, interactive discussion, demonstrations and Q&A sessions, indicating the importance of multimodal education rather than information delivery alone.

Septiana et al. (2025) reviewed a study of 14 articles and revealed that most studies employed quasi-experimental designs, demonstrating that educational media interventions possess significant potential as preventative and promotional techniques to address anaemia in adolescent females. They reported that the health education media using Print Media (brochures, flip charts), Media Technology (audiovisual, animated videos), Telephone calls and text messages, Social Media (WhatsApp, TikTok), Game Media (Monopoly), and peer groups substantially increase self-awareness and adherence to iron supplement consumption in preventing anaemia among adolescent girls.

A recent systematic review/meta-analysis covering 32 studies and 14,053 Indian adolescent girls estimated pooled anaemia prevalence at approximately 65%, with substantial regional variation. Nutrition education may be particularly valuable when it translates knowledge of iron-rich and culturally acceptable foods into practical dietary choices (Narwal et al., 2026). In this context, locally available food-based strategies, including nutrient-dense traditional formulations, may complement educational approaches by providing feasible options for improving dietary iron intake.

The high burden of anaemia among adolescent girls in North India highlights the continued need for effective, context-specific nutritional interventions (Kumari et al., 2025). A recent systematic review and meta-analysis reported a pooled anaemia prevalence of 65% among adolescent girls in North India, with moderate anaemia accounting for 38% (95% CI: 23–57%) of cases. Against this background, strengthening nutrition education focused on iron-rich foods, iron bioavailability, nutrient conservation and therapeutic dietary practices may provide an important complementary approach to existing anaemia-control measures.

Interestingly, knowledge gain did not differ significantly according to the assessed socio-demographic characteristics, suggesting that the educational intervention was potentially applicable across diverse participant backgrounds. This may partly reflect the use of standardized, multimodal educational materials and interactive teaching approaches designed for the common educational and age-related characteristics of the participants.

Future studies should employ controlled designs with longer follow-up periods to determine whether nutrition education translates into sustained dietary behaviour change and improved haematological outcomes (Hb and serum ferritin), while also assessing intervention adherence and long-term retention of nutritional knowledge.

Conclusion

A structured three-month nutrition education intervention was associated with a substantial improvement in nutritional knowledge among anaemic adolescent girls across all three domains, with the greatest gains observed in therapeutic nutrition and sources and conservation of nutrients. The findings support the incorporation of structured, multimodal nutrition education into adolescent health and anaemia-control programmes. Future controlled studies incorporating dietary behaviour and biochemical indicators of iron status are necessary to determine whether improvements in knowledge translate into sustained dietary changes and improved iron status.

References

Contento, I. R. (2016). Nutrition Education: Linking Research, Theory, and Practice. Jones & Bartlett Learning.

Daniel, R. A., Kalaivani, M., Kant, S., & Gupta, S. (2023). Prevalence of anaemia among adolescent girls (10-19 years) in India: A systematic review and meta-analysis. The National Medical Journal of India, 36(4), 233–240. https://doi.org/10.25259/NMJI_637_21

Das, D. B. and Goswami, K. D. (2023). Iron deficiency anaemia and effect of nutrition education on change in dietary behavior among the adolescent girls of tea garden area in Nagaon district, Assam. International Journal of Advance Research in Nursing, 6(2):162-173. DOI: 10.33545/nursing.2023.v6.i2.C.355

Das, J. K., Salam, R. A., Mahmood, S. B., et al. (2023). Nutrition and dietary practices among adolescents in low- and middle-income countries: A systematic review. Nutrients, 15(8), 1894.

Ghadam, O. S., Sohrabi, Z., Mehrabi, M., Fararouei, M., Shahraki, M., Hejazi, N., Clark, C. C. T., Mehrabani, S., Gerami, S., & Nouri, M. (2022). Evaluating the effect of digital game-based nutrition education on anemia indicators in adolescent girls: A randomized clinical trial. Food science & nutrition, 11(2), 863–871. https://doi.org/10.1002/fsn3.3120

Ghatpande, N. S., Apte, P. P., Naik, S. S., & Kulkarni, P. P. (2019). Fruit and Vegetable Consumption and Their Association with the Indicators of Iron and Inflammation Status Among Adolescent Girls. Journal of the American College of Nutrition, 38(3), 218–226. https://doi.org/10.1080/07315724.2018.1492470

Hurrell, R. F., Reddy, M., & Cook, J. D. (1999). Inhibition of non-haem iron absorption in man by polyphenolic-containing beverages. The British journal of nutrition, 81(4), 289–295.

Hurrell, R., & Egli, I. (2010). Iron bioavailability and dietary reference values. The American journal of clinical nutrition, 91(5), 1461S–1467S. https://doi.org/10.3945/ajcn.2010.28674F

Indian Council of Medical Research–National Institute of Nutrition (ICMR–NIN). (2020). Dietary Guidelines for Indians. Hyderabad: ICMR–NIN.

International Institute for Population Sciences (IIPS) and ICF. (2021). National Family Health Survey (NFHS-5), 2019–21: India Report. Mumbai: IIPS.

International Institute for Population Sciences (IIPS), & ICF. (2021). National Family Health Survey (NFHS-5), 2019–21: India report. Ministry of Health and Family Welfare, Government of India.

Kumari, A., Kumari, A., Mudgal, S. K., Patidar, V., Singh, A. K., Ganguly, A., & Singh, S. K. (2025). Regional Burden of Anemia among Adolescent girls in India: A systematic review and meta-analysis. Nepal journal of epidemiology, 15(3), 1386–1396. https://doi.org/10.3126/nje.v15i3.77656

Lutfiasari, D., Martini, S., Widati, S., & Fatmaningrum, W. (2024). Effective communication methods in preventing anaemia in adolescents: A systematic review. African journal of reproductive health, 28(10s), 318–331. https://doi.org/10.29063/ajrh2024/v28i10s.35

Narwal, M., Soni, D., & Kaur, P. (2026). Development, standardization and nutritional evaluation of traditional iron supportive foods based on dietary habits of anaemic adolescent girls. Adolescencia e Saude, 21(4s), 749–761

NCD Risk Factor Collaboration (NCD-RisC). (2022). Worldwide trends in body mass index and dietary risk factors among children and adolescents. The Lancet, 400(10352), 785–794.

Patton, G. C., Sawyer, S. M., Santelli, J. S., et al. (2022). Our future: A Lancet commission on adolescent health and well-being. The Lancet, 399(10336), 1865–1934.

Piskin, E., Cianciosi, D., Gulec, S., Tomas, M., & Capanoglu, E. (2022). Iron absorption: Factors, limitations, and improvement methods. ACS Omega, 7(24), 20441–20456. https://doi.org/10.1021/acsomega.2c01833.

Salam, S. S., Ramadurg, U., Charantimath, U., Katageri, G., Gillespie, B., Mhetri, J., Patil, S., Mallapur, A., Karadiguddi, C., Vastrad, P., Dandappanavar, A., Roy, S., Peerapur, B., Goudar, S., & Anumba, D. O. C. (2023). Impact of a school-based nutrition educational intervention on knowledge related to iron deficiency anaemia in rural Karnataka, India: A mixed methods pre-post interventional study. BJOG : an international journal of obstetrics and gynaecology, 130(Suppl 3), 113–123. https://doi.org/10.1111/1471-0528.17619

Septiana, K. S., Adnani, Q. E. S., Susiarno, H., Tarawan, V. M., Arya, I. F. D., & Anwar, R. (2025). The Influence of Anemia Education Media on Increasing Self-Awareness and Compliance in Consuming Iron

Supplements in Adolescent Girls: A Systematic Review. International journal of women's health, 17, 2277–2289. https://doi.org/10.2147/IJWH.S532950

UNICEF (2020). Scaling Up Action on Adolescent Nutrition, Diets, Services, and Practices in India. https://www.unicef.org/documents/scaling-action-adolescent-nutrition-diets-services-and-practices-india

World Health Organization (WHO). (2024). Adolescent health fact sheet.

World Health Organization. (2018). Guideline: implementing effective actions for improving adolescent nutrition. Geneva: WHO.

World Health Organization. (2021). WHO Global Anaemia estimates, 2025 Edition. Geneva: WHO. https://www.who.int/data/gho/data/themes/topics/anaemia_in_women_and_children

World Health Organization. (2023). Daily iron supplementation in adult women and adolescent girls. Geneva