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Effect Of Health Education On Anaemia In School-Going Adolescent Girls Undergoing Standardized Supplementation For Anaemia

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ABSTRACT:

Background: Anaemia affects nearly two billion people globally, with a prevalence of 54% among adolescent girls in India (NFHS-4). Despite government initiatives such as Weekly Iron and Folic Acid Supplementation (WIFS) and Anaemia Mukt Bharat, the burden remains high due to poor compliance, inadequate knowledge, and unhealthy dietary practices. Evidence on the effectiveness of school-based health education interventions in this population is limited**.**

Aim: To assess the effect of health and nutrition education on anaemia among school-going adolescent girls receiving standardized iron and folic acid supplementation.

Method: A quasi-experimental pre–post interventional study was conducted in two girls' schools in Pune, India. 160 anaemic adolescent girls (80 intervention, 80 control) received WIFS (100 mg iron + 500 mcg folic acid weekly) for six months. The intervention group additionally received three months of health education (lectures, recipe booklets, counselling). Haemoglobin, knowledge (0–17 score), dietary intake (24-hour recall), and anthropometry were assessed at baseline and endline**.**

Result: Baseline haemoglobin was comparable between groups (9.25±1.09 vs 9.30±1.00 g/dL). Endline haemoglobin increased significantly more in the intervention group (10.23±1.00 vs 9.72±0.95; mean change +1.00 vs +0.50, p=0.004). Knowledge score improved dramatically in the intervention group (change +10.31 vs +0.37, p<0.001). Calorie, iron, and protein intake improved significantly only in the intervention group (p<0.001). Daily citric food consumption with meals increased from 0% to 25% in the intervention group**.**

Conclusion: Health and nutrition education combined with iron and folic acid supplementation significantly improves haemoglobin levels, knowledge, and dietary practices among adolescent girls. School-based nutrition education should be strengthened as a cost-effective strategy for anaemia control**..**.

Keywords: Anaemia; adolescent girls; health education; iron and folic acid supplementation; school-based intervention; India..

INTRODUCTION

Anemia, as defined by the World Health Organization (WHO), is a condition in which the Anemia is a condition wherein the number of red blood cells or their oxygen-carrying capacity is insufficient to meet physiological needs, which vary by age, sex, altitude, and pregnancy status.[1] Iron deficiency is the most common cause; however, deficiencies of folate, vitamin B12, and vitamin A, along with parasitic infections and inherited or acquired disorders, may also contribute. Nearly two billion people are affected globally, with approximately half attributed to iron deficiency anaemia. [2]

In India, anaemia remains a major public health problem, particularly among adolescent girls. According to the National Family Health Survey-4 (NFHS-4), the prevalence among adolescent girls aged 15–18 years is 54% nationally and 51.2% in Maharashtra.[3] The World Health Organization identifies iron deficiency as a leading nutritional risk factor in India, contributing to over 3% of disability-adjusted life years lost.[4] To address this, the

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Government of India implemented the Weekly Iron and Folic Acid Supplementation (WIFS) Programme in 2013.[5] Weekly supplementation is as effective as daily regimens for preventing and controlling adolescent anaemia.[6,7] Subsequently, the "Anaemia Mukt Bharat" initiative (2018) adopted the "Test, Treat, and Talk" strategy,[8] emphasising screening, treatment, and counselling on iron-rich foods.

Despite these national efforts, the anaemia burden remains high due to poor compliance, inadequate knowledge, unhealthy dietary practices, and low awareness. Evidence on the effectiveness of school-based nutrition and health education interventions specifically targeting anaemic adolescent girls is limited, and such education is often absent in schools

Hence, active participation of private healthcare, non-governmental organizations, schools, and communities is needed to support government efforts. [10] Behaviour Change Communication and culturally tailored nutrition education play a crucial role in improving dietary practices. School-based interventions are economical and effective for reaching adolescent girls, yet evidence of their impact remains scarce. Therefore, along with iron and folic acid supplementation, comprehensive health education focusing on anaemia, its complications, prevention, dietary modifications, and treatment compliance is essential. Considering these factors, the present study was undertaken to assess the impact of a health and nutrition education intervention on anaemia among school-going adolescent girls receiving standardized iron and folic acid supplementation.

MATERIALS AND METHODS

Settings and Participants: A quasi-experimental, non-randomized pre–post interventional study was conducted in the urban field practice area of the Urban Health Training Centre (UHTC), Pune, Maharashtra, India. The UHTC catered to 13 schools; two girls' schools were selected through convenience sampling, with one serving as the intervention group (School A) and the other as the control group (School B). The study population comprised adolescent girls studying in the 9th standard. Sample size was calculated using a published formula (n=72 per group); accounting for attrition, 80 anaemic girls per group were enrolled after screening 200 girls from School A and 185 from School B. Girls with serious illnesses (e.g., sickle cell anaemia, thalassemia major), hypersensitivity to iron-folic acid, or already receiving supplementation were excluded.

Intervention and Health Education Package: Both groups received Weekly Iron and Folic Acid Supplementation (WIFS) — 100 mg elemental iron + 500 mcg folic acid for six months, plus albendazole if indicated. The intervention group additionally received intensive health education over three months, delivered in four lectures: Lecture 1 (Week 1, December, 30 min): PowerPoint on anemia and complications; Lecture 2 (Week 2, December, 30 min): prevention, especially diet; Lecture 3 (Week 2, January, 30 min): distribution of recipe booklets and talk on iron-rich diet; Lecture 4 (Week 2, February, 30 min): videos on anemia and Q&A session. Pamphlets, visual demonstrations of iron-rich foods, and counseling on absorption (lemon, avoiding tea/coffee, iron utensils) were included. Compliance was monitored by class representatives with weekly charts.

Data Collection and Laboratory Assessment: Screening and post-intervention haemoglobin were measured using a portable Diaspect Haemoglobin Analyser (capillary blood, finger prick, photometric method). A prevalidated structured questionnaire (translated to Marathi and back-translated) collected anthropometric, socioeconomic, menstrual, dietary (24-hour recall, analyzed using Indian Food Composition Tables 2017), and knowledge data. Knowledge was assessed via 17 closed-ended questions (score 0–17). Post-intervention assessment (haemoglobin, knowledge, dietary practices) was conducted after six months. Participants with haemoglobin <8 g/dL were referred.

Ethical Considerations and Statistical Analysis: Ethical approval was obtained from the Institutional Ethics Committee. Administrative permission, written informed consent from parents/guardians, and assent from students were secured. Data were analyzed using SPSS version 25. Continuous variables were expressed as mean ± SD; categorical variables as frequencies/percentages. Independent t-test, chi-square/Fisher's exact test, and McNemar test were used. A p-value <0.05 was considered statistically significant.

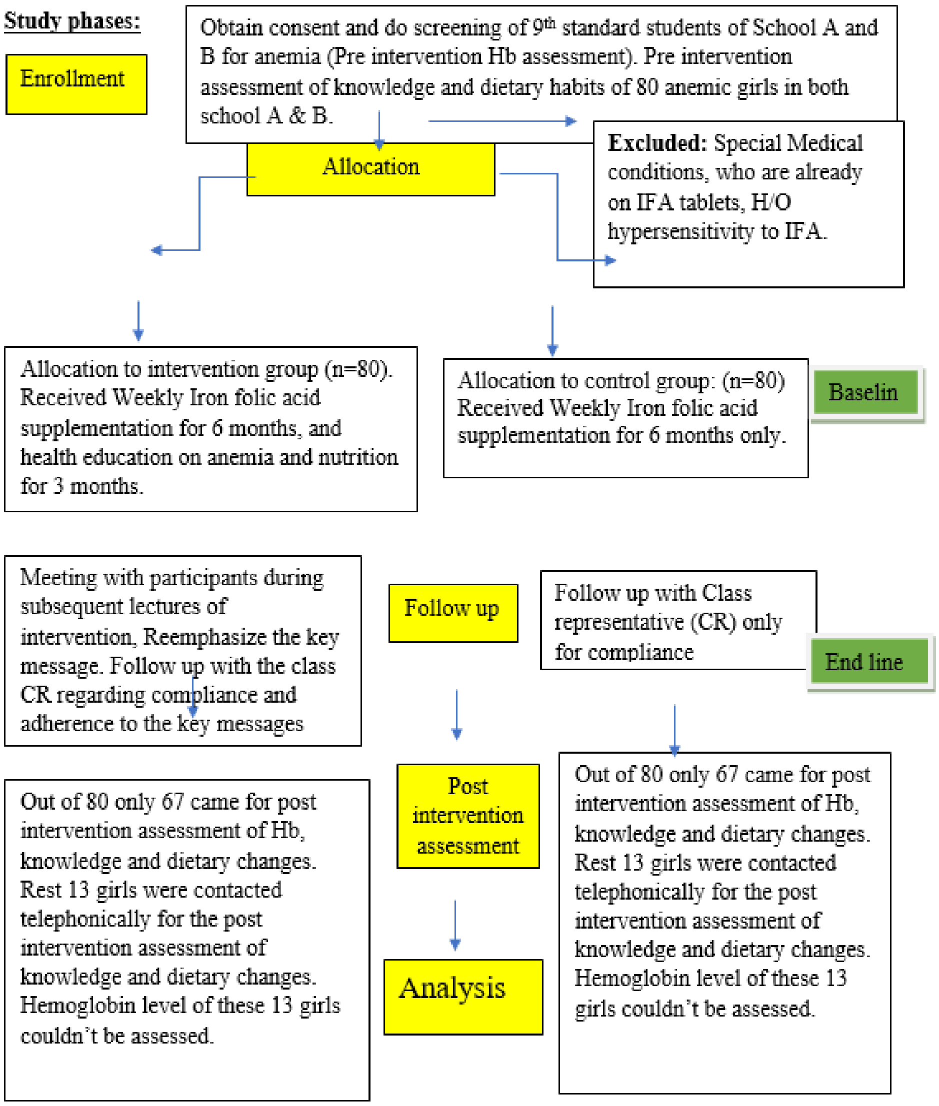

Fig: Flow Diagram of The Study

Health education timeframe for study group:

Lecture	**Time**	**Duration of session**	**Mode of delivery**
Lecture 1	Ist week of December	30 min session	PowerPoint presentation on anaemia and its complications.
Lecture 2	2nd week of December	30 min session	PowerPoint presentation on preventive measures for anaemia, especially diet.
Lecture 3	2nd week of January	30min session	Distribution of recipe booklet and talk on an iron-rich diet.
Lecture 4	2nd week of February	30min session	Videos on anaemia and the importance of an iron-rich diet. Question and answer session with students regarding anaemia.

RESULTS

Assessment of haemoglobin levels revealed that the majority of participants, 127 (79.3%), had moderate anaemia, while 18 (11.3%) had severe anaemia and 15 (9.3%) had mild anaemia. Most participants belonged to the lower middle socioeconomic class. In the control group, 15 (18.75%) girls belonged to the upper middle class, 50 (62.5%) to the lower middle class, and 15 (18.75%) to the upper lower class. In the intervention group, 18 (22.5%) girls belonged to the upper middle class, 42 (52.5%) to the lower middle class, and 20 (25%) to the upper lower class. None of the participants belonged to the upper or lower socioeconomic class. The difference in socioeconomic status between the two groups was not statistically significant (p = 0.431).

Table 1 shows the dietary practices of anaemic adolescent girls in the control and intervention groups.

Table No. 1: Dietary practices of anaemic adolescent girls in the control and intervention group.

Variable	Control N (%)	Intervention N (%)	P value
Meal frequency per day			
Thrice	18 (22.5%)	16 (20%)	0.624
More than thrice	62 (77.5%)	64(80%)	
Total	80 (100%)	80(100%)	
Post-meal consumption of milk/ tea (Within 30 minutes)			
Yes	26 (32.5%)	28 (35%)	0.738
No	54 (67.5%)	52 (65%)	
Total	80 (100%)	80 (100%)	
Type of diet			
Vegetarian	51 (63.75%)	35 (43.75%)	0.011
Mixed	29 (36.25%)	45 (56.25%)	
Total	80 (100%)	80 (100%)	
If mixed frequency of non-veg			
Once a week	12 (41.37%)	19 (42.2%)	0.004
Twice in a week	3 (10.3%)	18 (40%)	
Once a month	14 (48.27%)	8 (17%)	
Total	29 (100%)	45 (100%)	

Most participants in both groups consumed meals more than three times a day. Post-meal consumption of tea or milk within 30 minutes was reported by nearly one-third of participants in both groups. A significantly higher proportion of participants in the intervention group consumed a mixed diet compared to the control group (p = 0.011). Among participants consuming non-vegetarian food, intake twice a week was higher in the intervention group, and this difference was statistically significant (p = 0.004).

Table No. 2 shows the socio-demographic information of anaemic adolescent girls in the control and intervention groups.

Table No. 2: Socio-demographic information of adolescent anaemic girls in the control and intervention group.

variable	categories	Control n (%)	Intervention n (%)	p value
occupation of the	employed	30 (37.5%)	39 (49.36%)	0.131

mother	unemployed	50 (62.5%)	40 (50.63%)	
	total	80 (100%)	79 (100%)	
occupation of the father	employed	78	73	<0.001
	unemployed	0	0	
family type	nuclear	49 (61.25%)	52 (65.00%)	0.069
	joint	29 (36.25%)	20 (0.25%)	
	single parent	2 (0.025%)	8 (10 %)	
	total	80 (100%)	80 (100%)	
monthly income of the family	5000 - 10000	38 (47.5%)	40 (50%)	0.559
	11000-20000	42 (52.5%)	39 (48.75%)	
	more than 20000	0	1 (1.25%)	
	total	80 (100%)	80 (100%)	
birth order	less than or equal to 2	66 (82.5%)	73 (91.25%)	0.815
	more than 2	14 (17.5%)	17 (21.25%)	
	total	80 (100%)	80 (100%)	
Number of siblings	less than or equal to 2	51 (63.75%)	45 (56.25%)	0.333
	more than 2	29 (36.25%)	35 (43.75%)	
	total	80(100%)	80(100%)	

The majority of mothers in both groups had an education up to seventh standard or below. Most fathers were employed, and nuclear families were predominant in both groups. Nearly half of the families had a monthly income between ₹5,000 and ₹10,000. Most participants had a birth order of less than or equal to two and had two or fewer siblings.

Table No. 3 compares mean haemoglobin levels at baseline and end line in both groups.

Table No. 3: Comparison of mean haemoglobin level for baseline and end line in control and intervention group.

variable Hb g/dl	control group	intervention group	p value
	mean +-SD	mean +-SD	
base line	9.25+-1.09	9.30+- 1.00	0.783
end line	9.72+-0.95	10.23+-1.00	0.003
change	0.50+-1.00	1.00+-0.98	0.004

Baseline haemoglobin levels were comparable between the groups. However, end-line haemoglobin levels and mean change in haemoglobin were significantly higher in the intervention group compared to the control group.

Figure 1 shows a box plot of pre-intervention haemoglobin level, post-intervention haemoglobin level and change after intervention in both the control and intervention groups.

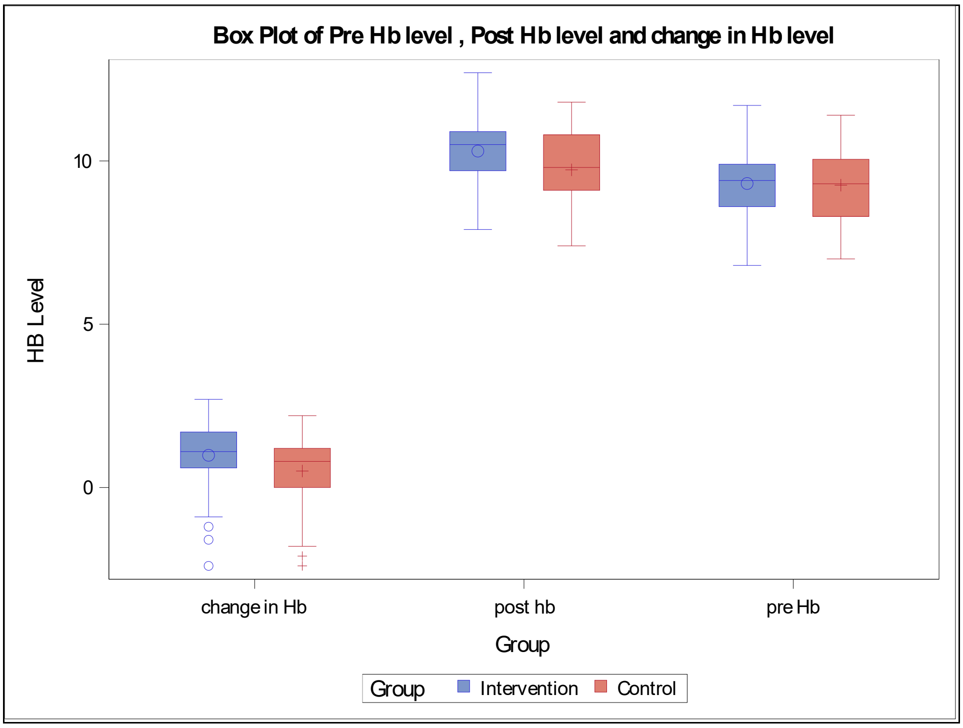

Table No 4 shows the comparison of the knowledge score for baseline and end line in the control and intervention groups.

Table No. 4: Comparison of knowledge score for baseline and end line in control and intervention group.

variable	control group	intervention group	p value
knowledge score	mean+-SD	mean +-SD	
base line	6.55+-1.65	5.78+- 2.66	0.046
end line	6.83+-1.77	16.1+-1.019	<0.001
change	0.37+-1.05	10.31+-2.74	<0.001

A marked improvement in knowledge scores was observed in the intervention group after health education, while only minimal change was observed in the control group.

For the assessment of anthropometric changes, data from 67 participants in each group were analysed due to the dropout of 13 participants from both groups. Mean baseline weight in the control and intervention groups was 42.5 ± 8.64 kg and 40.29 ± 8.28 kg, respectively. Mean weight gain was significantly higher in the intervention group (1.16 ± 2.114 kg) compared to the control group (0.22 ± 1.84 kg). Similarly, baseline BMI was 18.3 ± 3.9 in the control group and 17.8 ± 3.7 in the intervention group. Mean BMI improvement was significantly greater in the intervention group (0.5 ± 1.0) than in the control group (0.00 ± 0.8).

Table No. 5 compares calorie, iron, and protein intake at baseline and end line between the two groups.

Table No. 5: Comparison of calorie intake, iron intake and protein intake for baseline and end line in control and intervention.

Variable	Control group	Intervention group	
Caloric intake	**Mean+-SD**	**Mean +-SD**	**P Value**
Base line	1648.91+-276.17	1693.69+-319.47	0.344

End line	1623.96+-225.26	1900.38+-239.00	<0.001
Change	-39.52+-206.75	216.93+-298.31	<0.001
Iron intake	**Mean+-SD**	**Mean +-SD**	**P Value**
Base line	13.78+-3.46	12.51+-3.46	0.022
End line	12.61+-3.37	19.89+-4.89	<0.001
Change	-1.16+-2.86	7.38+-4.65	<0.001
Protein intake	**Mean+-SD**	**Mean +-SD**	**P Value**
Base line	30.14+-5.78	29.41+-6.35	0.451
End line	30.05+-5.94	37.49+-5.97	<0.001
Change	0.08+-3.89	8.39+-6.78	<0.001

The intervention group showed significant improvement in caloric, iron, and protein intake following health education, whereas minimal or negative changes were observed in the control group. Consumption of citric foods with meals also improved significantly in the intervention group. At baseline, none of the participants in either group consumed citric foods daily. However, at the end line, 25% of participants in the intervention group reported daily consumption of citric foods, while no such improvement was observed in the control group. This difference was highly statistically significant ($p < 0.001$).

DISCUSSION

The present quasi-experimental study assessed the effect of health and nutrition education along with Weekly Iron and Folic Acid Supplementation (WIFS) on anaemia among school-going adolescent girls. The findings demonstrated significant improvement in haemoglobin level, knowledge, dietary intake, and nutritional practices among participants who received health education in addition to iron supplementation. Globally, the WHO reviewed population-based studies (1993–2015) and estimated that nearly 1.6 billion people were affected by anaemia, with the highest prevalence among preschool children (47.4%) and women of reproductive age (45.7%) in Africa and South-East Asia.[12] According to NFHS-5, anaemia among girls aged 15–19 years in Maharashtra was 56.4% in urban and 57.7% in rural areas; in Pune district, prevalence increased from 48.4% (NFHS-4) to 58.6% (NFHS-5).[13]

Anaemia

In the present study, the majority of adolescent girls had moderate anaemia, with smaller proportions having mild and severe anaemia. Similar findings have been reported by Malwani et al., Bodat S., and Deshpande et al., where moderate anaemia was predominant. [14,15,16] Despite national programs (WIFS and Anaemia Mukt Bharat), anaemia remains a major public health problem among adolescents, likely due to poor dietary habits, inadequate awareness, low compliance, and lack of effective health education.

Most participants belonged to the lower middle socioeconomic class, similar to observations by Deshpande et al., Bharati et al., and Varma et al., who found higher anaemia prevalence among lower socioeconomic groups. [16, 17, 18] Socioeconomic status influences dietary quality, healthcare access, and nutrition awareness. Dietary assessment revealed that while most participants ate more than three times daily, calorie, protein, and iron intake remained inadequate at baseline, highlighting the importance of dietary quality over meal frequency. Anaemia was more common among vegetarians, consistent with Mahajani et al., Chaturvedi et al., and Jawarkar et al., [19, 20, 21], as vegetarian diets provide non-heme iron with lower bioavailability. Parental education, especially maternal education, showed an important relationship with anaemia. Most mothers had an education up to seventh standard and were unemployed. Similar findings were reported by Bhise et al., Pattnaik et al., and Arya et al., where lower maternal education was associated with higher anaemia prevalence. [22, 23, 24] Family type and birth order did not significantly influence anaemia status. Nutritional assessment using BMI-for-age showed most girls had normal BMI despite being anaemic, indicating that normal weight does not guarantee adequate micronutrient status, as also observed by Gupta et al. and Kaur et al.[25, 26]

Effect on Haemoglobin Levels and Knowledge

A major finding was a significant improvement in haemoglobin levels in the intervention group. Mean haemoglobin increased more among participants receiving health education plus iron supplementation compared to supplementation alone. Similar improvements have been reported by Sunuwar et al., Sharma et al., Dongre et al., and Singh et al., demonstrating that combining nutritional education with iron supplementation leads to greater haemoglobin improvement and anaemia reduction.[27], [28],[29],[30] Knowledge regarding anaemia improved significantly in the intervention group. Baseline knowledge scores were low in both groups, indicating poor awareness about causes, symptoms, prevention, and treatment. After the intervention, the mean knowledge score increased substantially in the intervention group. Similar findings were observed by Bandyopadhyay et al., Bhalsod et al., and Karmakar et al., where structured educational interventions significantly improved knowledge about anaemia and healthy dietary practices.[31],[32],[33]. Improved knowledge promotes behavioural change and better compliance with preventive measures.

Effect on Dietary Practices, Nutritional Status, and Vitamin C Intake

The intervention group also showed significant improvement in weight and BMI compared to the control group, indicating improved overall nutritional status, consistent with Kumar A et al., Mittal et al., and Sujatha et al.[34],[35],[36]. Dietary assessment revealed significant improvement in calorie, protein, and iron intake among intervention participants, whereas little or negative change was observed in the control group. Similar findings have been reported by Charawandya et al., Alaofe et al., and Mustafa et al., confirming that nutrition education effectively improves dietary intake and nutrient adequacy among adolescent girls.[37],[38],[39] An important finding was improved consumption of citric foods with meals in the intervention group. Vitamin C enhances non-heme iron absorption. At baseline, no participants reported daily intake of citric foods with meals; after intervention, a substantial proportion in the intervention group reported regular consumption of lemon and other citric foods. Similar findings were reported by Charawandya et al., and Khoshnevisan et al.,[37],[40] and Hallberg et al. demonstrated the important role of vitamin C in enhancing iron absorption.[41] Increased awareness about citric foods likely contributed to the observed haemoglobin improvement.

Overall, health and nutrition education combined with iron and folic acid supplementation significantly improves knowledge, dietary behaviour, nutritional intake, and haemoglobin levels among adolescent girls. School-based interventions are practical, cost-effective, and capable of reaching large numbers of adolescents. Strengthening school health programs with regular nutrition education and counselling may contribute substantially to reducing anaemia among adolescent girls.

Recommendations: Health and nutrition education on anaemia should be incorporated into school curricula to improve awareness and promote healthy dietary practices among adolescents. Interactive educational sessions can enhance knowledge and encourage behavioural change. Continued nutrition education among adolescent girls can contribute to improved health and nutritional status, benefiting both future mothers and their families.

Limitation: During post-intervention assessment, only 67 participants from each group were available for haemoglobin estimation. The remaining participants were contacted telephonically for reassessment of knowledge and dietary practices; however, post-intervention haemoglobin levels could not be assessed for them.

CONCLUSION

The majority of adolescent girls in the study had moderate anaemia despite ongoing national anaemia control programs. Health and nutrition education, along with iron and folic acid supplementation, significantly improved knowledge regarding anaemia, haemoglobin levels, and dietary intake of calories, protein, and iron among participants in the intervention group. Strengthening health education and motivation among adolescents is essential for effective and sustainable control of iron deficiency anaemia

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