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Research Article

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Evaluating the effectiveness of a community-based intervention in changing the knowledge, attitude, norms, and practices related to anemia among adolescents in the selected blocks of the Gorakhpur district, Uttar Pradesh

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ABSTRACT

Introduction: Adolescent girls are one of the most vulnerable groups for anemia. The high prevalence of anemia among adolescent girls is caused by various factors, including inadequate nutrition, gender disparities, poor sanitation and hygiene, and deeply rooted cultural and social norms. Therefore, anemia prevention and timely management require a broad, multi-dimensional approach that addresses these determinants.
Objectives: The present study was conducted to assess the effectiveness of community-based intervention in improving knowledge, attitudes, practices, and norms among adolescent girls (15-19 years) in the selected blocks of the Gorakhpur district, Uttar Pradesh.
Methods: A cross-sectional quantitative study was conducted in two intervention blocks (*Khajani* & *Pipraich*) of the Gorakhpur district. A baseline survey was followed by 5 months of intervention, after which an endline survey was conducted among unmarried adolescent girls (15-19 years). The baseline and endline surveys were conducted with a minimum of 400 adolescent girls. Moreover, the education intervention was conducted across 120-150 villages of the intervention district. The data were analyzed and presented as mean, and standard deviation (interquartile range), and frequencies (percentages) using STATA version 16.0.
Results: The findings indicate a significant improvement in healthy eating intentions, perceived behavior control and social norms related to nutrition and anemia prevention from baseline to endline ($p<0.05$). We also noticed a statistically significant increase in knowledge, positive attitude, norms, and practices from baseline to end line.
Conclusions: The present study suggests that community-based interventions are feasible strategiesfor improving awareness, knowledge, attitudes, and behaviors among adolescents. Future interventions should incorporate components that target prevailing social norms, peer influence, and evidence-based behavior change strategies for sustainable outcomes.
Keywords: Anemia, social norms, healthy eating, intentions

Introduction

Anemia, defined as reduced hemoglobin in red blood cells, is prevalent in developing countries, contributing to about one million deaths each year worldwide.[1] Iron-folate deficiency anemia (IDA) is the most common form of anemia. Around half a billion women of reproductive age are anemic globally, with prevalence being higher in low and middle-income countries (LMICs) like India. The most recent National Family Health Survey (NFHS 5; 2019-2021) reveals a significant burden of anemia, impacting 57% of women of reproductive age in India, while in the aspirational districts, the prevalence among women of reproductive age is even higher at 61%.[2] According to NFHS-5, a high prevalence of anemia (52.9%) is observed among women aged 15–49y, with 41.4% of pregnant women being anemic. Notably, the prevalence is highest among adolescent girls aged 15–19y, where 55.8% are affected in the Gorakhpur district of Northern India.

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Research suggested that preventive supplementation along with nutrition education may be a more effective strategy associated with better compliance and improvement in iron status. Other effective long-term approaches are fortification, promoting dietary diversity, improving access to nutritious food, enhancing antenatal care, implementing effective disease prevention and control measures, and strengthening healthcare systems to ensure early detection and appropriate management of anemia.[3]

Furthermore, the evidence suggested that gender inequalities adversely affect women through male-dominated decision-making, economic and educational disparities, violent relationships, and the socialization of women to be "other-oriented" at the expense of their own health.[4]Gender norms and discrimination can contribute to higher rates of anemia among women in India, and results are consistent in studies.[5] Traditional gender roles often assign women the responsibility of household chores, childcare, and agricultural work, which warrants higher energy and nutrient requirements.[6] However, women face limited access to nutritious food, healthcare, and rest, which increases their risk of anemia.[7] Cultural beliefs and practices involve exploring how cultural norms, beliefs, and practices impact individuals' perceptions, attitudes, and behaviors regarding anemia. These beliefs and practices vary significantly across societies and communities, shaping people's understanding of anemia, its causes, and its management. The cultural practices may restrict women's access to iron-rich foods or promote dietary habits that do not adequately address nutritional needs, increasing their susceptibility to anemia.[8]

Social norms, such as descriptive norms, injunctive norms, and collective norms, affect the intention to improve dietary intake, consume iron-folic acid (IFA) tablets, and the behavior of consuming iron-rich foods and a balanced diet. Girls receive IFA tablets and calcium tablets from schools or *Anganwadi* centers. Descriptive norms are characterized as beliefs about how the members of a group behave, and injunctive norms refer to beliefs about how the members of a group expect others to behave. On the contrary, collective norms refer to the true prevalence of behavior within a group or setting. These social norms predict behavior intentions, which can influence behavior.[9]

According to the theory of normative social behavior, the relationship between social norms and behavior is mediated by intentions, as shown below. All three forms of norms are powerful predictors of intentions moderated by multi-level factors (**Fig.1).**[9] The research highlighted that anemia is often attributed to perceived supernatural or spiritual causes alongside biological factors. For instance, some groups may view anemia as stemming from ancestral curses, malevolent spirits, or imbalances in bodily humors. These cultural interpretations influence how individuals respond to anemia, affecting their healthcare-seeking behaviors and treatment decisions.[8] Socioeconomic norms and disparities may limit access to nutritious food, healthcare facilities, and education about anemia prevention and management, particularly among marginalized communities.[11]

Addressing anemia in India requires challenging and changing social norms through community engagement, awareness campaigns, and targeted interventions. Poor water and sanitation facilities are some of the most critical, preventable risk factors of anemia. A study found that the odds of anemia in children were 40% higher in households going for open defecation or unimproved sanitation facilities, and in about a quarter of the countries, anemia was more common in children living in households without access to an improved water source.[12] In a study conducted in Uttar Pradesh to assess the risk factors associated anemia it was seen that untreated water intake and poor hygiene practices were among the major causes of IDA.[13] As per NFHS-5, in rural India, only 64.9% of people live in households with improved sanitation facilities.

It is crucial to promote gender equality, improve access to education and healthcare, empower women, and raise awareness about the importance of a diverse and nutritious diet. Additionally, collaboration with community leaders, influencers, and healthcare providers can help debunk myths, improve cultural sensitivity, and promote evidence-based practices for anemia prevention and management. Therefore, we conducted a community-based intervention to educate women and girls on a diverse balanced diet, nutrition, anemia, and its management. The present study aimed to assess the effectiveness of community-based education in improving knowledge and changing attitudes, practices, and norms among adolescent girls in the selected blocks of the Gorakhpur district of Uttar Pradesh.

Material and Methods

Study design, population, and settings: A cross-sectional quantitative study was conducted at the baseline, followed by the intervention, and then the endline at the end of the intervention. The study was conducted in the selected two intervention blocks (*Khajani and Pipraich*) of the Gorakhpur district. These two blocks were selected as they had poor maternal health indicators and limited access of women to health services. Adolescent girls (15-19 years)

and adult women (20-45 years) were enrolled in the study. The other beneficiaries, such as frontline workers (ASHAs/ *Anganwadi* workers) and government school teachers, were also involved in the study.

All the unmarried adolescent girls (15-19 years) living in the study area for at least 1 year and were willing to provide information were enrolled in the study. The sample size was calculated using an effect size of 0.3 to achieve through the intervention, an alpha error of 5%, 95% power, 1.5 design effect, and 20% drop-out rate; the minimum sample size was calculated at 396. So, a minimum of 400 adolescent girls were surveyed at the baseline and endline. Furthermore, all government school teachers and frontline workers were purposefully included in the study. We included them in our study as they were trusted and familiar figures within the community, which further enhanced the credibility and acceptance of the intervention at a larger level. The regular interaction with the community positioned them well to reinforce key messages, ensure continuity, and sustain the promoted practices as part of their routine responsibilities.

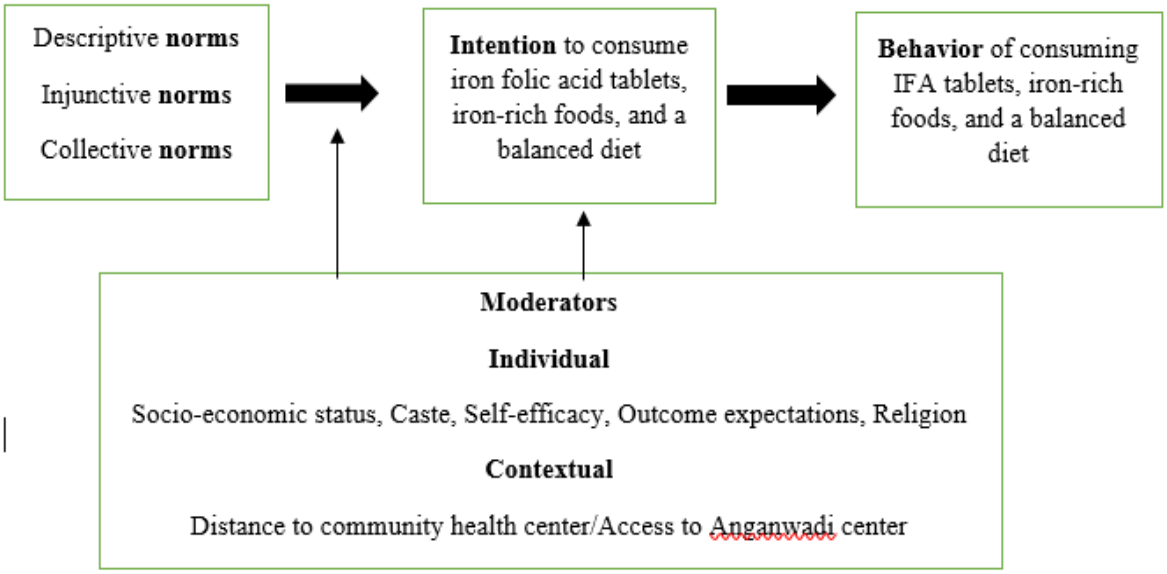

Fig 1. Conceptual Framework on the Influence of Social Norms and Moderators on Iron and Nutrition Consumption Behavior[9]

Study tools: A pre-designed semi-structured questionnaire was developed consisting of information on socio-demography knowledge, attitude, and practice questions (KAP) on anemia, nutrition, and access to *Anganwadi* services, tools/scales to measure norms, intentions, and behavior controls. The questionnaires were translated into the local language (Hindi). The tool was further pretested and validated on a small subset of the population before collecting the actual data. Based on the feedback received, the necessary changes were incorporated in the questionnaire. The questionnaire was divided into five sections. ***Section I*** consisted of socio-demographic information such as age, marital status, highest educational status, occupation, religion, type of family, and so on. Furthermore, ***section II*** focused on water, sanitation and hygiene (WASH) habits such as washing hands with soap at critical times like after defecation, before and after cooking, and trimming of nails regularly. ***Section III*** comprised of access to health services such as registration at *Anganwadi centre* (AWC), and receiving supplementary nutrition and services at AWC.

Section IV comprised questions related to awareness of anemia. These included questions on anemia definition, symptoms and reasons for anemia, ways of preventing anemia, and iron-rich foods. In total, there were 32 questions related to awareness, apart from the first question on "*ever heard of anemia*". The correct responses to 32 questions were coded as 1, and the incorrect responses were coded as 0. The scores of all 32 questions were

summed up to calculate the cumulative scores. Hence, the maximum score was 32, and the minimum score was 0. The Cronbach's alpha of 32 items was 0.97.

Besides, in the same section, there were questions on food groups/items for a balanced diet, perception related to anemia among girls, and the consumption of deworming tablets, IFA tablets, and calcium tablets. There were 12 statements on the perception related to anemia. It was a 5-item Likert scale with options ranging from strongly agree to strongly disagree. The Cronbach's alpha was 0.98 for all the 12 items together. Since all the statements were positive, the strongly agree responses were coded 2, agree were coded 1, and the rest of the options were coded as 0. The scores of all twelve items were summed up to calculate the combined score. Hence, the maximum score was 24, and the minimum score was 0.

In ***Section V***, the questionnaire incorporated the descriptive norms, which included 8 statements; injunctive norms, which included 7 statements; healthy intentions, which included 8 statements, and perceived behavior control, which included 3 statements. The descriptive norms were a 5-item Likert scale with options ranging from bad to good. Likewise, injunctive norms were a 5-item Likert scale with options ranging from strongly agree to strongly disagree. The healthy intentions were also a 5-item Likert scale with options ranging from definitely yes to definitely no. Since all the statements in all 4 scales were positive, the "*strongly agree, good and definitely yes*" options were coded 2, *agree, useful, and somewhat yes* were coded 1, and the rest of the options were coded 0. The scores of all the items in the 4 scales were summed up to calculate the combined score. There were 26 statements, and hence, the maximum score of the scale was 52, and the minimum was 0. The reliability coefficient (Cronbach's alpha) was 0.93 for all 26 items together.

At the endline, the participants were asked if they participated in the sessions or events, how much they were satisfied with the sessions, did they share information with their peers, and how many people did they reach out to with the information.

The data were collected by the trained investigators, who were supervised by the district coordinator at the field level. They were trained virtually for the administration of various questionnaires before the initiation of the survey. During the training, emphasis was given to achieving the maximum intra and inter-individual agreement in respect of all the measurements. Mock surveys were also carried out to assess the level of proficiency. To ensure quality control in the administration of questionnaires or measurements, continuous supervision, and monitoring were conducted for no days/months/no of sessions. The data was collected in an institutional mobile-based application. The ethical clearance of the study was obtained from the MAMTA Institutional Review Board (MIRB) under reference number MIRB/September-2023/006.

Intervention

The study adopted the multi-pronged approach to reach out to different beneficiaries with interesting and engaging messages on anemia identification and early management. Six structured group education sessions on identification, prevention and management of anemia, food fortification, personal and food safety and hygiene, growth and nutritional requirements of adolescent girls were conducted using a flipbook, the content of which was tested for efficacy (**Fig 2**). The information was disseminated through community-based events such as showcasing videos, conducting recipe demonstrations, role plays using comic books with girls, and street plays for enhanced engagement and reaching out to villagers who play a critical role in decision-making for girls and women. We also conducted stakeholder meetings with the village-level stakeholders, like *Sarpanchs*, school teachers, ANM, etc., to apprise them about the need for community-level nutritional interventions using POSHAN ABHIYAN dialogue cards for Panchayati Raj Institutions (PRI) members.

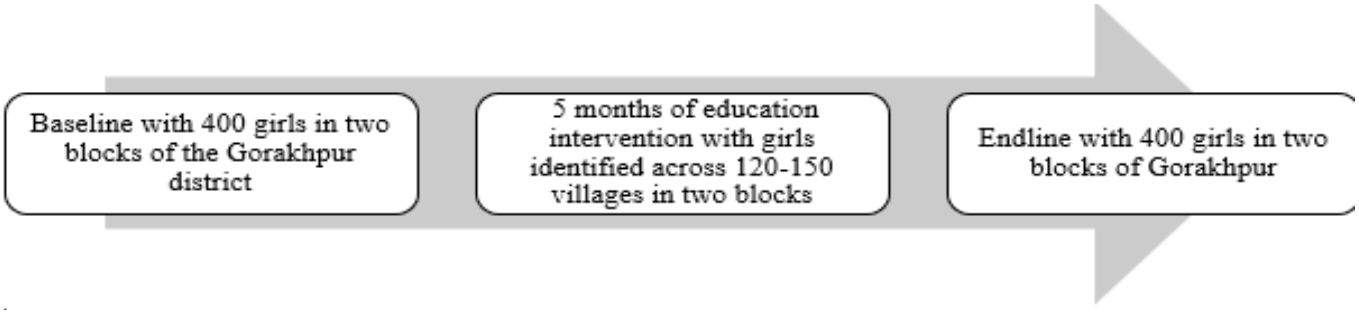

Fig 2. Strategic Community-Based Intervention on Anemia Among Adolescent Girls in Gorakhpur District

Statistical analysis

The data were presented as mean (median), standard deviation (interquartile range), and frequencies (percentages). The data were dichotomized into baseline and endline. We performed logistic regression analysis using the consumption of IFA tablets as the dependent variable and age, baseline or endline, type of cards (BPL, APL, AAY), education status, and annual family income as predictors. The association was expressed as an odds ratio (OR) and a 95% confidence interval. Linear regression was performed using a combined knowledge score, attitude score, and norms score as separate dependent variables and the rest of the variables as predictors. The associations were expressed as beta coefficients **(β)** and 95% confidence intervals (CI). We considered a p-value <0.05 as the statistically significant value. The regression coefficient (R^2) was calculated to express the strength and direction of the effect of the predictors on the outcome variable. All the analyses were performed using STATA version 16.0.

Results

A comparison of the baseline and endline data reveals notable differences. The baseline included 442 girls (y), while the endline involved 456 girls (y). The median (IQR) age of the beneficiaries was 17 (16-18) years (**Table 1**). Nearly three-fourths of the girls had below-the-poverty-line cards. There was an increase in the percentage of girls who heard of anemia from 42% at baseline to 58% at the endline (**Table 2**). Also, there was an increase in the percentage of girls who were aware of iron-rich foods from 32.8% at the baseline to 87.3% at endline. Likewise, the percentage of girls who consumed calcium tablets increased by 44% from baseline to the endline. There has been a slight change in the norms towards the consumption of a healthy diet. The descriptive norms changed by 1 unit, followed by injunctive norms by 2, and intention and perceived behavior control by 3 units from baseline to endline.

The findings of the study indicate a significant improvement in healthy eating intentions, perceived behavior control, and social norms related to nutrition and anemia prevention from baseline to endline (**Table 3**). Descriptive norms indicated a higher perception of the benefits of taking iron-folic acid (IFA) tablets, double-fortified salt, and nutrient-dense foods such as green leafy vegetables, fruits, and pulses. Injunctive norms also improved, with more girls strongly agreeing that friends, family, teachers, media, and government authorities favor healthy food intake to avoid anemia. Adolescent girls agreed to adopt healthy practices, such as consuming IFA tablets, eating healthy foods, hand washing, and regularly wearing shoes was much higher, with a greater percentage of the adolescent girls responding with "definitely yes" during the endline. The perceived behavioral control was also improved among the adolescent girls, who perceived greater confidence in their ability, self-discipline, and time management to maintain healthy eating practices.

There has been a statistically significant increase in knowledge, positive attitude, norms, and practices from baseline to end line (**Table 4**). There was an increase of 16.5 units in the combined knowledge score at the endline compared to the baseline (β_0, 95%CI: 16.5 (15.4, 17.6); p-value<0.001). Likewise, the attitude score increased by 7.2 units at the endline compared to the baseline (β_0, 95%CI: 7.2 (6.2, 8.2); p-value<0.001). Around 90% of participants at the end line participated in the sessions, and 98% participated in one of the many community-based events. At the endline, most of the participants reported that they were satisfied with the program and had given it an average of 10 out of 10 scores. Nearly 84% of the respondents said that they would share the information gained during the project with an average (IQR) of 3 (2-5) people.

Table 1. Socio-demographic characteristics of study participants at the baseline and endline

Socio-demographic Characteristics	Baseline (n = 442) N (%)	Endline (n = 456) N (%)
Age of girls (years) (Median, IQR)	17 (16–18)	17 (16–18)
Education status		
Illiterate and 1st–4th standard	9 (2.0%)	3 (0.7%)
5th–8th standard	103 (23.3%)	107 (23.4%)
9th–12th standard and above	330 (74.7%)	346 (75.9%)
Type of family		
Nuclear	310 (70.1%)	301 (66.0%)
Joint	132 (29.9%)	155 (34.0%)
Toilet type used		

Flush toilet	233 (52.7%)	295 (64.7%)
Digging toilet	172 (38.9%)	158 (34.6%)
Open defecation	37 (8.4%)	3 (0.7%)
Type of ration card		
AAY (Antyodaya Anna Yojana)	65 (14.7%)	58 (12.7%)
APL (Above Poverty Line)	23 (5.2%)	55 (12.0%)
BPL (Below Poverty Line)	318 (72.0%)	341 (74.8%)
None	36 (8.1%)	2 (0.5%)
Family income (INR) (Median, IQR)	₹70,000 (40,000–1,00,000)	₹52,000 (45,000–68,000)

Abbreviations*: APL: Above the Poverty Line; AAY: Antayodya Anna Yojna (Extremely Below-the-Poverty-Line) BPL: Below the Poverty Line; IQR: Interquartile Range*

Table 2. Distribution of knowledge, attitudes, practices, norms (descriptive, injunctive), intentions, and perceived behavior control related to diet and nutrition among adolescent girls at baseline and endline, respectively.

Indicator	Baseline (n = 442) N(%)	Endline (n = 456) N (%)
Have you heard of anemia		
Yes	185 (42.0%)	452 (100.0%)
No	257 (58.0%)	0 (0.0%)
Do you know what anemia is		
Yes	171 (38.7%)	448 (98.3%)
No	271 (61.3%)	8 (1.7%)
Symptoms of anemia (Median, IQR)	0 (0–8)	8 (8–8)
Common causes of anemia (Median, IQR)	0 (0–5)	5 (5–5)
Can anemia be prevented		
Yes	172 (38.9%)	451 (98.9%)
No	270 (61.1%)	5 (1.1%)
Prevention methods known (Median, IQR)	0 (0–7)	7 (7–7)
Awareness of iron-rich foods		
Yes	145 (32.8%)	398 (87.3%)
No	297 (67.2%)	58 (12.7%)
Balanced diet items known (Median, IQR)	6 (3–9)	3 (0–6)
Correct number of food groups identified		
Yes	120 (27.1%)	352 (77.2%)
No	322 (72.9%)	104 (22.8%)
Consumes adequate food groups daily		
Yes	68 (15.4%)	153 (33.5%)
No	374 (84.6%)	303 (66.5%)
Combined knowledge score (Median, IQR)	5 (0–24)	27 (25–31)
Attitude score (Median, IQR)	12 (12–13)	24 (24–24)
Consumed deworming pills		
Yes	316 (71.5%)	407 (89.2%)
No	126 (28.5%)	49 (10.8%)
Consumed calcium tablets		
Yes	84 (19.0%)	288 (63.2%)
No	358 (81.0%)	168 (36.8%)

Consumed iron-folic acid tablets (IFA)		
Yes	75 (17.0%)	230 (51.0%)
No	367 (83.0%)	224 (49.0%)
Descriptive norms score (Median, IQR)	8 (8–12)	9 (8–13)
Injunctive norms score (Median, IQR)	7 (7–8)	10 (7–13)
Intentions score (Median, IQR)	12 (11–16)	16 (13.5–16)
Perceived behavior control score (Median, IQR)	3 (3–6)	6 (5–6)

Abbreviations: *IQR: Interquartile Range*

Table 3. Distribution of the various norms and intentions among adolescent girls at the baseline and endline

Healthy eating intentions	**Baseline n=442 N(%)**	**Endline n=456 N(%)**
Descriptive norms		
a. Girls should take iron folic acid tablets regularly.		
Bad/harmful	10 (2.2)	1 (0.2)
Foolish	4 (0.9)	0
Useless	9 (2.0)	11 (2.4)
Very good / beneficial	70 (15.8)	78 (17.1)
Good	349 (79.0)	366 (80.3)
b. Using double fortified salt in daily food		
Bad/harmful	4 (0.9)	1 (0.2)
Useless	2 (0.4)	2 (0.4)
Very good / beneficial	85(19.2)	129 (28.3)
Good	351 (79.5)	324 (71.1)
c. For girls, eat green leafy vegetables, fruits, sprouted gram, milk and pulses.		
Bad/harmful	4 (0.9)	0
Foolish	1 (0.9)	0
Useless	0	2 (0.4)
Very good / beneficial	139 (31.5)	197 (43.2)
Good	298 (67.4)	257 (56.4)
d. Consuming deworming tablets for 6 months		
Bad/harmful	49 (11.1)	120 (26.3)
Foolish	11 (2.5)	1 (0.1)
Useless	22 (4.9)	6 (1.3)
Very good / beneficial	76 (17.2)	120(26.3)
Good	284 (64.2)	277 (60.7)
e. Wearing shoes/slippers at all times while leaving the house		
Bad/harmful	4 (0.9)	1 (0.2)
Foolish	1(0.9)	0
Useless	0	2 (0.4)
Very good / beneficial	124 (28.0)	130 (28.5)
Good	313 (70.8)	323 (70.8)
f. Wash hands with soap and water every time after defecation.		
Bad/harmful	3 (0.7)	0
Foolish	1 (0.2)	2 (0.4)
Useless	0	0

Very good / beneficial	144 (32.6)	149 (32.7)
Good	294 (66.5)	305 (66.9)
g. A girl should have at least 3 main meals (breakfast, lunch, and dinner) and snacks (after breakfast and in the evening)		
Bad/harmful	3 (0.7)	0
Foolish	2 (0.4)	0
Useless		2 (0.4)
Very good / beneficial	131 (29.6)	190 (41.7)
Good	306 (69.2)	264 (57.9)
h. Get your hemoglobin tested at a health center to check for anemia.		
Bad/harmful	4 (0.9)	0
Foolish	1 (0.2)	0
Useless	7 (1.5)	2 (0.4)
Very good / beneficial	77 (17.4)	153 (33.60)
Good	353 (79.8)	301 (66.0)
Injunctive Norms		
a. My friends think I should eat healthy to avoid diseases like anemia		
Completely disagree	35 (7.9)	8 (1.8)
Agree	271 (61.3)	241 (52.90)
Disagree	17 (3.8)	6 (1.3)
Fully agree	81 (18.3)	197 (43.2)
Neutral	38 (8.6)	4 (0.9)
b. My family thinks I should eat healthy food to avoid diseases like anemia		
Completely disagree	19 (4.3)	5 (1.1)
Agree	304 (68.7)	216 (47.4)
Disagree	10 (2.2)	5 (1.1)
Fully agree	86 (19.5)	229 (50.2)
Neutral	23 (5.2)	1 (1.1)
c. My classmates think I should eat healthy to avoid diseases like anemia		
Completely disagree	11 (2.5)	4 (0.90
Agree	293 (66.3)	219 (48.0)
Disagree	9 (2.0)	3 (0.7)
Fully agree	85 (19.2)	229 (50.2)
Neutral	44 (9.9)	1 (0.2)
d. My teacher thinks I should eat healthy food to avoid diseases like anemia		
Completely disagree	8 (1.8)	3 (0.7)
Agree	292 (66.0)	230 (50.4)
Disagree	12 (2.7)	3 (0.7)
Fully agree	90 (20.3)	216 (47.4)
Neutral	40 (9.0)	4 (0.9)
d. According to the TV programs I watch, I should adopt healthy eating habits to avoid diseases like anemia.		
Completely disagree	7 (1.6)	3 (0.7)
Agree	314 (71.0)	231 (50.70)
disagree	6 (1.3)	2 (0.4)
fully agree	102 (23.0)	218 (47.8)

Neutral	13 (2.9)	2 (0.4)
e. According to the newspapers I read, I should adopt healthy eating habits to protect myself from diseases like anemia.		
Completely disagree	6 (1.3)	3 (0.7)
Agree	288 (65.1)	225 (49.3)
Disagree	7 (1.6)	1 (0.2)
Fully agree	103 (23.3)	226 (49.3)
Neutral	38 (8.6)	1 (0.2)
f. Government officials believe that I should adopt healthy eating habits to protect myself from diseases like anemia.		
completely disagree	5 (1.1)	3 (0.7)
Agree	272 (61.5)	230 (50.4)
disagree	6 (1.3)	1 (0.2)
fully agree	122 (27.6)	221 (48.50)
Neutral	37 (8.4)	1 (0.2)
Intentions		
a. I plan to eat a healthy diet rich in green leafy vegetables and fruits during the next two weeks		
Definitely yes	208 (47.0)	336 (73.7)
Neutral	21 (4.7)	7 (1.5)
No way	10 (2.2)	0
To some extent no		1 (0.2)
Yes to some extent	203 (45.9)	112 (24.6)
b. I plan to take iron folic acid tablets weekly during the next two weeks		
Definitely yes	185 (41.8)	333 (73.0)
Neutral	27 (6.1)	6 (1.3)
No way	17 (3.8)	0
To some extent no	1 (0.2)	1 (0.2)
Yes to some extent	212 (47.9)	116 (25.4)
c. I plan to eat double fortified iodized salt during the next two weeks		
Definitely yes	207 (46.8)	334 (73.2)
Neutral	27 (6.1)	11 (2.4)
No way	15 (3.4)	1 (0.2)
To some extent no	2 (0.4)	1 (0.2)
Yes to some extent	191 (43.2)	109 (23.9)
d. I plan to have at least three main meals and two snacks a day during the next two weeks		
Definitely yes	225 (50.9)	347 (76.1)
Neutral	23 (5.2)	4 (0.9)
No way	17 (3.8)	0
To some extent no	1 (0.2)	2 (0.4)
Yes to some extent	176 (39.8)	103 (22.6)
e. I plan to wash my hands with soap and water every time after defecation		
Definitely yes	292 (66.0)	354 (77.6)
Neutral	17 (3.8)	7 (1.5)
No way	16 (3.6)	1 (0.2)

To some extent no	3 (0.7)	0
Yes to some extent	114 (25.8)	94 (20.6)
f. I plan to wear sandals/chappals every time I step out of the house		
Definitely yes	276 (62.4)	354 (77.6)
Neutral	17 (3.8)	8 (1.8)
no way	18 (4.1)	1 (0.2)
yes to some extent	131 (29.6)	93 (20.4)
g. I plan to take deworming pills every six months		
Definitely yes	182 (41.2)	346 (75.9)
Neutral	23 (5.2)	8 (1.8)
No way	25 (5.6)	0
To some extent no	4 (0.9)	102 (22.4)
Yes to some extent	208 (47.0)	0
h. I plan to get my hemoglobin checked regularly at the health center to check for anemia.		
Definitely yes	179 (40.5)	354 (77.6)
Neutral	39 (8.8)	4 (0.9)
No way	23 (5.2)	1 (0.2)
Yes to some extent	201 (45.5)	97 (21.3)
Perceived behavioural control		
a. Would you make an effort to eat more green leafy vegetables and take weekly iron folic acid tablets during the next two weeks to protect yourself from diseases like anemia?		
Definitely yes	203 (46.0)	352 (77.2)
Neutral	20 (4.5)	4 (0.9)
No way	20 (4.5)	0
Yes to some extent	199 (45.0)	100 (21.9)
b. Do you have enough discipline to eat green leafy vegetables and weekly iron folic acid tablets to protect yourself from diseases like anemia during the next two weeks?		
Definitely yes	186 (42.0)	355 (77.9)
Neutral	26 (5.8)	5 (1.1)
No way	21 (4.7)	0
Yes to some extent	209 (47.3)	95 (20.8)
To some extent no		1 (0.2)
c. Do you have enough time to eat green leafy vegetables and weekly iron folic acid tablets to protect yourself from diseases like anemia during the next two weeks?		
Definitely yes	186 (42.0)	351 (77.0)
Neutral	23 (5.2)	2 (0.4)
No way	17 (3.8)	0
Yes to some extent	216 (48.9)	103 (22.6)

Table 4. Linear and Logistic regression of association between the predictors and the combined score of knowledge, attitude, norms, and the consumption of iron folate tablets among girls at baseline and endline, respectively

Predictors	Knowledge combined β0 (95% CI)	Attitude combined β0 (95% CI)	Norms combined β0 (95% CI)	Consumption of IFA tablets* OR (95% CI)
End line	**16.5 (15.4, 17.6); <0.001**	**10.7 (10.3, 11.1); <0.001**	**7.2 (6.2, 8.2); <0.001**	**1.7 (1.4, 2.0); <0.001**
Baseline	Reference	Reference	Reference	Reference
Age (years)	-0.4 (-0.9, 0.006); 0.05	-0.14 (-0.31, 0.02); 0.10	**0.4 (0.005, 0.8); 0.04**	**0.2 (0.09, 0.3); 0.001**
Cards				
APL	**-2.7 (-5.1, -0.2); 0.03**	0.09 (-0.81, 0.99); 0.84	**-2.8 (-5.0, -0.6); 0.01**	**1.6 (0.9, 2.4); <0.001**
BPL	**-0.3 (-1.9, 1.3); 0.69**	0.57 (-0.01, 1.16); 0.05	-1.0 (-2.4, 0.4); 0.2	**1.7 (1.0, 2.3); <0.001**
None	**7.5 (4.5, 10.6); <0.001**	-0.11 (-1.23, 1.0); 0.84		**1.3 (0.2, 2.4); 0.01**
AAY	Reference	Reference	0.8 (-1.9, 3.6); 0.5	Reference
Annual family income (Rs)	-2.1 *10-5 (-3.0*10-5, -1.2*10-5); <0.001	3.5 *10-6 (2.4*10-6, 6.7*10-6); 0.03	Reference -9.9 *10-6 (18.0*10-6, -1.8*10-6); 0.01	1.9*10-6 (5.6*10-6, 4.4*10-6); 0.1
Education				
5th-8th standard	**3.4 (-1.4, 8,3); 0.16**	**2.6 (0.8, 4.4); 0.004**	**7.7 (3.3, 12.1); 0.001**	-0.04 (-1.5, 1.4); 0.9
9th and above standard	**4.8 (0.06, 9.6); 0.04**	**2.5 (0.7, 4.2); 0.005**	**7.7 (3.4, 12.0); <0.001**	0.08 (-1.4, 1.5); 0.9
1st-4th standard	Reference	Reference	Reference	Reference
R2	50.4%	76.2%	19.7%	

Abbreviations: *APL: Above the Poverty Line; AAY: Antayodya Anna Yojna (Extremely Below-the-Poverty-Line) BPL: Below the Poverty Line; IFA: Iron Folic Acid; R^2: Regression Coefficient; OR: Odds Ratio*

β_0 (95% CI): Beta Coefficient and 95% Confidence Interval

**We applied logistic regression method; p-value <0.05 were highlighted in bold*

Discussion

The present study's findings highlighted the effectiveness of a community-based intervention in improving knowledge, attitudes, norms, and practices related to anemia among adolescents (15-18y) in the Gorakhpur district, Uttar Pradesh. The present study showed a positive shift toward intentions to adopt healthier dietary behaviors and practices among adolescent girls, which is significantly influenced by both injunctive and descriptive norms. The results indicated a significant improvement in healthy eating intentions, perceived behavior control, and social norms related to nutrition and anemia prevention from baseline to endline. Our findings are in congruency with the Theory of Planned Behavior (TPB), which emphasizes the role of attitudes, subjective norms, and perceived behavior in shaping the strength of the intention to achieve healthy behavior.[11]r Evidence suggests the stronger the intention, the more likely an individual is to engage in the behaviour.[12]

Our study showed a significant increase in knowledge and attitude among adolescent girls from baseline to endline. Our results are congruent with the findings from other studies as well. A study conducted in *Madiun,* East Java by Puspitasari *et al.* in 2021 revealed that positive attitudes, subjective norms, perceived behavior control, and intentions have shown a strong relationship with anemia prevention behaviors such as consuming iron-rich foods and taking IFA supplements by adolescent girls.[14] However, Yao did not find any change in the consumption of IFA tablets despite the increase in knowledge and attitude towards anemia and practices.[13] This aligns with our baseline findings where only 32.8% of the adolescent girls had an awareness of iron-rich foods; however, at the end line, the parameters have improved among adolescent girls where the awareness of iron-rich foods had increased to 87.3%. This suggests that tailoring targeted community-based interventions played an important role in addressing the knowledge gaps and influencing behavior change.

However, some evidence suggests that lower-to-moderate level of knowledge, attitude, and practices among

Indonesian adolescent girls were not associated with the prevalence of anemia, which suggests that strategies and interventions should be tailored depending upon the cultural and socio-economic contexts and combined it with improved knowledge, attitude and practices to reduce the prevalence of anemia.[15] The increase in descriptive norms, injunctive norms, and perceived behavioral control in our study are aligned with the findings from behavior change models such as the Theory of Planned Behaviour.[14]

Gender disparities have been a crucial construct of our society with impacts on the nutritional status of the population. They have shaped disparities in access to resources, healthcare, and nutrition among boys and girls. Food insecurity due to socio-cultural norms affected girls from the marginalized sections of society.[16] Prevalent norms prioritized male family members in food distribution. It is established that economic constraints and gendered labor divisions have limited women's ability to access nutrient-rich foods, thereby exacerbating malnutrition and micronutrient deficiencies.[17]Hence, addressing societal norms and gender disparities is crucial in designing community-based interventions aimed at improving the nutrition of the vulnerable sections of society.[18]

The present study has several strengths and limitations as well. One of the key strengths was the implementation of a community-based intervention with the direct involvement of adolescent girls in their own social and cultural contexts to significantly improve knowledge, attitudes, and practices on anemia prevention. Moreover, the study assessed the changes in social norms, perceived behavior control, and intentions, providing a complete insight into behavior change dynamics. Nonetheless, this study has some limitations. The present study did not include the control group for comparison, making it difficult to attribute all observed improvements in the study. The study was conducted for a short duration, nearly 6 months, which further limits the potential for the long-term sustainability of the behavioral changes.

Conclusions

Our study demonstrated that community-based approaches could be an effective approach to promoting awareness and changing attitudes and practices among younger generations. The significant improvements in knowledge, attitude, norms, and practices were in alignment with the need for multi-faceted, community-driven interventions in addressing anemia among adolescent girls. Future interventions should continue to address social norms, peer influence, and behavior change strategies to sustain positive outcomes.

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Conflict of Interests

None

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