AIMS Medical Science

AIMS Medical Science, 13(3): 187–201.
DOI: 10.3934/medsci.2026013
Received: 29 August 2025
Revised: 10 July 2026
Accepted: 31 July 2026
Published: 12 August 2026

http://www.aimspress.com/journal/medicalScience

Research article

Bridging knowledge and nutrition: Improving maternal hemoglobin levels and dietary practices through structured education at Al Sabeen maternal hospital in Sana'a, Yemen

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Abstract: Anemia in pregnancy is a significant global health challenge, especially in low-resource settings, where it contributes to adverse maternal and neonatal outcomes. Nutrition education is widely recognized as an effective approach to improving dietary behaviors and reducing the prevalence of anemia among pregnant women. *Objective:* To evaluate the effect of a structured nutrition education program on hemoglobin levels, body mass index (BMI), dietary knowledge, and practices among pregnant women attending Al Sabeen Maternal Hospital in Sana'a, Yemen. *Methods:* A quasi-experimental study was conducted utilizing a purposive sampling from November 2024 to June 2025 among second-trimester pregnant women, with 58 participants allocated to the intervention group receiving structured nutrition education and dietary counseling, and 56 participants assigned to the control group receiving routine antenatal care. Data was collected at baseline and post-intervention to evaluate the hemoglobin levels, BMI, dietary knowledge, and practices. *Results:* The intervention group demonstrated a significant increase in hemoglobin levels ($p = 0.001$), while the control group showed only a minor, non-significant change ($p = 0.021$). BMI in the intervention group increased from 22.92 ± 3.58 to 24.54 ± 3.71, compared to a smaller rise in the control group from 23.39 ± 4.07 to 24.54 ± 3.64. Dietary knowledge improved from 10.7% to 63.8% in the intervention group versus 12.5% to 17.9% in the control group ($p < 0.001$). Similarly, adherence to iron-rich foods and supplementation significantly increased in the intervention group (24-hour dietary practice seven-day practice) with minimal change in the control group. *Conclusion:* Nutrition education significantly enhances maternal dietary knowledge, behaviors, and health outcomes. Integrating structured nutrition education into routine antenatal care is recommended to reduce anemia prevalence and improve pregnancy outcomes. Expanding community-based programs and digital health strategies can further strengthen adherence and sustainability. Future research should examine the long-term effects on both maternal and infant health.

Keywords: knowledge; nutrition; maternal; dietary; education

1. Introduction

Anemia is a critical global health concern, particularly among pregnant women, as it adversely impacts both maternal and fetal health. It is characterized by reduced hemoglobin levels, which can result in fatigue, weakness, and increased susceptibility to infections. Iron deficiency anemia (IDA) is the most prevalent form, accounting for nearly 80% of cases worldwide [1]. Other contributing factors include deficiencies in folate and vitamin B12, as well as infections such as malaria and hookworm [2]. Pregnant women are especially vulnerable due to increased iron requirements associated with fetal growth and maternal blood volume expansion [3].

During pregnancy, anemia is associated with serious complications, including maternal hemorrhage, preterm labor, and low birth weight, with long-term consequences for child health [4]. To address these risks, the World Health Organization (WHO) recommends iron–folic acid supplementation (IFAS) alongside nutrition education, aligning with global strategies to reduce anemia prevalence [2,5]. Nevertheless, in resource-limited settings such as Yemen, where food insecurity and healthcare barriers are common, anemia remains highly prevalent. Recent estimates suggest that anemia affects 36% of pregnant women in Yemen [6], with previous studies reporting rates between 26.5% and 81% [7]. In Sanaa City, one study reported a prevalence of 25%, with 70.83% of cases classified as mild, 28.13% as moderate, and 1.04% as severe [8]. Risk factors include limited maternal health knowledge, inadequate dietary intake, and cultural practices that impair iron absorption, such as khat chewing and frequent tea consumption [9].

Nutrition education has been shown to be an effective strategy for anemia prevention, as it improves maternal dietary knowledge, promotes adherence to iron supplementation, and enhances pregnancy outcomes [10]. Evidence from Ethiopia and Sudan highlights that structured nutrition counseling combined with the use of locally available iron-rich foods can reduce anemia prevalence and improve hemoglobin levels [11,12]. Similar findings from Indonesia and India demonstrated improvements in maternal dietary practices and significant reductions in anemia rates [4,13]. Despite this global evidence, research examining the impact of nutrition education on maternal health outcomes in Yemen remains limited.

The ongoing conflict in Yemen has further exacerbated maternal health challenges, with more than 50% of healthcare facilities damaged or destroyed [6]. Evidence from conflict-affected countries indicates that integrating nutrition education into maternal healthcare services can enhance maternal nutrition, reduce pregnancy-related complications, and improve overall health outcomes [1,14]. Given the high prevalence of anemia among pregnant women in Yemen, this study seeks to evaluate the impact of nutrition education on dietary knowledge, practices, and hemoglobin levels. The findings are expected to provide evidence-based recommendations to incorporate structured nutrition education into antenatal care in Yemen, thus contributing to improved maternal health and reduced anemia prevalence.

1.1. Study aim and hypothesis

The present study aimed to evaluate the effect of a structured nutrition education program on maternal hemoglobin levels, body mass index (BMI), dietary knowledge, and dietary practices among pregnant women attending Al Sabeen Maternal Hospital (SMH) in Sana'a, Yemen. It was hypothesized that pregnant women who received structured nutrition education and dietary counseling would demonstrate significantly greater improvements in hemoglobin levels, BMI, dietary knowledge, and dietary practices than those receiving routine antenatal care.

This study employed a quasi-experimental, nonequivalent control group (Two-groups) design to evaluate the impact of nutrition education on dietary knowledge, practices, and hemoglobin levels among pregnant women. The study was conducted at SMH in Sanaa City, Yemen, a major maternal healthcare facility that provides comprehensive antenatal, delivery, and postnatal care services. The hospital serves a diverse population from both urban and rural areas, thus ensuring a representative sample.

Participants were recruited between November 2024 to June 2025, with baseline data collected at enrollment and end-line data after ten weeks of intervention. Pregnant women were assigned to either the intervention group that received structured nutrition education and a diet plan or the control group that only received general health education. This setting facilitated accessibility for participants and ensured continuity of care throughout the study period (Figure 1).

1.2. Study population and sampling

The study targeted pregnant women aged 18–45 years in their second trimester (gestational age 13–28 weeks) attending antenatal care (ANC) visits at SMH and diagnosed with mild to moderate anemia (hemoglobin < 11 g/dL). Eligible participants had no chronic illnesses such as kidney or liver disease, diabetes, or hypertension, no gastrointestinal disorders including inflammatory bowel disease or celiac disease, and no blood disorders such as sickle cell anemia or thalassemia. Women with multiple pregnancies, pregnancy complications, prior participation in a nutrition education intervention within the past two months, or inability to attend scheduled follow-up sessions were excluded.

The required sample size was calculated based on a previous study by Otoo and Adam [15], thereby accounting for a 10% non-response rate and 20% potential loss to follow-up, resulting in 114 participants (58 intervention, 56 control). The sample size calculation was performed using STATA, version 13.0, at a 5% significance level and 90% power. A convenience sampling approach was employed to recruit participants daily from ANC outpatient clinics. Eligible women were consecutively enrolled and allocated to intervention and control groups based on the availability and eligibility, thus ensuring representation from both urban and rural populations.

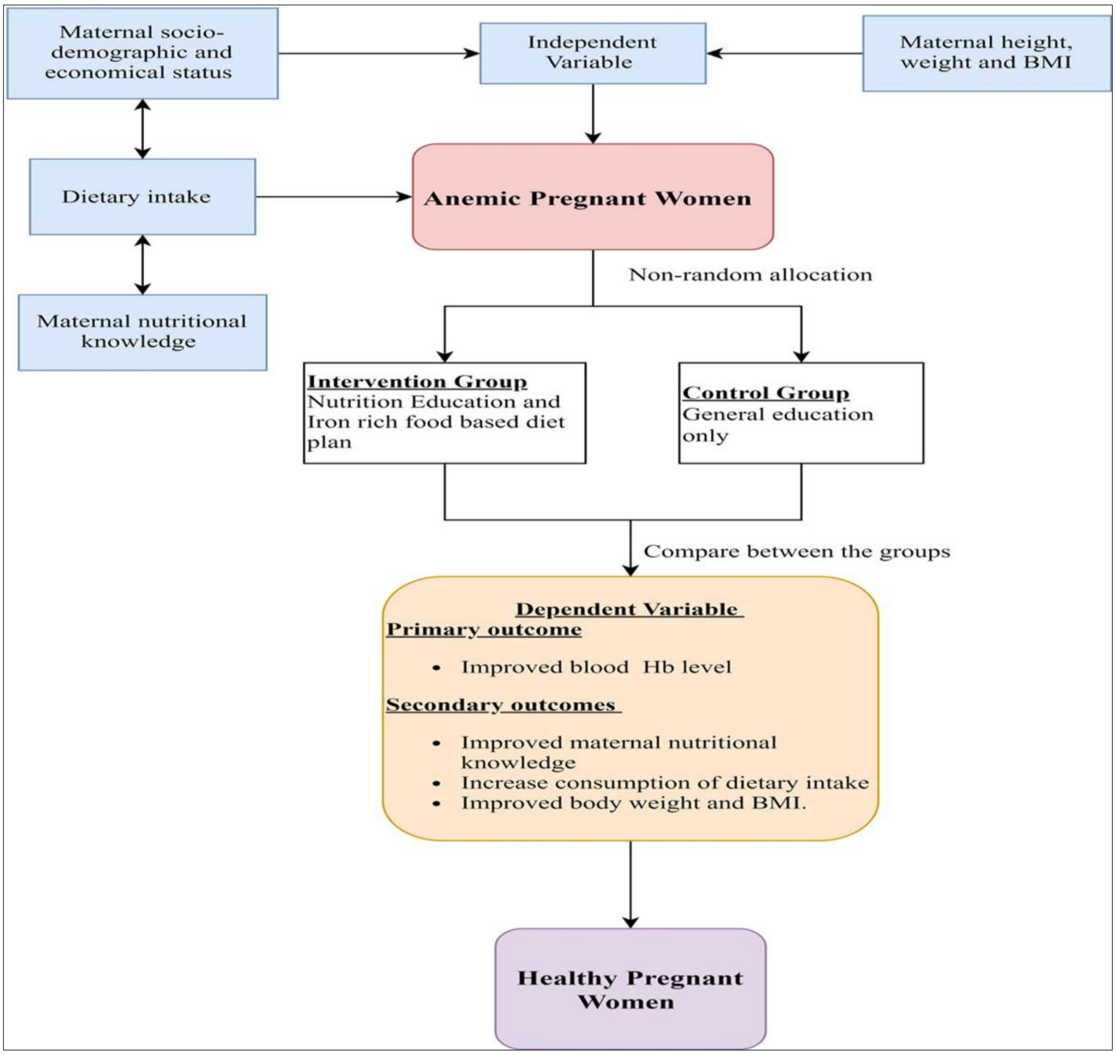

Figure 1. Conceptual framework of the study.

2. Materials and methods

2.1. Data collection and intervention

Data collection was conducted from November 2024 to June 2025 after obtaining written informed consent from all participants. Baseline data were collected using a semi-structured questionnaire covering socio-demographic characteristics, obstetric history, ANC service utilization, dietary knowledge and practices (assessed via 24-hour and 7-day food frequency recall), anthropometric measurements (height, weight, and BMI), and hemoglobin levels. Dietary knowledge was assessed using a researcher-developed questionnaire based on the WHO recommendations and relevant literature on maternal nutrition and anemia prevention. Each correct response was assigned one point, while incorrect or "don't know" responses received zero points. The total score was converted into a percentage, and participants who scored ≥60% were classified as having good dietary knowledge, whereas those who scored <60% were classified as having poor dietary knowledge. Because pre-pregnancy body weight was not collected, gestational weight gain (GWG) could not be calculated. Therefore, BMI was used as the anthropometric indicator to assess maternal nutritional status throughout the study. End-line data were collected after ten weeks of intervention.

The intervention group received two structured nutrition education counselling sessions and a personalized iron-rich food-based diet plan, while the control group only received general health education. Nutrition education sessions were delivered by a research team member using materials adapted from previous studies [11,16,17] and translated into Arabic. The nutrition education program was developed based on WHO recommendations and a review of previous nutrition education interventions targeting pregnant women with anemia. The program was structured by the research team to address maternal nutrition and anemia prevention, including anemia definition, symptoms, causes, consequences, risk factors, prevention strategies, iron-rich food sources, factors affecting iron absorption, and recommended dietary practices during pregnancy. The educational materials were reviewed by experts in maternal health and nutrition to ensure content validity and cultural appropriateness before implementation. The control group received general education on hygiene, sanitation, rest, exercise, and pregnancy danger signs. Each counselling session lasted approximately one hour at enrollment, followed by biweekly phone calls (3–5 minutes) and monthly ANC follow-ups to reinforce key messages.

A personalized diet plan was developed for each participant in the intervention group using food exchange principles and standardized portion size recommendations routinely adopted by the Dietary Department of SMH. The food exchange list included major food groups (cereals, vegetables, fruits, milk and dairy products, meat and meat alternatives, and fats), with standardized serving sizes used to individualize meal plans according to the participant's nutritional requirements. The dietary counselling emphasized the consumption of iron-rich foods (e.g., red meat, liver, poultry, fish, legumes, dark green leafy vegetables, and iron-fortified cereals), vitamin C-rich foods to enhance iron absorption, and the avoidance of tea and coffee immediately after meals to reduce iron absorption. Meals were individualized according to each participant's nutritional requirements and structured into five daily portions (breakfast, lunch, snack, dinner, and bedtime snack). The total energy requirements were calculated using the Harris–Benedict equation with an additional 300–350 kcal/day to meet pregnancy needs. Dietary adherence was monitored every four weeks during ANC visits and telephone follow-ups using the same structured dietary assessment tools employed in the study, including the 24-hour dietary recall and the 7-day food frequency questionnaire, to evaluate the participant's compliance with the recommended dietary plan. The participants were purposively allocated to the intervention or control group based on the day of their ANC visit, with odd days allocated to the intervention group and even days to the control group.

2.2. Pilot study, validity and reliability

A pilot study was conducted with 10% of the intended sample to evaluate the feasibility of the intervention, identify potential challenges in data collection, and refine the study questionnaire. The questionnaire's face and content validity were confirmed through expert review by nutritionists and epidemiologists, thus ensuring it accurately captured the intended outcomes. Reliability testing using Cronbach's alpha yielded coefficients of 0.78 for dietary knowledge and 0.80 for dietary practices, indicating strong internal consistency. The participants involved in the pilot study were excluded from the final analysis to avoid potential bias.

2.3. Outcome measures

The primary outcome of the study was the change in maternal hemoglobin concentration, measured through blood tests at baseline and end-line. Additional primary outcomes included changes in maternal BMI. Secondary outcomes focused on changes in dietary knowledge and dietary practices, which were assessed using a researcher-developed questionnaire at baseline and end-line in both the intervention and control groups.

2.4. Statistical analysis

Data analyses were performed using the SPSS statistical software package. Descriptive statistics summarized the participant's demographic characteristics, including age, education level, income, and parity. Continuous variables were reported as means with standard deviations, while categorical variables were expressed as frequencies and percentages. The chi-square test was used to assess associations between the intervention and anemia prevalence by comparing the proportions of anemic women before and after the intervention. Additional analyses, including paired t-tests or independent t-tests, were applied as appropriate to evaluate changes in continuous outcomes such as hemoglobin levels, BMI, dietary knowledge, and dietary practices, with a significance level set at $p < 0.05$.

3. Results

3.1. Baseline socio-demographic characteristics of pregnant women

The intervention and control groups were largely comparable in socio-demographic characteristics, thus minimizing the potential influence of pre-existing differences on study outcomes. The mean age was slightly lower in the intervention group (26 ± 6 years) compared to the control group (28 ± 6 years, $p = 0.006$), though this minor difference was unlikely to affect the results. No significant differences were observed between groups in education, employment, marital status, or family income ($p > 0.05$). A higher proportion of husbands in the intervention group held a bachelor's degree or higher compared to the control group (58.6% vs. 35.7%, $p = 0.040$), while other socio-economic factors showed no significant variation (Table 1).

Table 1. Baseline socio-demographic characteristics of intervention and control groups (n = 114).

Variables			Groups				P-value
			Control (56)		Intervention (58)		
			F	%	F	%	
Age (year) *mean* ± *SD*			28 ± 6		26 ± 6		0.006
Mother education	•	Illiterate	2	3.6	0	0.0	0.098
	•	Primary education	22	39.3	14	24.1	
	•	Secondary education	19	33.9	22	37.9	
	•	Bachelor and above	13	23.2	22	37.9	
Mother occupation	•	Employe	5	8.9	7	12.1	0.861
	•	Housewife	46	82.1	46	79.3	
	•	Student	5	8.9	5	8.6	
Marital status	•	Married	55	98.2	53	91.4	0.224
	•	Separate	1	1.8	5	8.6	
Husband's education	•	Illiterate	0	0	0	0	0.040
	•	Primary education	15	26.8	8	13.8	
	•	Secondary education	21	37.5	16	27.6	
	•	Batchelor and above	20	35.7	34	58.6	
Husband's occupation	•	Employee	32	57.1	44	75.9	0.054
	•	Non-employee	24	42.9	14	24.1	
Family monthly income	•	Hight	1	1.8	6	10.3	0.064
	•	Moderate	38	67.9	47	81	
	•	Low	17	30.4	5	8.6	

3.2. Obstetric histories of pregnant women

The intervention and control groups were comparable in baseline obstetric characteristics, with no statistically significant differences observed in gestational age, gravidity, parity, number of live births, or age of the youngest child (all $p > 0.05$), thus indicating similar baseline obstetric profiles between the two groups (Table 2).

3.3. Utilization of antenatal care (ANC) services

Baseline ANC utilization was comparable between the intervention and control groups, with no statistically significant differences in ANC attendance, regular check-ups, iron–folic acid supplementation, folic acid intake, or reported barriers to supplementation (all $p > 0.05$), thus indicating similar baseline utilization of maternal health services (Table 3).

3.4. Hemoglobin (Hb) level among pregnant women in control and intervention groups

Baseline hemoglobin (Hb) levels were comparable between the intervention and control groups. Following the ten-week nutrition education program, the intervention group demonstrated a significant improvement in Hb levels compared with the control group, while only a modest change was observed in the control group (Table 4).

Table 2. Obstetric history of participants in intervention and control groups at baseline (n = 114).

Variables		Groups				P-value
		Control (56)		Intervention (58)		
		F	%	F	%	
Base line gestational age(weeks) *mean* ± *SD*		21.06 ± 4.74		21.32 ± 4.89		0.244
Gravidity	Primigravida	12	21.4	20	34.5	0.179
	Multigravida	44	78.6	38	65.5	
Parity	1	17	30.4	16	27.6	0.903
	2–4	23	41.1	18	31	
	>4	4	7.1	4	6.9	
Number of live births	1	15	26.8	16	27.6	0.761
	2–4	21	37.5	17	29.3	
	>4	3	5.4	4	6.9	
Age of youngest child (Years)	1–2	13	23.2	12	20.7	0.281
	3–4	10	17.9	14	24.1	
	>4	19	33.9	11	19	

Table 3. Utilization of antenatal care (ANC) services among participants in intervention and control groups at baseline (n = 114).

Variables		Groups				P-value
		Control (56)		Intervention (58)		
		F	%	F	%	
Attended the health center during this pregnancy	Yes	43	76.8	45	77.6	1.000
Regular antenatal check-ups	First time	21	37.5	18	31	0.901
	2	10	17.9	11	19	
	3	11	19.6	12	20.7	
	4 or more	14	25	17	29.3	
Given iron/folic acid during pregnancy	Yes	47	83.9	51	87.9	0.7298
Take folic acid yesterday	Yes	30	53.6	33	56.9	1.0000
If the answer is no, what are the reasons?	I didn’t have the tablets.	4	7.1	4	6.9	0.9970
	Because of the side effects	5	8.9	6	10.3	
	Negligence	6	10.7	7	12.1	
	I am not anemic.	1	1.8	1	1.7	

Table 4. Comparison of blood hemoglobin (Hb) levels among pregnant women in control and intervention groups at baseline and endline after educational intervention (n = 114).

Blood Hb level gm/dl	Control (56)	Intervention (58)	P-value
	mean ± SD	mean ± SD	
Baseline	10.23 ± 0.63	10.22 ± 0.65	0.901
End line	10.57 ± 1.17	11.36 ± 0.97	0.000
P-value	0.021	0.001	

3.5. Body mass index of pregnant women in control and intervention groups (n = 114).

BMI changed over the study period in both groups. However, the participants in the intervention group demonstrated greater improvements than those in the control group, thus indicating a more favorable anthropometric outcome following the nutrition education program (Table 5).

Table 5. Comparison of BMI levels among pregnant women in control and intervention groups at baseline and endline after educational intervention.

Mean of BMI		Control (56)	Intervention (58)	P-value
		mean ± SD	mean ± SD	
BMI	Baseline	23.39 ± 4.07	22.92 ± 3.58	0.016
	End line	24.54 ± 3.64	24.54 ± 3.71	0.012
	P-value	0.0169	0.003	

3.6. Overall dietary knowledge level about anemia among pregnant women in intervention and control groups before and after the educational program (n = 114).

Baseline overall dietary knowledge was comparable between the intervention and control groups. Following the nutrition education program, the participants in the intervention group demonstrated a marked improvement in dietary knowledge compared with the control group, thus indicating the effectiveness of the intervention (Table 6).

Table 6. Comparison of overall knowledge level about anemia among pregnant women in intervention and control groups before and after the educational program (n = 114).

Overall level of knowledge	Control (56)	Intervention (58)	P-value
	mean ± SD	mean ± SD	
Baseline	9.80 ± 4.39	10.83 ± 4.56	0.222
End line	10.61 ± 4.01	24.27 ± 10.10	0.000
P-value	0.310	0.000	

3.7. Overall dietary level about anemia among pregnant women in intervention and control groups before and after the educational program

Baseline dietary practices, assessed using both the 24-hour dietary recall and the seven-day food frequency questionnaire, were comparable between the intervention and control groups. Following the ten-week nutrition education program, the intervention group demonstrated significant improvements in dietary practices, whereas no meaningful changes were observed in the control group (Table 7).

Table 7. Comparison of overall dietary practices level about anemia among pregnant women in intervention and control groups before and after the educational program (n = 114).

Overall level of practices	Control (56)	Intervention (58)	P-value
	% of "Correct" answers	% of "Correct" answers	
24-hour food frequency questionnaire			
Baseline	49.28%	50.50%	0.955
End line	49.46%	62.07%	0.261
p-value	0.984	0.209	
Seven-day food frequency questionnaire			
Baseline	58.94%	59.69%	0.887
End line	59.28%	79.82%	0.041
p-value	0.970	0.018	

4. Discussion

Maternal nutrition is a crucial determinant of pregnancy outcomes, influencing both maternal health and fetal development. IDA remains a significant public health concern, contributing to complications such as preterm birth, low birth weight, and increased maternal morbidity. This study demonstrates that nutrition education, combined with an iron-rich diet plan, significantly improved the hemoglobin levels, BMI, dietary knowledge, and dietary practices among pregnant women. These findings align with global research supporting structured nutrition education as an effective intervention to reduce anemia risk and promoting healthier pregnancy outcomes [11,12,16].

The impact of nutrition education on hemoglobin levels was evident in this study, with a significant improvement observed in the intervention group compared to the control group. This finding is consistent with previous research indicating that structured dietary counseling enhances hemoglobin levels and reduces anemia prevalence [11,18]. Similar studies in Nepal, Ethiopia, and Ghana have reported that trimester-based nutrition education, combined with mobile-assisted follow-ups, significantly improved iron-rich diet adherence and supplementation practices [15,19,20]. However, some studies suggest that education alone may not be sufficient, thereby emphasizing the need for complementary interventions such as micronutrient supplementation and food fortification [21,22].

In addition to hemoglobin levels, BMI and maternal nutritional status significantly improved among women in the intervention group, thus confirming the effectiveness of nutrition education in promoting healthy weight gain. These findings are supported by studies in Indonesia, Côte d'Ivoire, and Egypt, where structured education led to improved dietary intake and maternal weight gain [23–25]. Additionally, research has highlighted the role of community-based and mobile-assisted interventions in optimizing maternal dietary intake, thereby reinforcing the importance of accessible, tailored education programs [4,13].

The study also revealed a significant increase in dietary knowledge among pregnant women in the intervention group, particularly regarding anemia prevention, iron-rich foods, and supplementation adherence. These results mirror findings from Ghana, Ethiopia, and Côte d'Ivoire, where structured education programs led to substantial improvements in anemia-related knowledge [11,23,26]. Additionally, digital and multimedia-based education has been shown to be highly effective in enhancing maternal nutritional awareness, as demonstrated in studies from Egypt and Indonesia [27,28]. Additionally, the use of mobile health strategies, including text messaging and app-based interventions, has been recognized as a practical approach to improving dietary adherence and knowledge retention [29,30].

Beyond knowledge improvement, dietary practices significantly improved in the intervention group, with increased consumption of iron-rich foods, vitamin C-rich foods, and overall dietary diversity. These findings are consistent with studies from Nepal, Ethiopia, and China, where nutrition education led to long-term changes in dietary behavior [16,17,31]. Research has shown that structured nutrition education enhances dietary compliance and increases the intake of essential micronutrients, particularly when combined with community-based interventions [32,33].

Despite the positive outcomes, challenges remain, particularly low adherence to dietary recommendations and supplementation. Studies from India and Indonesia suggest that integrating nutrition counseling into routine antenatal care and employing mobile-based strategies could enhance compliance and encourage sustained dietary improvements [13,29]. Moreover, research from Burkina Faso and Niger has demonstrated that community-led interventions significantly improved maternal dietary adherence and anemia prevention, thus highlighting the importance of culturally adapted strategies [32,34].

While this study provides strong evidence of the effectiveness of nutrition education, several limitations should be acknowledged. The sample size was relatively small, which may limit the generalizability of the findings. Additionally, reliance on self-reported dietary adherence may introduce bias, as compliance with dietary recommendations and supplementation was not objectively verified. Furthermore, this study did not differentiate between various types of anemia, such as iron deficiency anemia, genetic anemia, or infectious anemia, thus limiting a more comprehensive analysis of anemia causes. Moreover, pre-pregnancy body weight was not collected, preventing the calculation of GWG. Consequently, BMI was used as the available anthropometric indicator to monitor maternal nutritional status during the study. Future studies should collect pre-pregnancy anthropometric data to enable assessment of GWG according to established pregnancy guidelines and should consider larger randomized controlled trials (RCTs) with longer follow-up periods to evaluate the sustainability of nutrition education on maternal and infant health outcomes.

In addition, some potential confounding variables, such as socioeconomic status, underlying nutritional conditions, and other lifestyle-related factors, were not fully assessed, which may have influenced the observed outcomes. Future studies should consider controlling these variables to provide more robust estimates of the intervention effect.

5. Conclusion

This study highlights the effectiveness of structured nutrition education programs in antenatal care, thereby demonstrating significant improvements in maternal hemoglobin levels, BMI, dietary knowledge, and dietary practices. To maximize impact, future interventions should integrate digital education tools, community-based engagement, and culturally tailored approaches to enhance maternal nutritional awareness and adherence. Expanding access to mobile health applications, social support programs, and multi-sectoral collaboration can further reduce anemia prevalence and improve pregnancy outcomes in low-resource settings. These findings provide evidence for policymakers and healthcare providers to incorporate structured nutrition education into routine maternal health services, thus ultimately supporting healthier pregnancies and long-term maternal and child health.

Author contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

Use of AI tools declaration

The authors declare they have not used Artificial Intelligence (AI) tools in the creation of this article.

Ethics approval and consent to participate

The study received ethical clearance from the Ethics Committee for Research at Al-Razi University (7/2024; Ref: RU/17/FMHS/2024) and administrative approval from SMH. Aim of the study was clarified to the participants. A written informed consent was obtained from all participants before data collection with the ability to withdraw from the study neither penalty nor award. The authors granted that all data were kept confidentially. Routine antenatal care was ensured for all, with the intervention group receiving additional nutrition education. It was conducted in line with the Declaration of Helsinki.

Acknowledgments

The authors would like to express their sincere gratitude to all individuals who contributed to the successful completion of this research. Special thanks are extended to all participants for their valuable cooperation and willingness to participate in this study.

Data availability statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.

Conflicts of interest

The authors declare no conflicts of interest.

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