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Effectiveness of Health Education and Short Message Service Reminders Reminders on Iron Supplement Adherence among Pregnant Women

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ABSTRACT

Purpose of the study: This study aimed to evaluate effectiveness structured health professional led education embedded within routine antenatal care in enhancing iron supplement adherence among pregnant women.

Methodology: A quasi-experimental pretest–posttest control group design conducted among 120 pregnant women at Masis Maternity Hospital. Participants allocated to intervention group receiving structured professional-led education with reinforcement or a control group receiving routine care. Primary outcome was iron supplement adherence (≥80% consumption), while secondary outcomes included knowledge score and hemoglobin level changes over 8 weeks. Data analyzed using chi-square tests, independent and paired t-tests, and logistic regression.

Main Findings: After 8 weeks, adherence significantly increased to 81.0% in intervention group compared with 51.7% in control group ($p < 0.001$). The intervention group was nearly five times more likely to achieve adequate adherence (AOR = 4.83; 95% CI: 2.01–11.61). Knowledge scores improved by +5.27 points in the intervention group versus +1.78 in controls ($p < 0.001$). Hemoglobin levels increased by 0.86 g/dL in intervention group compared to 0.32 g/dL control group ($p < 0.001$).

Novelty/Originality of this study: This study advances maternal health practice by reframing health education as a structured, professionally embedded care model rather than a single counseling encounter, demonstrating measurable behavioral and clinical impact within routine antenatal services.

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1. INTRODUCTION

Maternal health remains critical priority within global public health agendas, particularly in preventing avoidable maternal morbidity and mortality. Despite substantial progress in antenatal coverage, nutritional deficiencies during pregnancy continue to undermine maternal and neonatal outcomes [1]-[3]. Iron deficiency anemia remains the most prevalent micronutrient disorder in pregnancy worldwide and is strongly associated with increased risks of hemorrhage, infection, low birth weight, preterm birth, and perinatal mortality [4]-[6]. Although iron supplementation has long been embedded within routine antenatal care as a cost-effective preventive strategy, its population-level impact is highly dependent on consistent adherence [7], [8]. Thus,

improving adherence to iron supplementation represents not merely a behavioral issue, but a systemic challenge within maternal healthcare delivery.

Global estimates indicate that a considerable proportion of pregnant women fail to consume iron supplements according to recommended duration and dosage standards set by the world health organization [9]-[11]. Evidence from multi-country analyses demonstrates that non-adherence remains pervasive, even in settings where iron tablets are freely distributed through antenatal services [12]-[14]. Barriers commonly reported include limited understanding of anemia risks, misconceptions about supplementation benefits, fear of side effects, forgetfulness, and inadequate counseling during antenatal visits [15]-[17]. These findings suggest that improving access alone is insufficient; instead, strengthening the quality and continuity of professional-led education within routine maternal care is essential to achieving meaningful behavioral change.

Health professional–led education has been recognized as a cornerstone of maternal nutrition programs [18]-[20]. Structured counseling delivered by midwives, nurses, and primary care providers plays a pivotal role in shaping pregnant women's knowledge, attitudes, and health behaviors [21]-[23]. Studies consistently show that education improves awareness regarding the importance of iron supplementation and anemia prevention. However, Kim & Kim [24] it also shows that increased knowledge does not automatically translate into sustained compliance. Behavioral relapse, particularly due to forgetfulness and unmanaged side effects, frequently diminishes the long-term effectiveness of educational interventions when they are not reinforced over time [25]-[27].

Behavioral science frameworks further explain this phenomenon, emphasizing that adherence is influenced by both cognitive determinants (Knowledge and beliefs) and practical determinants (Habit formation and cues to action) [28]-[30]. Education alone primarily targets cognitive components but may not sufficiently address routine-related barriers such as daily recall [31]-[33]. Consequently, Morgenstern et al. [34] explaining even well-designed counseling sessions may yield only short-term improvements if ongoing reinforcement mechanisms are absent. This gap underscores the need to re-conceptualize health education not as a single encounter, but as a continuous, professionally guided process embedded within antenatal care pathways.

Recent advancements in digital health technologies offer promising opportunities to complement traditional education strategies [35]-[37]. Mobile phone–based reminder systems, particularly short message service (SMS) notifications, have demonstrated effectiveness in improving medication adherence across various health conditions [38], [39]. In maternal health contexts, reminder systems have been shown to reduce missed doses of iron supplements and enhance self-reported compliance. Nevertheless, many digital interventions operate independently of structured professional counseling, potentially limiting their contextual relevance and integration into routine care workflows.

A critical gap in the literature lies in the limited evaluation of integrated models that combine structured health professional–led education with systematic digital reinforcement. Studies Linn et al. [40] examine either educational counseling or SMS reminders as standalone interventions, resulting in fragmented evidence regarding their synergistic potential. Furthermore, few investigations explicitly position health professionals as central agents who deliver, monitor, and reinforce adherence strategies within routine maternal services [41], [42]. This lack of integration constrains scalability and weakens translation into everyday clinical practice.

Embedding reinforcement mechanisms within professional practice may enhance sustainability and scalability of adherence interventions. When education is delivered by trained health professionals and supported by structured reminder systems, pregnant women receive both cognitive empowerment and practical cues for consistent supplement intake. Such integration aligns with contemporary models of patient-centered care and task optimization in primary healthcare. By situating adherence support within routine antenatal visits, the intervention becomes part of standard professional responsibilities rather than an external add-on program.

Therefore, this study to evaluate effectiveness of enhancing iron supplement adherence through structured health professional–led education within routine maternal care. Specifically, the research seeks to determine whether a reinforced educational approach improves adherence outcomes compared to standard antenatal practices. The novelty of this study lies in reframing education as sustained professional practice model rather than a one-time information session, thereby addressing both cognitive and behavioral determinants of adherence. By generating empirical evidence on this integrated approach, the study contributes to strengthening general health professional practice and advancing sustainable strategies to reduce anemia during pregnancy.

2. RESEARCH METHOD

2.1 Study Design and Setting

This study employed a study employed quasi-experimental pretest–posttest control group design to evaluate the effectiveness health professional–led education in enhancing iron supplement adherence among pregnant women. The design was selected to allow comparison between an intervention group receiving structured educational reinforcement and a control group receiving routine antenatal care [43], [44]. Quasi-

experimental pretest–posttest control group design to evaluate the effectiveness of health professional–led education in enhancing iron supplement adherence among pregnant women. The design was selected to allow comparison between an intervention group receiving structured educational reinforcement and a control group receiving routine antenatal care [45], [46].

The research was conducted at Masis Maternity Hospital, a secondary-level maternal healthcare facility providing comprehensive antenatal services. The hospital was selected because it serves a diverse population of pregnant women from both urban and peri-urban communities and routinely implements iron supplementation according to national maternal health guidelines. The study was carried out over a four-month period, ensuring adequate follow-up time to assess changes in adherence behavior.

2.1 Subjec Research

Pregnant women attending antenatal care (ANC) services during the study period were screened for eligibility. Inclusion criteria were: (1) confirmed pregnancy in the second trimester (gestational age 13–28 weeks), (2) prescription of daily oral iron supplementation, (3) ownership of a mobile phone for communication purposes, and (4) willingness to provide informed consent. Women with high-risk pregnancies requiring specialized management, diagnosed hematologic disorders other than iron deficiency anemia, or cognitive impairments affecting communication were excluded.

A minimum sample size was calculated using power analysis for detecting moderate effect sizes (power 80%, $\alpha = 0.05$), resulting in a required total of 100 participants. To account for potential attrition, 120 pregnant women were recruited and equally allocated into intervention (n = 60) and control (n = 60) groups using systematic allocation based on clinic visit schedules. Baseline demographic and obstetric characteristics were collected to ensure comparability between groups [47]. Before presenting the baseline characteristics, Table 1 summarizes the sociodemographic and clinical profiles of participants in both groups.

Table 1. Baseline Characteristic of participants

Variable	Intervention	Control	p-value
Mean age (years)	27.8 ± 4.6	28.1 ± 5.1	0.72
Gestational age (weeks)	20.4 ± 3.2	21.1 ± 3.5	0.31
Primigravida (%)	46.7	50.0	0.68
Secondary education or higher (%)	73.3	70.0	0.67
Baseline hemoglobin (g/dL)	10.9 ± 0.8	11.0 ± 0.9	0.59

The intervention consisted of structured health professional–led education delivered by trained midwives during routine ANC visits. The educational session lasted approximately 30–40 minutes and followed a standardized module covering:

1. Causes and consequences of iron deficiency anemia during pregnancy
2. Benefits of consistent iron supplementation
3. Management of common side effects
4. Strategies for daily adherence and habit formation

Educational delivery emphasized interactive counseling, visual aids, and personalized problem-solving. Participants also received a printed educational leaflet summarizing key messages. In addition to the initial session, reinforcement counseling was provided briefly (10–15 minutes) during subsequent ANC visits to strengthen adherence motivation and address barriers. This structured reinforcement model aimed to embed adherence support into routine maternal care rather than providing a one-time educational exposure.

The control group received standard antenatal care, including routine verbal advice regarding iron supplementation without structured educational modules.

2.3 Outcome Measures

The primary outcome was iron supplement adherence, measured using a validated self-reported adherence questionnaire combined with pill count verification during follow-up visits. Adherence was operationalized as consumption of ≥80% of prescribed tablets over the observation period.

Secondary outcomes included change in knowledge score regarding iron supplementation and change in hemoglobin level (g/dL) from baseline to 8-week follow-up

The knowledge questionnaire consisted of 15 multiple-choice items (score range 0–15), previously tested for reliability (Cronbach's alpha = 0.87). Hemoglobin levels were measured using standardized laboratory procedures within the hospital laboratory. Table 2 presents the operational definitions of study variables.

Table 2. Operational Definitions of Study Variables

Variable	Definition	Measurement Method	Scale
Iron supplement adherence	≥80% of tablets consumed	Questionnaire + pill count	Dichotomous
Knowledge score	Correct responses to 15 items	Structured questionnaire	Continuous
Hemoglobin level	Concentration of Hb in blood	Laboratory analysis	Continuous

These measures ensured both behavioral and clinical dimensions of adherence were evaluated.

2.4 Research Procedure

The study procedure was conducted in sequential stages, beginning with participant recruitment and baseline assessment, followed by intervention delivery and outcome evaluation.
Below is the procedural flow of study:

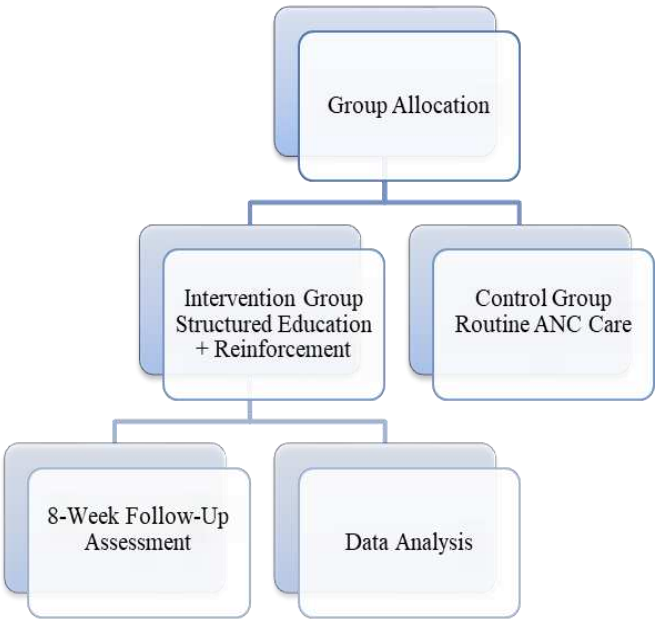

Figure 1. Research procedure

Procedure began screening and informed consent. Baseline data collection included sociodemographic information, knowledge assessment, adherence baseline evaluation, and hemoglobin measurement. The intervention was delivered immediately after baseline assessment for the intervention group. Follow-up evaluation occurred eight weeks later during routine ANC visits to minimize participant burden and ensure ecological validity.

2.5 Data Analysis

Dataset processed using IBM SPSS Statistics version 27. Participant characteristics were first described through appropriate summary measures to provide an overview of the sample profile [48], [49]. Baseline comparability between intervention and control groups was examined using independent sample t-tests for continuous variables and chi-square tests for categorical variables. Changes within each group between the pre-intervention and post-intervention assessments were analyzed using paired sample t-tests. Differences in outcome changes across groups were further evaluated using independent sample t-tests. To identify factors associated with adherence while accounting for possible confounding variables, multivariable logistic regression analysis conducted. A p-value of less than 0.05 was considered statistically significant. Additionally, Cohen's d was computed to quantify magnitude intervention effect.

2.6 Ethical Considerations

Ethical approval was obtained from the Institutional review board of masis maternity hospital. All participants provided written informed consent prior enrollment. Confidentiality was maintained through anonymized coding, and participants retained the right to withdraw at any time without affecting their access to care.

2 RESULTS AND DISCUSSION

A total of 138 pregnant women were assessed for eligibility during the recruitment period. Eighteen women were excluded. 120 participants were enrolled and allocated equally to the intervention (n = 60) and control (n = 60) groups. During the 8-week follow-up period, four participants lost to follow-up (two from each group) due to relocation or missed scheduled visits. Therefore, complete outcome data were available for 116 participants (intervention n = 58; control n = 58), yielding a retention rate of 96.7%. All analyses were conducted using complete-case analysis.

Baseline demographic and obstetric characteristics were examined to determine comparability between groups prior to intervention delivery. Table 3 presents the baseline characteristics of participants included in final analysis.

Table 3. Baseline Characteristics of Participants

Variable	Intervention	Control	p-value
Mean age (years)	27.9 ± 4.5	28.3 ± 4.9	0.64
Gestational age (weeks)	20.6 ± 3.1	21.0 ± 3.4	0.48
Primigravida (%)	48.3	51.7	0.71
Secondary education or higher (%)	75.9	72.4	0.67
Employed (%)	41.4	39.7	0.85
Baseline hemoglobin (g/dL)	10.92 ± 0.82	10.97 ± 0.88	0.74
Baseline adherence ≥80% (%)	34.5	36.2	0.84
Baseline knowledge score (0–15)	7.21 ± 2.04	7.36 ± 2.11	0.69

As shown in table 3, no statistically significant differences were observed between groups at baseline ($p > 0.05$ for all variables), indicating adequate comparability prior to the intervention. Adherence rates were reassessed after 8 weeks using combined self-report and pill count verification. Table 4 summarizes changes in adherence within and between groups.

Table 4. Changes in Iron Supplement Adherence After 8 Weeks

Adherence (≥80%)	Intervention	Control	p-value (between groups)
Baseline (%)	34.5	36.2	0.84
8 weeks (%)	81.0	51.7	<0.001
Absolute increase (%)	+46.5	+15.5	—

Within-group analysis showed a significant increase in adherence in intervention group ($\chi^2 = 21.6$, $p < 0.001$), while the control group demonstrated a smaller but statistically significant improvement ($\chi^2 = 4.2$, $p = 0.04$). Between-group comparison at 8 weeks revealed a markedly higher adherence rate in the intervention group compared control (81.0% vs. 51.7%, $p < 0.001$). The calculated relative risk (RR) of achieving adequate adherence in intervention group was 1.57 (95% CI: 1.23–2.01). The effect size (Cohen's h) for adherence improvement was 0.63, indicating a moderate-to-large intervention effect.

Changes in knowledge regarding iron supplementation were assessed using the validated 15-item questionnaire. Table 5 presents pretest and posttest knowledge scores.

Table 5. Changes in Knowledge Scores (0–15 Scale)

Group	Baseline Mean ± SD	8 Weeks Mean ± SD	Mean Difference	p-value
Intervention (n=58)	7.21 ± 2.04	12.48 ± 1.76	+5.27	<0.001
Control (n=58)	7.36 ± 2.11	9.14 ± 2.03	+1.78	0.002

Independent t-test comparison at 8 weeks demonstrated significantl higher knowledge scores in the intervention group compared to control ($p < 0.001$). The between-group effect size (Cohen's d) was 1.76, indicating a large educational impact. These findings suggest that structured professional-led education substantially improved maternal knowledge beyond routine counseling. Hemoglobin (Hb) levels were measured at baseline and after 8 weeks to evaluate clinical impact. Table 6 summarizes changes in hemoglobin concentrations.

Table 6. Changes in Hemoglobin Levels (g/dL)

Group	Baseline Mean ± SD	8 Weeks Mean ± SD	Mean Change	p-value (within group)
Intervention (n=58)	10.92 ± 0.82	11.78 ± 0.74	+0.86	<0.001
Control (n=58)	10.97 ± 0.88	11.29 ± 0.81	+0.32	0.01

The increase in hemoglobin levels was significantly greater the intervention group compared to the control group (mean difference between groups = 0.54 g/dL; $p < 0.001$). The effect size (Cohen's d) for hemoglobin improvement was 0.69, representing a moderate clinical effect. Notably, the proportion of participants with anemia (Hb < 11 g/dL) decreased from 62.1% to 24.1% in the intervention group, compared to a reduction from 60.3% to 44.8% in [i]control group.

Logistic regression analysis was conducted identify predictors of adequate adherence at 8 weeks. Variables entered into the model included group assignment, age, education level, parity, and baseline knowledge score. Table 7 presents the adjusted odds ratios.

Table 7. Predictors of Adequate Adherence (≥80%) at 8 Weeks

Variable	Adjusted OR	95% CI	p-value
Intervention group	4.83	2.01–11.61	<0.001
Higher education	1.42	0.68–2.96	0.34
Primigravida	1.18	0.57–2.45	0.65
Baseline knowledge	1.09	0.94–1.27	0.24
Age	1.03	0.95–1.11	0.46

After adjustment, being in the intervention group remained the strongest independent predictor of adherence (AOR = 4.83; 95% CI: 2.01–11.61; $p < 0.001$). No sociodemographic variable demonstrated a statistically significant independent association. This study demonstrates that structured health professional–led education embedded within routine antenatal care significantly improves iron supplement adherence, maternal knowledge, and hemoglobin levels among pregnant women. The intervention group showed a 46.5% absolute increase in adherence (from 34.5% to 81.0%), compared with a 15.5% increase in the control group. Furthermore, the adjusted odds of achieving adequate adherence were nearly five times higher among women receiving structured education (AOR = 4.83; 95% CI: 2.01–11.61). These findings indicate that strengthening the educational role of health professionals within routine maternal services produces not only statistically significant improvements but also clinically meaningful outcomes, as evidenced by a 0.86 g/dL increase in hemoglobin levels and a substantial reduction in anemia prevalence.

The present findings align with previous evidence indicating that educational interventions can improve knowledge and short-term adherence to iron supplementation. However, Hyman et al., [50] prior studies frequently reported modest behavioral changes when education was delivered as a single counseling session without structured reinforcement [51], [52]. Many interventions have focused on information dissemination, often neglecting the continuity and professional accountability required to sustain adherence behavior. In contrast, the current study demonstrates a larger magnitude of effect, suggesting that embedding structured, standardized education within routine care workflows enhances consistency and effectiveness. The high effect size observed in knowledge improvement (Cohen's d = 1.76) further supports the value of professionally delivered, structured educational modules compared with unstructured routine advice.

Importantly, this study addresses a critical gap in the literature regarding the operationalization of education within maternal health systems [53]. Existing research has often evaluated either patient-level counseling or digital reminder systems independently, without sufficiently examining the role of health professionals as central agents of adherence reinforcement [54]. The novelty of this study lies in reframing education not as an isolated informational encounter but as a professional practice model integrated into antenatal service delivery. By positioning midwives and primary care providers as structured educators with defined content, duration, and reinforcement schedules, the intervention strengthens professional accountability and standardizes behavioral support. This systems-oriented approach advances beyond traditional patient education paradigms and contributes to the evolving discourse on optimizing general health professional practice.

The clinical significance of the hemoglobin improvement observed in this study further underscores the value of the intervention [55]. An average increase of 0.86 g/dL in the intervention group represents a meaningful physiological change over an eight-week period, particularly when compared with the smaller 0.32 g/dL increase in the control group. The substantial reduction in anemia prevalence from 62.1% to 24.1% indicates that enhanced adherence translated into tangible health benefits. This finding reinforces the concept that behavioral interventions embedded in professional care can yield measurable biomedical outcomes, bridging the gap between counseling and clinical impact.

From a short-term perspective, the intervention strengthens immediate adherence behavior, improves maternal understanding of iron supplementation, and reduces anemia risk during pregnancy. These effects can directly contribute to decreased maternal fatigue, improved immune resilience, and better preparation for childbirth [56]-[58]. For health professionals, the structured model provides a replicable framework for delivering consistent nutritional counseling within limited consultation time [59], [60]. It enhances role clarity and reinforces the preventive function of primary maternal care.

In the long term, embedding structured education into routine antenatal services has broader implications for health system strengthening. Improved adherence iron supplementation may reduce the incidence of severe maternal anemia, postpartum hemorrhage complications, and adverse neonatal outcomes such low birth weight and preterm delivery. At systems level, standardizing professional-led education can improve quality-of-care indicators and contribute to achieving maternal health targets aligned with global strategies promoted by the world health organization. Furthermore, the scalability of structured educational modules within primary healthcare settings makes the intervention feasible for integration into national maternal health programs without requiring advanced technological infrastructure.

Despite strengths, this study has several limitations. Adherence was partly measured through self-report, which may introduce social desirability bias despite the addition of pill count verification. Follow-up period was limited to eight weeks; longer-term adherence patterns throughout the entire pregnancy remain uncertain. Additionally, the study was conducted in a single healthcare facility, which may affect generalizability to different healthcare contexts or cultural settings.

3 CONCLUSION

This study aimed to evaluate effectiveness structured health professional–led education embedded within routine antenatal care in improving iron supplement adherence among pregnant women. The findings demonstrate the intervention significantly increased adherence rates from 34.5% at baseline to 81.0% after 8 weeks, compared with a smaller increase from 36.2% to 51.7% in the control group. Participants receiving structured education were nearly five times more likely to achieve adequate adherence (AOR = 4.83; 95% CI: 2.01–11.61). In addition, the intervention group experienced a clinically meaningful improvement in hemoglobin levels (+0.86 g/dL) and substantial reduction in anemia prevalence (from 62.1% to 24.1%), exceeding changes observed in routine care. These results confirm that embedding standardized, professional-led educational reinforcement into antenatal services produces significant behavioral and physiological benefits. The study Highlights importance strengthening preventive educational roles general health professionals in maternal care. Structured counseling models integrated into routine practice can transform adherence support from informal advice into a measurable, accountable clinical function. Health systems should incorporate standardized educational modules into antenatal care guidelines to enhance consistency and impact. Future multicenter randomized studies with longer follow-up periods are recommended to evaluate sustainability and cost-effectiveness across broader healthcare settings.

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USE OF ARTIFICIAL INTELLIGENCE (AI)-ASSISTED TECHNOLOGY

The authors confirm that no artificial intelligence (AI) assisted technologies were utilized in the preparation, analysis, or writing of this manuscript. All stages of the research process, including data collection, data interpretation, and the development of the manuscript, were conducted solely by the authors without any support from AI-based tools.

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