

Association of Structured Antenatal Health Education with Maternal Haemoglobin and Skilled Birth Attendance: A Quasi-Experimental Study

Amadi Ngozi Miriam ¹; Ohenhen Victor ²; Akubue Nnaemeka Emmanuel ³; Nwankwo Ifeyinwa Gloria ⁴; Okoli Adaora Ukamaka ⁵; Ajator Chioma Chetachukwu ⁶; Chinekwu S. Anyaoku ⁷; Eze Emmanuel Nnaemeka ⁸; Best Ordinioha ¹ and Chiejine Gibson Ifechukwude ⁶

¹Doctor of Public Health, School of Public Health, University of Port Harcourt. Rivers State, Nigeria.

²Department of Obstetrics and Gynaecology, Benson Idahosa University, Benin City, Edo State, Nigeria.

³Institute of Public Health, College of Medicine, University of Nigeria, Nsukka, Nigeria. ⁴Department of Haematology, Nnamdi Azikiwe University, Awka, Anambra State, Nigeria. ⁵Department of Nursing, Enugu State College of Nursing Sciences Parklane Enugu, Enugu State, Nigeria. ⁶Department of Community Medicine, Nnamdi Azikiwe University Teaching Hospital, Nnewi, Nigeria. ⁷Department of Family Medicine, Nnamdi Azikiwe University Teaching Hospital Anambra State, Nigeria. ⁸Department of Obstetrics and Gynaecology, Nnamdi Azikiwe University Teaching Hospital, Nnewi, Nigeria.

Corresponding author: dr gib2002@gmail.com

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Abstract

Maternal anaemia and childbirth without skilled attendance remain important maternal health challenges in Nigeria. Antenatal education may support nutritional practices and informed delivery decisions. This study assessed the effect of structured antenatal health education on maternal haemoglobin levels and skilled birth attendance among pregnant women. A quasi-experimental study was conducted in 16 model primary healthcare centres across 10 local government areas. Facilities were allocated by balloting to intervention and control groups. Of 516 women enrolled, 506 completed follow-ups: 256 in the intervention group and 250 in the control group, representing 98.1% retention. The intervention comprised six monthly, interactive, 45–60-minute educational sessions delivered by trained nurses and midwife's alongside routine antenatal care. Controls received routine care and conventional health talks. Questionnaires and clinical records provided data. Haemoglobin was assessed at baseline and delivery, and skilled attendance was documented at childbirth. Analyses included independent-samples and paired-samples t-tests, chi-square tests, and risk ratios with 95% confidence intervals. Mean baseline haemoglobin was 10.27 ± 1.04 g/dL in the intervention group and 10.30 ± 1.06 g/dL in controls ($p = 0.731$). At delivery, corresponding means were 11.45 ± 1.17 in the intervention group and 10.30 ± 1.08 g/dL in the control group ($p < .001$). Skilled birth attendance occurred in 196 intervention participants (76.6%) and 119 controls (47.6%), an absolute difference of 29.0 percentage points (risk ratio = 1.61, 95% CI [1.39, 1.86]; $p < 0.001$). Structured antenatal health education was associated with higher maternal haemoglobin at delivery and greater skilled birth attendance. Integration into routine antenatal services warrants consideration, alongside measures addressing access to delivery care.

Keywords: Antenatal Health Education, Maternal Haemoglobin, Skilled Birth Attendance, Primary Healthcare, Quasi-Experimental, Rivers State.

Introduction

Maternal health depends on both adequate physiological preparation during pregnancy and timely access to appropriate care at childbirth (Zaman et al., 2025). Maternal anaemia and delivery without skilled attendance are therefore related priorities for antenatal services: the former concerns a woman's health before delivery, whereas the latter concerns access to professional care during a period when complications may arise (Anwar et al., 2023; Rahayu et al., 2024). In Nigeria, these priorities require interventions that combine clinical services with education that women can understand and apply. Recent Nigerian evidence documents a substantial burden of anaemia in pregnancy and incomplete progression from antenatal care to skilled delivery and postnatal care (Olowokere et al., 2020; Oyedele et al., 2023).

Anaemia during pregnancy is associated with adverse maternal and foetal outcomes, including reduced tolerance of blood loss and complications linked to severe anaemia. Its causes are diverse, and a low haemoglobin concentration should not automatically be attributed to iron deficiency. In a study that screened 11,582 pregnant women in Lagos and Kano, Babah et al. (2024) reported anaemia in 41.2%. Among 872 women with moderate or severe anaemia who underwent further assessment, approximately 41% had iron deficiency. These findings demonstrate the importance of maternal haemoglobin assessment while also showing why nutritional counselling must accompany appropriate investigation and clinical management rather than replace them.

Antenatal education offers a means of addressing behaviours that may influence nutritional status, including food selection and adherence to prescribed iron-folic acid supplements (Herval et al., 2019; Athinaidou et al., 2024). Engidaw et al. (2025), in a systematic review and meta-analysis of 53 studies involving 13,475 pregnant women in low- and middle-income countries, found that nutrition education improved supplement adherence and favoured better haemoglobin outcomes. This finding was also supported by the work done by Beressa et al. (2025). However, substantial heterogeneity limited the certainty with which pooled effects could be applied to individual settings. A cluster-randomised trial in Ethiopia also demonstrated higher endline haemoglobin following intensive nutrition education and counselling, compared with routine education (Wakwoya et al., 2023). Together, these studies support evaluating structured education within the service conditions in which it will be implemented.

The transition from antenatal attendance to skilled care at childbirth represents a second important challenge. Antenatal contact provides opportunities for counselling and planning, but attendance alone does not ensure that women will obtain skilled delivery care. Oyedele et al. (2023), analysing 21,447 pregnancies reported in the 2018 Nigeria Demographic and Health Survey, identified substantial discontinuity across the maternity

care pathway. Education, household wealth, decision-making autonomy and rural residence were associated with continuation or dropout. Because these were observational findings, they identify relevant influences without establishing that education alone can overcome all barriers to care.

Intervention research nevertheless indicates that antenatal education can contribute to improved delivery-care utilisation. Okafor and Yewande (2020) reported improved knowledge and utilisation of facility-based delivery services following an educational intervention in Lagos State. Facility delivery is relevant to skilled attendance, although the two measures are not interchangeable. In rural Edo State, Okonofua et al. (2022) found improved use of primary healthcare services following a multifaceted programme incorporating community education (Bossman et al., 2022), emergency transport arrangements, financing mechanisms and service improvements. The latter study supports linking information with practical access measures, but its combined intervention does not isolate the contribution of education.

The present study examines a structured antenatal health-education programme delivered alongside routine care in model primary healthcare centres in Rivers State. The programme combines nutrition and supplement counselling with pregnancy danger signs, timely care-seeking and birth preparedness. Its proposed pathway is that repeated explanation, discussion and practical planning may improve women's ability to apply health information, supporting both maternal haemoglobin and use of skilled care at childbirth (Wafula et al., 2022; Coleman et al., 2020). These pathways are plausible explanations to be evaluated; they should not be treated as demonstrated mechanisms unless the relevant behaviours are measured.

Statement of the Problem

The availability of antenatal services does not necessarily resolve the nutritional and delivery-care risks experienced by pregnant women. Women may receive prescriptions and general health talks yet have difficulty translating advice into sustained dietary practices, supplement use and delivery plans. Iron Deficiency Anemia (IDA) is highly prevalent among pregnant women in Nigeria generally, with reported rates ranging from 25% to 45.6%; and the reported prevalence of anaemia among pregnant women at booking in the Rivers State University Teaching Hospital (RSUTH) was 60.2% (Obeagu et al., 2025; Awoyesuku et al., 2020). The documented burden of anaemia in Nigerian facilities, together with losses along the maternity care continuum, indicates that contact with healthcare services can coexist with unmet needs (Babah et al., 2024; Oyedele et al., 2023). This creates a practical question about how antenatal communication can be strengthened to support outcomes beyond attendance or knowledge acquisition.

A further problem concerns the evidence needed to guide programme selection. Nutrition-focused interventions commonly assess dietary behaviour, supplement adherence or haemoglobin, while delivery-care interventions may assess birth preparedness or facility use. Muriithi et al. (2024) identified considerable methodological and clinical variation

across behaviour-change interventions in sub-Saharan Africa, preventing quantitative pooling. Consequently, effectiveness demonstrated in one setting or for one outcome should not be assumed to apply uniformly to another.

Study objectives

1. To assess the effect of a structured health education program provided during pregnancy on the changes in maternal haemoglobin levels in Rivers State.
2. To assess the effect of a structured health education program provided during pregnancy on the uptake of skilled birth attendance in Rivers State.

Research questions

1. What is the effect of a structured health education program for pregnant women on their haemoglobin levels at the time of delivery?
2. How does a structured health education program for pregnant women influence the uptake of skilled birth attendance?

Hypothesis

Hypothesis One

H_0 : There is no significant difference in the change in maternal haemoglobin levels between pregnant women who receive structured health education and those who receive routine antenatal care in Rivers State.

H_1 : There is a significant difference in the change in maternal haemoglobin levels between pregnant women who receive structured health education and those who receive routine antenatal care in Rivers State.

Hypothesis Two

H_0 : There is no significant difference in the uptake of skilled birth attendance between pregnant women who receive structured health education and those who receive routine antenatal care in Rivers State.

H_1 : There is a significant difference in the uptake of skilled birth attendance between pregnant women who receive structured health education and those who receive routine antenatal care in Rivers State.

For the participating primary healthcare centres in Rivers State, the problem addressed is therefore whether adding a repeated, structured educational programme to routine antenatal care is associated with better maternal haemoglobin at delivery and a higher proportion of births attended by skilled personnel than routine care and conventional health talks alone (Rivers State MOH, 2022). For primary healthcare managers and policymakers, the study provides context-specific evidence for considering a structured curriculum within routine services. The Nigerian experience reported by Okonofua et al. (2022) indicates that financial and transport barriers also warrant attention. Thus,

educational improvement should be considered alongside accessible, adequately equipped and responsive delivery services rather than assumed to resolve structural barriers by itself.

Conceptual Framework

The programme was organised around the Health Belief Model. Structured education was expected to increase perceived susceptibility to anaemia and obstetric complications, clarify their severity, strengthen perceived benefits of diet, supplementation and skilled care, reduce perceived barriers through practical planning, and provide cues and self-efficacy for action. These pathways were expected to influence iron–folic acid adherence, dietary practice, facility selection and birth preparedness, leading to higher haemoglobin and skilled attendance. The model is consistent with recent theory-based maternal nutrition and behaviour-change interventions (Beressa et al., 2024; Muriithi et al., 2024).

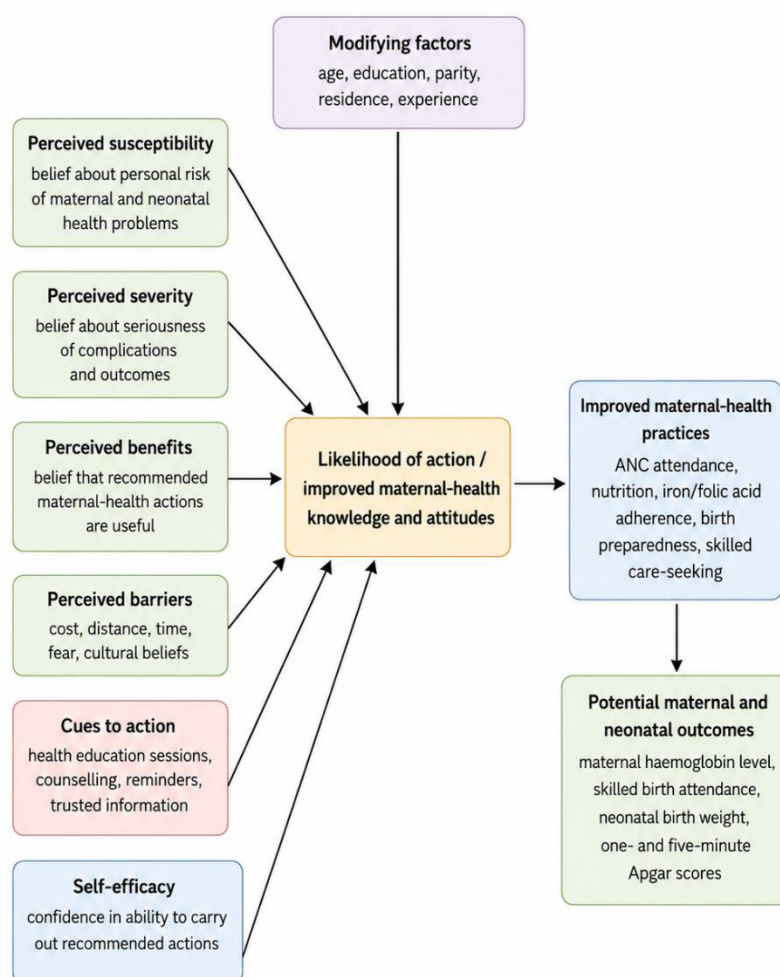


Figure 1: Health Belief Model (HBM) Applied to the Maternal Health-Education Intervention

Source: Framework was developed from the synthesis of related literature

Methodology

Research Design

The study used a quasi-experimental, non-equivalent intervention and comparison group design with pre-intervention and post-intervention assessments. This manuscript reports maternal haemoglobin and skilled birth attendance outcomes from the broader maternal and newborn health evaluation.

Study Area

The study was conducted in Rivers State, in Nigeria's South-South geopolitical zone. The state comprises 23 local government areas (LGAs), with Port Harcourt as its capital. Metropolitan, rural and riverine settlements provide varied contexts for access to maternity services. Healthcare is organised into primary, secondary and tertiary levels, with primary healthcare services coordinated through the Rivers State Primary Health Care Management Board. Selected model primary healthcare centres provided the study setting. Simple English, Nigerian Pidgin English and pictorial illustrations were used during education to accommodate participants' linguistic and educational differences.

Study Population

The source population comprised pregnant women registered for antenatal care in the selected centres; the accessible population comprised attendees during recruitment. Eligible women were recruited from intervention and comparison facilities and followed from enrolment until delivery. Intervention participants received structured health education alongside routine antenatal care, whereas comparison participants received routine care and conventional health talks. Participants required identifiable antenatal records and availability for follow-up.

Inclusion and Exclusion Criteria

Inclusion Criteria

Participants were registered antenatal attendees in their first trimester, with sufficient time to complete the six-month programme before delivery. They had a confirmed viable singleton pregnancy, resided within the facility catchment area without plans to relocate, and were willing to participate and complete the intervention and follow-up assessments.

Exclusion Criteria

Women were excluded if they had severe anaemia requiring immediate specialist management, a high-risk pregnancy or a serious condition requiring specialised care, including severe hypertension, pre-eclampsia, diabetes mellitus, chronic renal disease or significant cardiac disease. Women whose mental health condition prevented participation were also excluded.

Study Tools

Two principal instruments were used: a structured interviewer-administered questionnaire and a structured health-education evaluation checklist. Researcher-developed items were adapted from World Health Organization maternal and newborn healthcare recommendations, the JHPIEGO Birth Preparedness and Complication Readiness tool and the Kirkpatrick training-evaluation framework. Relevant items were modified for the study objectives rather than adopting a single questionnaire unchanged.

Structured Interviewer-Administered Questionnaire

The questionnaire was administered to both groups at baseline and after the intervention and contained six sections. Section A recorded sociodemographic and obstetric characteristics. Section B assessed maternal-health knowledge using ten questions scored 1 for correct and 0 for incorrect responses. Topics included antenatal contacts, danger signs, folic acid, prolonged labour, dietary practices, facility delivery, reduced foetal movement, breastfeeding and newborn immunisation. Identical items and scoring procedures were used at both assessments. Section C assessed attitudes using eight five-point Likert statements, with negative items reverse-scored. Statements covered antenatal attendance, recognition of danger signs, supplementation, home delivery, provider communication, traditional birth attendants, postpartum care and newborn care. Section D assessed antenatal attendance, supplementation, nutrition and birth-planning practices. Section E examined healthcare barriers, including transport, cost, distance, responsibilities and perceptions of providers. Section F documented formal, informal, community and digital sources of maternal-health information.

Structured Health-Education Evaluation Checklist

The checklist was used in the intervention group during sessions, behavioural follow-up and delivery. Section A linked demographic information to participant identifiers. Section B documented content coverage, teaching methods and engagement. Section C assessed knowledge before and after education. Section D assessed behavioural changes four to six weeks after relevant sessions, including dietary improvement and birth planning. Section E extracted clinical and delivery outcomes, including haemoglobin and skilled attendance. Section F assessed usefulness, clarity, confidence and suggestions for improvement. The checklist reflected the Kirkpatrick domains of reaction, learning, behaviour and results. Participant evaluations included four Likert statements and open-ended questions. The broader checklist also captured neonatal outcomes, which are outside this manuscript's outcome scope.

Sample Size Calculation

Sample size was calculated using

$$n = [(Z_{1-\alpha/2} \times \sqrt{(2P(1-P))} + Z_{1-\beta} \times \sqrt{(P_1(1-P_1) + P_2(1-P_2))})^2] / (P_1 - P_2)^2 \text{ (Fleiss et al., 2003)}$$

$P_1 = 0.177$ Proportion of anaemia prevalence after nutrition education in Control group

$P_2 = 0.072$ Proportion of anaemia prevalence after nutrition education in Intervention group (Anato & Reshid, 2025)

$Z_{1-\alpha/2} = 1.96$ (for 95% confidence level)

$Z_{1-\beta} = 0.84$ (for 80% power)

With $P = (P_1 + P_2)/2 = 0.1245$, $Z_{1-\alpha/2} = 1.96$ and $Z_{1-\beta} = 0.84$, the calculation yielded approximately 154 women per group.

The design effect was calculated as $DEFF = 1 + (m - 1)\rho$.

Where:

DEFF = design effect

m = average number of participants recruited from each primary healthcare centre

ρ = intracluster correlation coefficient

The planning calculation assumed three centres per group, giving $m = 154/3 = 51.33$ and an intracluster correlation coefficient of 0.01. The resulting design effect of 1.5033 increased the requirement to 232 women per group. Allowing 10% attrition gave $232/0.90 = 257.78$, rounded to 258 per group, or 516 overall. Facility inclusion and allocation are described below.

Sampling Method

A four-stage multistage sampling procedure was used.

Stage One: Selection of Local Government Areas

Ten of the 23 LGAs were selected by simple random sampling through balloting without replacement: Oyigbo, Ogba/Egbema/Ndoni, Etche, Emohua, Gokana, Eleme, Port Harcourt City, Obio/Akpor, Ikwerre and Okrika.

Stage Two: Selection of Model Primary Health Centres

All 16 model primary healthcare centres approved within the selected LGAs were included by total enumeration. The centres were Minimini, Omoku, Ozuzu, Egwi, Ulakwo, Ogbakiri, Kpor, Onne, Elekahia, Churchill, Rumuodumaya, Ozuoba, Rumuigbo, Adanta, Igwuruta and Okochiri.

Stage Three: Allocation of Facilities to Study Groups

The 16 centres were allocated by balloting to intervention and comparison groups, with eight facilities in each group.

Stage Four: Selection of Pregnant Women

Participants were selected proportionately to the number of eligible antenatal attendees in each facility. Centres with larger eligible populations contributed more participants. A total of 258 women was recruited per group.

Method of Data Collection

Data collection comprised pre-intervention, intervention and post-intervention phases.

Pre-intervention Phase

Research assistants with nursing or midwifery qualifications received two weeks of training in recruitment, questionnaire administration, record review, confidentiality and outcome documentation. Eligible women were screened during antenatal visits and enrolled after written informed consent. Unique identification numbers linked questionnaires and clinical records. Baseline assessments covered demographic and obstetric characteristics, knowledge, attitudes, practices, barriers and information sources. Baseline haemoglobin was extracted from antenatal or laboratory records; previous pregnancy outcomes were recorded for multiparous women.

Intervention Phase

Women in intervention facilities received structured education during antenatal visits over six months, alongside routine care. Trained midwives used face-to-face group teaching, demonstrations, visual aids, booklets, charts and flipbooks. The curriculum addressed antenatal care, nutrition, pregnancy danger signs, birth preparedness, family planning, postpartum care, newborn care and maternal emotional well-being. The nutrition content included iron-rich foods and supplementation, while behavioural follow-up assessed dietary improvement, identification of a skilled attendant and preparation of a birth plan. Attendance and session completion were documented. Comparison facilities continued routine antenatal care and conventional health talks without the structured programme or additional materials.

Post-intervention Phase

Maternal haemoglobin, delivery location and skilled birth attendance were extracted from delivery records. For women delivering elsewhere, outcomes were obtained from the receiving facilities' records. Telephone or facility follow-up within two to five days after delivery confirmed outcome information. Forms were checked daily for completeness, consistency and correct identification before storage.

Validity and Reliability of Study Tools

Experts in maternal and child health, health education, epidemiology and biostatistics assessed face and content validity. Instruments were reviewed for relevance, clarity, coverage and consistency with study objectives, revised and pretested in a comparable facility excluded from the main study. Review included the questionnaire, educational guide, intervention checklist and clinical outcome extraction component. Necessary corrections were incorporated before recruitment and data collection. Internal consistency was assessed using Kuder–Richardson 20 for dichotomous items and Cronbach's alpha for Likert-scale items, yielding coefficients of 0.83 and 0.78, respectively. Standardised

outcome definitions, uniform extraction forms, trained collectors and supervisory verification supported consistent data collection.

Method of Data Analysis

Data were analysed using IBM SPSS version 27. Categorical variables were summarised as frequencies and percentages; continuous variables as means and standard deviations, with medians and interquartile ranges where appropriate. Baseline characteristics were compared using Pearson's chi-square and independent-samples t-tests.

For this manuscript, haemoglobin was compared between groups at baseline and delivery using independent-samples t-tests. Within-group changes were assessed using paired-samples t-tests, with mean changes and 95% confidence intervals. Skilled birth attendance proportions were compared using Pearson's chi-square test and expressed as a risk ratio with a 95% confidence interval. Tests were two-tailed, with $p < .05$ indicating statistical significance. The reported analyses did not include multivariable or facility-cluster adjustment.

Ethical Consideration

Ethical approval was obtained from the University of Port Harcourt Ethics Committee before commencement. Administrative permission was obtained from the Rivers State Primary Health Care Management Board and participating facility management. The reference number is RSHREC/2025/085, and dated 29th September, 2025. Written informed consent followed explanation of the study's purpose and procedures. Participation was voluntary, and withdrawal did not affect access to routine healthcare. Coded identifiers protected confidentiality; records were securely stored and accessible only to authorised research personnel.

Results

In the study, participants aged 30–34 years formed the largest age group in both the intervention and control groups, representing 27.3% and 28.8%, respectively. Secondary education was the predominant educational level, most participants were married, trading or business was the most frequently reported occupation, and urban residence was more common than rural residence in both groups. Multigravidae constituted 64.1% of the intervention group and 66.0% of the control group, while every participant was enrolled during the second trimester. None of the assessed sociodemographic or obstetric characteristics differed significantly between the groups ($p > 0.05$). See table 1.

Table 1. Sociodemographic and obstetric characteristics

Characteristic	Category	Intervention (n=256) n (%)	Control (n=250) n (%)	χ^2	p-value
Age group (years)	15–19	30 (11.7)	32 (12.8)	0.93	0.920

Characteristic	Category	Intervention (n=256) n (%)	Control (n=250) n (%)	χ^2	p-value
	20–24	55 (21.5)	47 (18.8)		
	25–29	67 (26.2)	69 (27.6)		
	30–34	70 (27.3)	72 (28.8)		
	≥35	34 (13.3)	30 (12.0)		
Educational level	No formal education	18 (7.0)	13 (5.2)	1.21	0.750
	Primary	55 (21.5)	59 (23.6)		
	Secondary	126 (49.2)	127 (50.8)		
	Tertiary	57 (22.3)	51 (20.4)		
Marital status	Single	45 (17.6)	41 (16.4)	0.36	0.833
	Married	202 (78.9)	202 (80.8)		
	Divorced/Widowed	9 (3.5)	7 (2.8)		
Occupation	Unemployed/Housewife	58 (22.7)	57 (22.8)	0.68	0.995
	Trader/Business	95 (37.1)	96 (38.4)		
	Civil servant	40 (15.6)	37 (14.8)		
	Artisan	30 (11.7)	30 (12.0)		
	Farmer	13 (5.1)	10 (4.0)		
	Student	17 (6.6)	18 (7.2)		
	Other	3 (1.2)	2 (0.8)		
Residence	Urban	147 (57.4)	150 (60.0)	0.35	0.556
	Rural	109 (42.6)	100 (40.0)		
Parity	None	69 (27.0)	68 (27.2)	0.47	0.977
	One	67 (26.2)	64 (25.6)		
	Two	54 (21.1)	56 (22.4)		
	Three	33 (12.9)	28 (11.2)		
	Four or more	33 (12.9)	34 (13.6)		
Gravidity	Primigravida	46 (18.0)	40 (16.0)	0.36	0.835
	Multigravida (2–4)	164 (64.1)	165 (66.0)		
	Grand multigravida (≥5)	46 (18.0)	45 (18.0)		

Note: Others- security personnel,

In the study, the intervention and control groups had closely comparable baseline clinical measurements. The mean haemoglobin levels were 10.27 ± 1.04 g/dL in the intervention group and 10.30 ± 1.06 g/dL in the control group. Mean gestational age, weight, height, systolic and diastolic blood pressure, number of antenatal visits and haemoglobin level did not differ significantly between the groups ($p > 0.05$). See table 2

Table 2: Clinical Characteristics of Participants in the Intervention and Control Groups

Clinical characteristic	Intervention (n=256) Mean $\pm$ SD	Control (n=250) Mean $\pm$ SD	t	p-value
Gestational age at baseline (weeks)	20.4 $\pm$ 3.3	20.3 $\pm$ 3.2	0.34	0.733
Weight (kg)	67.9 $\pm$ 12.8	67.6 $\pm$ 13.0	0.28	0.776
Height (m)	1.64 $\pm$ 0.08	1.64 $\pm$ 0.08	0.04	0.965

Clinical characteristic	Intervention (n=256) Mean ± SD	Control (n=250) Mean ± SD	t	p-value
Systolic blood pressure (mmHg)	111.0 ± 10.9	111.2 ± 11.6	-0.20	0.839
Diastolic blood pressure (mmHg)	68.8 ± 7.4	69.0 ± 7.5	-0.28	0.781
Antenatal visits completed at baseline	2.54 ± 1.12	2.54 ± 1.11	-0.09	0.929
Haemoglobin level (g/dL)	10.27 ± 1.04	10.30 ± 1.06	-0.34	0.731

Note: Independent-samples t-test was used. SD = standard deviation.

The study showed that 76.6% of intervention participants delivered with a skilled birth attendant compared with 47.6% of control participants. The difference was statistically significant ($\chi^2=45.15$, $p<0.001$). Participants in the intervention group were 1.61 times as likely to have skilled birth attendance as those in the control group (95% CI: 1.39–1.86). See table 3

Table 3: Comparison of Skilled Birth Attendance among Participants in the Intervention and Control Groups

Delivery attendance	Intervention (n=256) n (%)	Control (n=250) n (%)	χ^2	p-value	Risk ratio (95% CI)
Skilled birth attendant	196 (76.6)	119 (47.6)	45.15	<0.001	1.61 (1.39–1.86)
No skilled birth attendant	60 (23.4)	131 (52.4)			

Note: The between-group comparison was conducted using Pearson's chi-square test. CI = confidence interval.

Discussion

This study found that structured antenatal health education, provided alongside routine care, was associated with higher maternal haemoglobin at delivery and greater skilled birth attendance among pregnant women attending selected model primary healthcare centres in Rivers State. The groups had similar measured baseline characteristics and haemoglobin levels, while differences were evident at delivery. These findings suggest that a coordinated educational programme may support both maternal nutritional health and delivery-care utilisation.

No statistically significant baseline differences were reported in age, educational attainment, marital status, occupation, residence, parity or gravidity. Women aged 25–34 years accounted for approximately 54% of the intervention group and 56% of the

comparison group; secondary education was the predominant educational category, and most participants were married. Both groups included urban and rural residents and women with different pregnancy histories. This distribution provides a useful context for evaluating an antenatal programme delivered through primary healthcare services.

The descriptive similarity between the groups reduces concern that the findings simply reflect large differences in the measured background characteristics. Nevertheless, non-significant baseline tests do not establish statistical equivalence or eliminate confounding. Relevant influences such as household resources, partner support, dietary intake, previous delivery experiences and facility quality may differ despite similar demographic distributions. Oyedele et al. (2023) identified education, wealth, decision-making autonomy and residence as correlates of continuation through maternity care in Nigeria. Their findings reinforce the need to consider these factors when interpreting differences in delivery-care utilisation.

The predominance of women with secondary education suggests that written materials could have supported learning, while visual aids, demonstrations and discussion remained relevant for participants with limited formal education.

The paired analysis showed a significant haemoglobin increase of 1.17 g/dL in the intervention group, compared with a change of 0.01 g/dL in the comparison group. The principal finding is that delivery haemoglobin was higher among women exposed to structured education. This finding agrees with the cluster-randomised trial by Wakwoya et al. (2023) in Ethiopia where the intervention combined intensive nutrition counselling, mobile reminders and educational materials, and an adjusted analysis found an endline haemoglobin advantage of approximately 0.50 g/dL. The findings also align with the systematic review and meta-analysis by Engidaw et al. (2025), which reported improved iron-folic acid supplement adherence and favourable haemoglobin and anaemia outcomes following nutrition education in low- and middle-income countries. Supplement adherence was higher among women receiving education (odds ratio = 2.80, 95% CI [2.04-3.83]). A plausible explanation is that repeated counselling helped women understand the purpose of prescribed supplements, clarify concerns about adverse effects and identify suitable foods within their circumstances. Interactive teaching may also have provided opportunities to correct misconceptions and reinforce advice.

The higher delivery mean is potentially relevant to maternal physiological reserve, but it does not demonstrate that anaemia was eliminated or that obstetric complications were reduced. A group mean cannot identify the proportion of individual women with anaemia, its severity or its cause. Babah et al. (2024) found iron deficiency in approximately 41% of Nigerian women with moderate or severe anaemia, demonstrating that anaemia and iron deficiency are not interchangeable diagnoses. The present results therefore support structured nutrition education alongside clinical assessment and treatment; they do not establish correction of iron deficiency in the absence of iron-status measurements.

Skilled birth attendance was documented for 196 of 256 women in the intervention group (76.6%) and 119 of 250 women in the comparison group (47.6%). The absolute difference

was approximately 29.0 percentage points, and the reported risk ratio was 1.61 (95% CI [1.39-1.86]; $p < 0.001$). Thus, the proportion receiving skilled attendance was approximately 61% higher in the intervention group. The contrast reflects a difference between groups at delivery rather than a longitudinal change in skilled attendance. This finding is consistent with the study by Akinwaare and Oluwatosin (2023), who evaluated goal-oriented prenatal education in semi-urban Ibadan. Institutional delivery occurred in 93.5% of intervention participants and 53.5% of controls, alongside better birth preparedness and complication readiness. Both studies suggest that focused prenatal education can support delivery-care decisions. Nevertheless, institutional delivery measures place of birth, whereas skilled birth attendance measures the qualifications of the person providing care. These related outcomes should not be treated as identical, and differences in coverage between studies may reflect setting, service access, participant selection and outcome definitions. The result is also compatible with the Lagos study by Okafor and Yewande (2020), which reported improved knowledge and utilisation of facility-based delivery services after antenatal education. Together, these Nigerian studies provide support for educational approaches that link information with concrete delivery plans. The present programme addressed danger signs, prompt care-seeking and birth preparedness, potentially helping women identify an appropriate provider, anticipate costs and transport needs, and discuss support with family members. The outcome data do not establish which of these components accounted for the observed difference.

Education may help address uncertainty and delayed decisions, but practical access remains important. Okonofua et al. (2022) reported increased use of primary healthcare delivery services following a community-led programme in rural Edo State that combined education with financing, transport arrangements, health-worker retraining and facility support. Because that intervention was multifaceted, its findings cannot be attributed to education alone. They nevertheless show why structured counselling should be linked to measures enabling women to reach and receive appropriate care.

Despite the higher intervention-group coverage, 60 women (23.4%) delivered without documented skilled attendance. This remaining gap indicates that programme exposure did not ensure skilled care for every participant. Financial constraints, transport difficulties, rapid labour, household decision-making or service experiences are possible explanations requiring investigation rather than assumptions about these women. The associations reported by Oyedele et al. (2023) underscore the broader socioeconomic context of maternity-care continuity.

Relevance of the Health Belief Model to the Effectiveness of Structured Antenatal Health Education

The findings of this study can be explained within the framework of the Health Belief Model (HBM), which emphasises the influence of perceived susceptibility, perceived severity, perceived benefits, perceived barriers, cues to action, and self-efficacy on health-related behaviours. The structured antenatal health education intervention may have improved participants' understanding of the risks associated with maternal anaemia and unskilled

childbirth, while reinforcing the benefits of adequate nutrition, iron and folic acid supplementation, regular antenatal attendance, and delivery assisted by skilled birth attendants. Furthermore, the interactive educational sessions may have strengthened participants' confidence in adopting recommended maternal health practices, addressed misconceptions, and provided cues to action through repeated counselling and health information. These mechanisms offer a plausible explanation for the significantly higher mean haemoglobin level at delivery among women in the intervention group (11.45 ± 1.17 g/dL versus 10.30 ± 1.08 g/dL; $p < 0.001$) and the greater proportion who utilised skilled birth attendance (76.6% versus 47.6%; $p < 0.001$). The findings therefore support the relevance of the HBM as a theoretical framework for understanding how structured antenatal health education may promote positive maternal health behaviours and improve pregnancy-related outcomes. However, because changes in individual HBM constructs were not directly measured, these behavioural mechanisms should be regarded as plausible explanations rather than established mediating pathways.

The findings of the study support consideration of a structured antenatal curriculum that combines maternal nutrition, prescribed supplement use, danger-sign recognition and individual delivery planning. Nurses and midwives would require facilitator preparation, appropriate materials and supportive supervision. Counselling should be understandable across literacy levels and should allow women to discuss practical difficulties. Nutrition education must remain integrated with haemoglobin assessment, appropriate investigation, supplement provision and treatment or referral when required.

Conclusion

Structured antenatal health education provided alongside routine care was associated with higher maternal haemoglobin at delivery and greater skilled birth attendance among pregnant women attending selected model primary healthcare centres in Rivers State, Nigeria. Mean delivery haemoglobin was 11.45 ± 1.17 g/dL in the intervention group compared with 10.30 ± 1.08 g/dL in the comparison group. Skilled birth attendance was 76.6% and 47.6%, respectively, representing an absolute difference of approximately 29 percentage points. These findings suggest that a coordinated educational programme addressing nutrition, prescribed supplementation, danger signs and birth preparedness may strengthen routine antenatal services.

Recommendations

Integrate structured education into routine antenatal care: The Rivers State Primary Health Care Management Board and facility managers should consider phased adoption of a standardised, interactive antenatal curriculum covering maternal nutrition, iron and folic acid supplementation, pregnancy danger signs, timely care-seeking and birth preparedness. Implementation should be monitored before wider expansion.

Prepare and support facilitators: Nurses and midwives should receive training in participatory teaching, demonstrations and counselling appropriate to women's literacy

levels and preferred languages. Facilities should provide a common facilitator guide and educational materials, with supportive supervision to maintain consistent delivery.

Link nutrition education with clinical care: Counselling should address affordable, locally available nutritious foods, adherence to prescribed supplements and management of common difficulties with their use. Education should accompany reliable supplement provision, haemoglobin monitoring and assessment, treatment or referral for anaemia; it should not replace clinical management.

Develop and review individual birth plans: Antenatal providers should help each woman identify an appropriate delivery facility or skilled provider, transport arrangements, anticipated costs, emergency contacts and a support person. Plans should be reviewed during subsequent visits. Partners or other family members may be involved with the woman's agreement.

Address barriers to skilled delivery care: Health authorities and facility managers should assess financial, transport and service barriers and strengthen referral arrangements, staffing, essential supplies and respectful maternity care. Follow-up should identify women who remain unable to obtain skilled attendance despite educational exposure and determine their specific support needs.

Strengths and limitation of the Study

The study evaluated a practical intervention within routine primary healthcare services in Rivers State, using 16 model primary healthcare centres across 10 local government areas. The involvement of multiple facilities provides a broader service context than a single-centre evaluation. A comparison group receiving routine antenatal care and conventional health talks also allowed assessment of outcomes associated with the additional structured educational programme. Follow-up was high: 506 of the 516 enrolled women completed the study, representing 98.1% retention. This limited the proportion of missing delivery outcomes and strengthened the completeness of the evaluation. The groups had similar measured baseline sociodemographic, obstetric and clinical characteristics, including haemoglobin. This provides useful context for outcome comparisons, although non-significant baseline tests do not establish equivalence or exclude confounding.

The intervention used a common curriculum, trained nurses and midwives, interactive teaching methods, visual aids and participant materials. Attendance records, session checklists and supervisory activities supported monitoring of implementation. These features improve the clarity and reproducibility of the programme compared with an educational intervention whose content and delivery are poorly specified. The assessment included both maternal haemoglobin and skilled birth attendance. Haemoglobin provided a clinical outcome, while attendance reflected delivery-care utilisation. Obtaining outcomes from clinical records extended the evaluation beyond knowledge or intention alone. The use of baseline and delivery haemoglobin measurements also enabled assessment of change within groups alongside the between-group comparison.

The quasi-experimental evaluation did not provide adjusted estimates accounting for relevant participant and facility characteristics. Although facilities were allocated by balloting, women were not individually randomised, and the modest number of facilities permits chance differences between groups. Similar baseline characteristics do not remove potential influences such as household resources, partner support, supplement availability, dietary intake, clinical treatment or facility quality.

The findings apply most directly to pregnant women who attended antenatal care in the selected model primary healthcare centres and completed follow-up. They may not represent women who do not attend antenatal care, those receiving care in other sectors, or women using less-resourced facilities. Representation of both urban and rural residents broadens the sample but does not establish statewide population representativeness.

The analytical weaknesses limit causal attribution and confidence in the reported precision. Consequently, the observed differences should be interpreted as associations with structured education rather than definitive evidence that education alone produced the outcomes. The high retention rate reduces missing-data concerns, but selective loss to follow-up remains possible because the outcomes of the ten women without complete data were not included.

Mean haemoglobin values do not establish the prevalence or severity of anaemia, and haemoglobin alone cannot identify iron deficiency or other causes of anaemia. Similarly, skilled birth attendance indicates use of professional care but does not measure the quality, timeliness or adequacy of that care. The study therefore cannot establish elimination of anaemia, correction of iron deficiency, or improved management of obstetric complications.

Recommendations for Future Studies

Future studies should use a prospectively registered, adequately powered cluster-randomised design with sufficient facilities in each group. Sample-size calculations should incorporate the expected intracluster correlation, cluster size variation and attrition. Where feasible, allocation should balance important facility characteristics, and recruitment procedures should minimise selection related to knowledge of allocation.

Haemoglobin measurement should use standardised equipment, quality-control procedures and clearly defined gestational or delivery-related assessment windows. Studies should report individual anaemia prevalence and severity using appropriate criteria. Where feasible, ferritin and relevant measures of inflammation, infection or haemoglobin disorders should help distinguish nutritional and non-nutritional causes. Delivery records should verify provider qualifications and assess timeliness, referral and quality of care.

Prospective measurement of dietary practices, supplement adherence, birth preparedness and household support would permit investigation of behavioural pathways. Process evaluation should document attendance, exposure, fidelity, acceptability and potential contamination. Outcome assessors should be blinded where feasible, and a comparator

with similar contact time could help distinguish curriculum effects from additional attention.

Implementation and economic studies should assess staffing needs, workload, resource use, affordability and sustainability. Comparative evaluations could test structured education alone against education combined with transport support, financial assistance or service-quality improvements, helping identify which package is most useful for wider adoption.

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