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Knowledge, perceptions and dietary practices of iron-absorption modulation, and the prevalence of anaemia, among pregnant women attending antenatal care in Ogun State, Nigeria: an exploratory sequential mixed-methods study

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Abstract

Background

Iron-deficiency anaemia (IDA) remains the leading nutritional contributor to anaemia in pregnancy and a severe public health problem in Nigeria. Emerging evidence suggests that a specific gap in knowledge of dietary iron-absorption enhancers and inhibitors, rather than a general lack of dietary iron, may be an important, modifiable determinant of persistent anaemia. This study assessed the knowledge, perceptions and dietary practices of dietary modulation of iron absorption, and the prevalence of anaemia, among pregnant women attending antenatal care in Ogun State, Nigeria.

Methods

An exploratory sequential mixed-methods design was used. Seventeen in-depth interviews were conducted with pregnant women at three Primary Health Care facilities in Ewekoro and Abeokuta South, Ogun State, and analysed using reflexive thematic analysis; findings informed a structured, interviewer-administered questionnaire subsequently administered by census to 258 pregnant women at the same three facilities. The questionnaire assessed knowledge (43 items), perception (Health Belief Model constructs) and dietary practice of iron-absorption modulation, and capillary haemoglobin concentration was measured for each respondent. Spearman's correlation, chi-square tests and the Mann-Whitney U test were used to examine associations between knowledge, perception, dietary practice and anaemia status.

Results

Qualitatively, participants held a fragmented, experience-based understanding of anaemia and showed minimal spontaneous awareness of iron-absorption enhancers or inhibitors, alongside contested beliefs that avoiding tea, coffee or milk protects against an oversized baby rather than iron malabsorption. Quantitatively, 57.4% of respondents had moderate and 20.9% good overall knowledge, yet only 10.9% correctly identified milk as an absorption inhibitor. Perception was predominantly positive (98.4%), but perceived personal susceptibility to anaemia was low (23.3%) despite an anaemia prevalence of 68.2%. Dietary practice was the weakest construct (only 0.8% good practice; mean score 51.7%). Knowledge was significantly, negatively correlated with dietary practice ($\rho = -0.218$, $p = 0.0004$), while perception was significantly, positively correlated with dietary practice ($\rho = 0.159$, $p = 0.0107$). Dietary-practice but not knowledge category, was significantly associated with anaemia status ($\chi^2 = 20.911$, $p < 0.001$ versus $\chi^2 = 5.05$, $p = 0.08$). Anaemia prevalence varied markedly by facility, from 14.3% to 44.8% not anaemic.

Conclusions

Antenatal nutrition counselling should move beyond generic iron-rich food messaging toward explicit, skills-based food-pairing guidance, individualised risk communication, and facility-level anaemia surveillance.

Background

Anaemia in pregnancy remains one of the most persistent and consequential nutritional public health problems worldwide, with more than 2 billion people globally affected by iron-deficiency anaemia (IDA), equivalent to approximately one-third of the world's population [1]. IDA has been identified as the second leading cause of disability worldwide, accounting for an estimated 50.3 million years lived with disability [2]. Although the burden of IDA spans both high-income and low- and middle-income countries (LMICs), it is disproportionately concentrated in LMICs, where prevalence is approximately five times higher than in high-income settings (43% versus 9%) [3], with the highest regional burden reported in sub-Saharan Africa (47.5%) and South-East Asia (35.7%) [4, 5].

Nearly half of pregnant women globally are affected by anaemia, with iron deficiency accounting for approximately half of this global burden [5], and IDA remains the single most important contributor to anaemia in pregnancy [3, 6]. Physiologically, IDA arises when iron intake, storage and loss are insufficient to sustain adequate erythropoiesis [6], a deficit that is amplified in pregnancy by the expansion of maternal blood volume and the iron demands of the developing fetus and placenta [7, 8]. IDA in pregnancy is associated with fatigue, weakness and impaired cognitive function [6], reduced productivity [9], and, in its more severe forms, pre-eclampsia and heightened susceptibility to infection [10]. Maternal IDA additionally elevates the risk of preterm birth, low birth weight and maternal morbidity [11], with potential long-term neurodevelopmental consequences for the offspring through fetal iron deficiency [12]. These consequences have placed IDA prevention firmly on the global maternal health agenda [13].

Despite decades of national iron-supplementation programming, the prevalence of anaemia among pregnant women in Nigeria remains persistently high, with rates exceeding 40% in many regions and reaching as high as 68% in parts of the country's northern states [9], and a national prevalence of 55% among Nigerian women of reproductive age reported by the World Bank in 2019 [14]. In Ogun State, South-West Nigeria, a facility-based study in Abeokuta reported an even higher prevalence of 76% [15]. While this persistent burden is commonly attributed to poverty, limited healthcare access and parasitic infection, emerging evidence increasingly implicates gaps in nutrition knowledge and dietary practice as pivotal, and often overlooked, determinants [16]. In particular, the problem extends beyond the mere availability of iron-rich foods to the more nuanced issue of dietary iron bioavailability: many pregnant women remain unaware that co-ingesting iron enhancers such as ascorbic acid (found in citrus fruits) with iron-rich meals facilitates absorption, while the concurrent consumption of iron inhibitors such as tea, coffee and milk substantially reduces it [16]. A 2023 Nigerian study similarly found that pregnant women who habitually consumed iron-absorption enhancers had a significantly lower risk of IDA than those who frequently consumed common inhibitors [17].

This evidence points to a specific, actionable knowledge and practice gap: while antenatal care provides an established platform for nutrition intervention, awareness of how to combine foods, by avoiding the simultaneous consumption of iron-rich meals with inhibitors, or deliberately pairing them with enhancers, appears low among pregnant women [18]. In Ogun State, where dietary patterns are predominantly plant-based, this specific knowledge gap could represent a significant, modifiable determinant of the region's persistently high anaemia burden. However, there is a paucity of contemporary research that specifically examines the knowledge, perceptions and dietary practices of pregnant women in Ogun State in relation to iron-absorption inhibitors and enhancers, as distinct from general iron-rich food knowledge. This study was therefore designed to address this gap using an exploratory sequential mixed-methods design, combining in-depth qualitative exploration of local beliefs and practices with a quantitative assessment of knowledge, perception, dietary practice and measured anaemia status among pregnant women attending antenatal care in Ogun State, Nigeria.

However, there is a paucity of contemporary research that specifically examines the knowledge, perceptions and dietary practices of pregnant women in Ogun State in relation to iron-absorption inhibitors and enhancers, as distinct from general iron-rich food knowledge. This study therefore used an exploratory sequential mixed-methods design, combining in-depth qualitative exploration of local beliefs and practices with a quantitative assessment of knowledge, perception, dietary practice and measured anaemia status among pregnant women attending antenatal care in Ogun State, Nigeria. Specifically, we explored women's opinions on dietary modulation of iron absorption, assessed their knowledge, perceptions and dietary practices, and examined the factors influencing these practices. We also determined the prevalence and severity of anaemia and investigated whether knowledge, perception and dietary practice were associated with each other and with anaemia status.

Methods

Study design

This study adopted an exploratory sequential mixed-methods design, in which qualitative data collection and analysis were conducted first, with findings subsequently used to inform the design and refinement of the quantitative phase [19]. This design was selected in preference to convergent or explanatory sequential alternatives because the research problem required that existing knowledge gaps regarding local beliefs, dietary practices and perceptions surrounding iron absorption first be explored qualitatively before being measured at scale. Qualitative data, gathered through in-depth interviews (IDIs), to contextualise and refine components of the quantitative instrument relating to local beliefs, perceptions and dietary practices; quantitative data were collected. Participants in the qualitative phase were drawn from the same three facilities as the quantitative phase but did not participate in the quantitative phase, to avoid duplication of data.

Study setting

The study was conducted in two Local Government Areas (LGAs) of Ogun Central Senatorial District, Ogun State, Nigeria: Ewekoro and Abeokuta South. Ewekoro LGA covers an area of 594 km² with an estimated population of 108,944, is predominantly rural, and is inhabited mainly by the Egba Owu sub-group of the Yoruba; its residents engage primarily in farming and trading. Abeokuta South LGA, the seat of Ogun State government, covers approximately 71 km² and recorded a population of 250,278 at the 2006 national census, making it one of the most densely populated and urbanised LGAs in the state; its economy combines civil service, trading and artisanal occupations. Respondents were drawn from three Primary Health Care (PHC) facilities: Obada PHC (Ewekoro LGA), and Kugba PHC and Oke-Ilewo PHC (both Abeokuta South LGA).

Study population and eligibility criteria

The target population comprised all pregnant women aged 18 to 49 years attending antenatal clinics at the three selected PHC facilities during the data-collection period, irrespective of gestational age. Inclusion criteria were: aged 18 to 49 years; currently registered and attending antenatal care (ANC) at one of the three selected facilities; and not managing a chronic illness that could independently affect iron metabolism or dietary intake (e.g., inflammatory bowel disease, renal disease). Exclusion criteria were: multiple gestation, given the distinctly elevated nutritional demands of multifetal pregnancy; and inability to understand English or Yoruba where a trained interpreter was not available. The potential for the language-based exclusion criterion to affect representativeness is acknowledged; trained interpreters were engaged where feasible to minimise exclusion on linguistic grounds.

Sample size and sampling procedure

A multi-stage sampling procedure was used for the quantitative phase. Ogun State was purposively selected as the study area; Ogun Central Senatorial District was purposively selected from the three senatorial districts comprising Ogun State on the basis of logistical accessibility and the concentration of comparably equipped PHC facilities offering both antenatal and basic haematology services. Two of the six LGAs comprising Ogun Central Senatorial District (Ewekoro and Abeokuta South) were then selected by simple random sampling (balloting). One PHC offering antenatal care was subsequently selected by simple random sampling from Ewekoro LGA (Obada PHC), and two were similarly selected from Abeokuta South LGA (Kugba PHC and Oke-Ilewo PHC). Given the manageable size of the eligible antenatal population accessible at the three facilities over the extended data-collection period, a total-population (census) sampling approach was adopted for the quantitative phase, in place of a formula-derived probability sub-sample; a census approach of this kind is appropriate where the accessible population is of manageable size, as it maximises statistical power and representativeness relative to a smaller formula-derived sample [20]. All eligible, consenting pregnant women attending the three facilities during the data-collection period were recruited consecutively, yielding a final quantitative

sample of 258 respondents: Oke-Ilewo PHC, n = 116 (45.0%); Obada PHC, n = 72 (27.9%); and Kugba PHC, n = 70 (27.1%).

For the qualitative phase, participants who had not participated in the quantitative phase were purposively recruited from the same three facilities, to avoid duplication of data. Sample size was determined by data saturation rather than fixed in advance, consistent with established best practice for qualitative sample-size determination in health research [21]; recruitment and interviewing continued until no substantially new themes or perspectives emerged, yielding a final sample of 17 in-depth interviews (Kugba, n = 6; Obada, n = 3; Oke-Ilewo, n = 8).

Data collectionprocedure and instruments

Ethical approval and institutional permissions were obtained prior to any data-collection activity. In the qualitative phase, prospective participants were approached by the facility nurse-in-charge, and interviews, lasting approximately 20 to 25 minutes, were conducted individually in a private space by the researcher using open-ended questions, active listening and probing follow-up questions, with non-verbal cues recorded in a field journal. In the quantitative phase, the research team, comprising the principal investigator, a sociodemographer, a laboratory/health worker responsible for haemoglobin testing, and trained research assistants, underwent structured training and a mock data-collection exercise prior to fieldwork. Eligible women were identified through the antenatal register, screened against the inclusion and exclusion criteria, briefed on the study, and invited to provide written informed consent. Questionnaires were interviewer-administered to accommodate varying literacy levels, and a capillary haemoglobin measurement was obtained from each respondent during the same clinic visit. Quality-control procedures included standardised training of all research assistants, end-of-session review of completed questionnaires by the principal investigator to identify and resolve missing or implausible responses, double data entry, and routine field supervision.

A semi-structured IDI guide, comprising a sociodemographic section and open-ended questions addressing participants' understanding of anaemia, perceived causes, awareness of dietary strategies and of iron-absorption enhancers and inhibitors, barriers to adequate dietary iron intake, cultural beliefs and practices, and sources of health information, was used for the qualitative phase. The guide was developed in English, translated into Yoruba by a certified linguistics expert, and back-translated to verify conceptual equivalence; interviews were conducted in the respondent's preferred language, with code-switching between English and Yoruba occurring in places, and were audio-recorded and transcribed verbatim.

The quantitative instrument was a structured, interviewer-administered questionnaire developed for this study. It was adapted from the FAO guidelines for assessing nutrition-related knowledge, attitudes and practices [23] and from previously published instruments on iron-deficiency anaemia and iron-rich food intake [22,24,25,27], and was subsequently refined and expanded using findings from the qualitative phase (local terminology, food beliefs about tea, coffee and milk, and perceived barriers). As the

questionnaire is an adaptation rather than a reproduction of any single published tool, the full English version is provided as Additional File. It covered six domains: sociodemographic and economic characteristics (8 items); obstetric and medication history (8 items); knowledge, perception and dietary practice of iron-absorption modulation; and haemoglobin concentration.

Knowledge was assessed with 11 items comprising 43 individual statements, adapted from previously published instruments [23–25]. These covered general awareness, causes, signs and symptoms, at-risk groups, complications, prevention methods, heme iron-rich foods, and iron-absorption inhibitors and enhancers. Three items were single questions scored 1 mark for a correct response. The remaining eight were compound items with five sub-statements each, scored 1 mark when three or more sub-statements were answered correctly against the established True/False answer key. The maximum score was therefore 11, which was converted to a percentage and categorised as poor (<50%), moderate (50–74%) or good (≥75%), following Bloom's cut-off convention [26].

Perception was assessed with six items on perceived susceptibility, perceived severity, and attitudes towards preparing, affording and enjoying iron-rich foods, consistent with Health Belief Model constructs. Each item was scored on a 3-point scale (aggregate range 6–18) and re-expressed as a percentage. Scores below 50% were classified as negative perception and scores of 50% or above as positive. Scores were also categorised as poor, moderate or good for comparability with the knowledge and practice constructs.

Dietary practice was assessed with four behavioural items (alcohol avoidance, timing of citrus-fruit consumption relative to meals, habitual tea or coffee consumption, and timing of tea or coffee intake relative to meals) and a 13-item food-frequency checklist, adapted from [27]. The checklist covered weekly consumption of five iron-absorption-enhancing fruits, five iron-rich animal-source foods and three iron-absorption-inhibiting dairy products. Favourable-practice scores were summed, expressed as a percentage of the maximum obtainable score, and categorised as poor (<50%), moderate (50–74%) or good (≥75%). Finally, haemoglobin concentration was measured directly rather than self-reported.

Capillary blood haemoglobin concentration was measured for each consenting quantitative-phase respondent using a calibrated point-of-care digital haemoglobinometer, following a sterile, single-use lancet finger-prick performed by a trained laboratory/health worker under standard infection-control procedures. Anaemia status was classified using World Health Organization (2011) haemoglobin thresholds for pregnancy: not anaemic (≥11.0 g/dl), mild anaemia (10.0–10.9 g/dl), moderate anaemia (7.0–9.9 g/dl) and severe anaemia (<7.0 g/dl) [28].

Reliability and validity of instruments

Face and content validity of the quantitative instrument were assessed through expert review by specialists in Community Health Nursing, Nutrition and Dietetics, Socio-demography, Obstetrics and Health Education, supplemented by relevant literature; ambiguous items were reworded and repetitive

items removed. The questionnaire was translated into Yoruba by a linguistic expert and back-translated to verify conceptual equivalence. The instrument was pre-tested with approximately 26 pregnant women (10% of the calculated feasible sample) attending Keesi Primary Health Centre, Abeokuta South LGA, a facility with a comparable client profile that was not among the three study facilities, thereby avoiding contamination of the main sample. Internal consistency was assessed using Cronbach's alpha, calculated separately for the knowledge, perception and dietary-practice scales, with a minimum acceptable value of 0.70 [29]; items yielding low item-total correlations were revised or removed. For the qualitative instrument, trustworthiness was addressed according to the criteria of Lincoln and Guba [30]: credibility was supported by prioritising direct quotation over paraphrase and repeated verification against verbatim transcripts; transferability was supported by purposive sampling across three facilities yielding a range of ages, parity, educational levels and antenatal-attendance patterns; and dependability was supported by the use of a consistent interview guide across all three sites and audio-recording of all interviews.

Statistical analysis

Quantitative data were compiled, cleaned, coded and entered into Microsoft Excel before export to IBM SPSS Statistics (version 23.0) for analysis. Descriptive statistics (frequencies, percentages, means and standard deviations) were used to summarise sociodemographic and obstetric characteristics and to describe the distribution of knowledge, perception, dietary-practice and anaemia-status variables. The normality of the continuous composite scores (knowledge, perception, dietary practice and haemoglobin concentration) was assessed using the Shapiro-Wilk test; as all four variables departed significantly from normality ($p<0.05$), non-parametric inferential procedures were adopted throughout. Spearman's rank-order correlation was used to examine the relationship between knowledge and dietary-practice scores and between perception and dietary-practice scores. The Mann-Whitney U test was used to compare median knowledge and dietary-practice scores between anaemic and non-anaemic respondents, and the chi-square test of independence was used to test associations between categorical knowledge, perception and dietary-practice classifications and anaemia status. All tests were two-tailed, with statistical significance set at $p<0.05$.

Qualitative data were analysed using reflexive thematic analysis, following the six-phase framework of Braun and Clarke [21,31]. Audio recordings were transcribed verbatim; Yoruba-language transcripts were translated into English by a certified linguistics expert and back-translated to verify accuracy. Transcripts were imported into NVivo 11 and read repeatedly to achieve familiarisation. Initial codes were generated through systematic, line-by-line analysis, collated into candidate themes and sub-themes, and iteratively reviewed against the transcripts for coherence and distinctiveness before final naming and reporting, supported by illustrative verbatim quotations.

A distinctive feature of the exploratory sequential design is the deliberate, sequential integration of qualitative and quantitative findings [19]. In this study, integration occurred at the design level, whereby

emergent qualitative themes concerning local terminology, food beliefs, perceived barriers and culturally embedded practices were used to refine the content and phrasing of the quantitative instrument, and at the interpretation level, whereby the qualitative and quantitative findings were triangulated and jointly interpreted, consistent with the principle of complementarity in mixed-methods research, wherein qualitative data provide contextual depth that enriches the breadth of quantitative findings [19].

Ethical considerations

Ethical approval was obtained from the Babcock University Ogun State and Ogun State Health Research Ethics Committee with reference numbers BUHREC 817/23 and OGHREC/467/209 respectively. Letters of introduction and permission were obtained from the office of the President of the West African Postgraduate College of Nursing and Midwives and from the Medical Officers of Health of the two selected LGAs. Written informed consent was obtained from all participants, with provision for thumbprint consent from those unable to sign. Participant names did not appear on any study instrument; unique identification codes were assigned for data-management purposes, and electronic data were stored on password-protected devices accessible only to the principal investigator and designated research-team members. Audio recordings were deleted upon completion of transcription, and study data will be retained for a minimum of five years before secure destruction, in accordance with institutional data-management guidelines. Participation carried minimal risk, the primary risks being the time required to complete interviews or questionnaires and the transient discomfort or minor bruising associated with the finger-prick blood sample, which was minimised through the use of sterile, single-use lancets administered by trained personnel.

Results

Qualitative findings: opinions of pregnant women regarding dietary modulation of iron absorption

In-depth interviews were conducted with 17 pregnant women across the three study facilities (Kugba, n = 6; Obada, n = 3; Oke-Ilewo, n = 8) until data saturation was reached. Participants ranged in age from 22 to 34 years; the majority (15/17) were married. Educational attainment ranged from primary to tertiary level, and parity ranged from nullipara (predominantly among Oke-Ilewo respondents) to grand multipara. Antenatal attendance in the index pregnancy ranged from a first to a sixth visit, and haemoglobin values recorded at interview ranged from 7.3 to 11.6 g/dl (Table 1).

Table 1. Sociodemographic and obstetric profile of qualitative study participants (n = 17)

IDI code	Facility	Age (years)	Marital status	Education	Parity	ANC visits	Hb (g/dl)
K1	Kugba	31	Married	Tertiary	3	6	10.1
K2	Kugba	26	Married	Secondary	1	4	7.3
K3	Kugba	25	Married	Secondary	3	2	9.4
K4	Kugba	24	Married	Secondary	1	1	10.1
K5	Kugba	34	Married	Tertiary (ND)	2	2	11.4
K6	Kugba	31	Married	Secondary	1	1	11.6
O1	Obada	29	Single	Tertiary	1	2	8.9
O2	Obada	25	Married	Secondary	1	4	7.6
O3	Obada	25	Married	Tertiary	1	4	9.2
OK1	Oke-Ilewo	27	Married	Tertiary	0	2	11.0
OK2	Oke-Ilewo	34	Married	Tertiary	0	3	9.5
OK3	Oke-Ilewo	28	Married	Tertiary	0	2	6.0
OK4	Oke-Ilewo	23	Married	Secondary	0	2	8.3
OK5	Oke-Ilewo	22	Married	Secondary	0	3	8.3
OK6	Oke-Ilewo	23	Married	Primary	0	3	10.2
OK7	Oke-Ilewo	31	Married	Secondary	0	2	7.8
OK8	Oke-Ilewo	22	Single	Primary	0	5	10.3

Eight interrelated themes were generated from the dataset using reflexive thematic analysis [21].

Theme 1: a fragmented, experience-based understanding of anaemia

Across all three facilities, participants' understanding of anaemia was built primarily around lay, experiential descriptions of ‘shortage’ or ‘insufficiency’ of blood, rather than the biomedical construct of iron deficiency; the specific term ‘iron deficiency anaemia’ was unfamiliar to the majority.

“It means that someone is not nutritionally balanced and it will cause shortage of blood and also dizziness from time to time.”

— K1, Kugba, age 31

Theme 2: attributed causes of anaemia in pregnancy

Participants attributed anaemia in pregnancy to a combination of dietary (inadequate or unbalanced diet), physiological (pregnancy-related nausea, vomiting and appetite loss), behavioural (non-adherence to prescribed haematinics) and, less commonly, psychosocial factors.

“Pregnancy is a stranger in the body... in the first trimester, some pregnant women are not always quick to eat... to meet those balanced diets will be difficult in the first three months.”

— K1, Kugba, age 31

Theme 3: dietary knowledge for iron-level enhancement

Participants demonstrated fairly consistent, broadly accurate knowledge of protein- and vegetable-based iron sources, but showed minimal spontaneous awareness of the biochemical mechanisms of absorption enhancement (e.g., vitamin C/ascorbic acid) or inhibition (e.g., tannins, phytates). Across all 17 interviews, no participant spontaneously named vitamin C, citrus fruit, tannins or phytates as absorption modulators.

“A person should eat beans, egg, vegetables, ewedu and also drink enough water.”

— K1, Kugba, age 31

Theme 4: contested beliefs about tea, coffee and milk

Beliefs regarding tea, coffee and milk consumption during pregnancy were heterogeneous and, in several cases, directly at odds with the biomedical rationale (iron-absorption inhibition) that the study sought to explore, with some participants instead attributing beverage avoidance to prevention of an oversized baby and difficult delivery.

“According to what I heard, they have always been saying that pregnant women should not take beverages... it can cause the baby to be big... and that will lead to CS.”

— OK8, Oke-Ilewo, age 22

“No, tea or milk cannot cause shortage of blood... it will increase the amount of blood.”

— OK1, Oke-Ilewo, age 27

Theme 5: barriers to optimal dietary iron practice

Participants identified financial constraints, physiological barriers (vomiting, appetite loss), attitudinal factors, and health-system factors such as pill burden and perceived staff hostility as consistent barriers to adherence with recommended dietary and pharmacological practices.

“Fruits are now expensive and everything, so based on their financial situation, they may not be able to take those things.”

— O1, Obada, age 29

Theme 6: cultural and traditional blood-building practices

A repertoire of traditional and home-based practices for ‘building blood’ was reported across all three facilities, ranging from sweetened concoctions (tomato and Fanta; malt and milk) to unnamed herbal preparations; attitudes toward these practices were mixed.

“She buys tomato and Fanta... mixes it till it is smooth... by the end of the week... there are already changes.”

— K2, Kugba, age 26

Theme 7: perceived benefits of preventing anaemia

Participants consistently associated the prevention of anaemia with safe delivery and maternal and fetal wellbeing.

“My baby will be able to have enough blood... there won't be any form of deformity... it will grow well and I'll also be okay.”

— O1, Obada, age 29

Theme 8: sources of information and cues to action

The antenatal clinic emerged as the dominant and most trusted source of information on anaemia prevention, with symptom experience and blood-test results serving as tangible cues prompting preventive action.

“Whatever the doctor says is what goes, because they are telling us for our benefit.”

— K4, Kugba, age 24

In summary, the reflexive thematic analysis revealed that pregnant women in this population hold a broadly experience-based, rather than biomedically precise, understanding of anaemia; are reasonably well informed about iron-rich food sources; but hold limited and, in places, contradictory beliefs regarding the role of tea, coffee and milk in iron absorption, shaped by financial constraints, physiological change, health-system factors and traditional blood-building practices.

Sociodemographic, economic and obstetric characteristics of respondents (quantitative phase)

A total of 258 pregnant women participated in the quantitative phase, with the largest proportion drawn from Oke-Ilewo PHC (45.0%). The mean age of respondents was 27.8 ± 5.1 years, and the modal age band was 25–29 years (38.8%). The overwhelming majority were married (95.3%) and of Yoruba ethnicity (87.6%). Educational attainment was moderate, with over half (55.0%) having attained only secondary education and 3.1% having received no formal education. Most respondents (66.7%) were in their second trimester, and 47.3% were primigravidae. Adherence to routine antenatal iron supplementation was encouraging, with 74.4% reporting daily haematinic use; however, 8.5% reported never taking their tablets, representing a subgroup at elevated risk that antenatal counselling should specifically target (Table 2).

Table 2. Sociodemographic, economic and obstetric characteristics of respondents (n = 258)

Variable / category	n	%
Age group (years)		
<20	6	2.3
20–24	68	26.4
25–29	100	38.8
30–34	56	21.7
≥35	28	10.9
Marital status		
Married	246	95.3
Single	10	3.9
Other	2	0.8
Educational level		
None	8	3.1
Primary	8	3.1
Secondary	142	55.0
Tertiary	100	38.8
Religion		
Christianity	168	65.1
Islam	88	34.1
Other	2	0.8
Ethnicity		
Yoruba	226	87.6
Igbo	20	7.8
Other	12	4.7
Occupation		
Artisan	100	38.8
Business	50	19.4
Professional	42	16.3
Petty trading	32	12.4

Housewife	18	7.0
Unemployed	10	3.9
Other	6	2.3
Average monthly household income		
<₦20,000	40	15.5
₦20,000–50,000	108	41.9
₦51,000–99,000	46	17.8
₦100,000–200,000	44	17.1
>₦200,000	20	7.8
Health facility		
Oke-Ilewo	116	45.0
Obada	72	27.9
Kugba	70	27.1
Gestational trimester		
1st (≤3 months)	8	3.1
2nd (4–6 months)	172	66.7
3rd (7–9 months)	78	30.2
Parity		
Primigravida (0)	122	47.3
1–2 children	112	43.4
≥3 children	24	9.3
Number of babies (this pregnancy)		
Singleton	212	82.2
Don't know	38	14.7
Twin	6	2.3
Triplet or more	2	0.8
Longstanding medical condition		
No	248	96.1
Yes	10	3.9

Haematinic (iron/folate) use		
Never	22	8.5
1–3 times/week	40	15.5
4–6 times/week	4	1.6
Everyday	192	74.4
Anti-malaria prophylaxis uptake		
None	60	23.3
Once	98	38.0
Twice	62	24.0
Thrice	24	9.3
>3 times	14	5.4
Deworming uptake		
None	234	90.7
Once	16	6.2
Twice	8	3.1

Knowledge of dietary modulation of iron absorption

Respondents demonstrated strong recognition of general anaemia facts, with signs/symptoms (88–94% correct) and prevention methods (88–90% correct) well identified. However, correct rejection of false distractor statements was consistently weak (fever as a symptom: 17.1%; sleeping well as prevention: 23.3%; sunlight as a cause: 29.5%), reflecting a tendency to over-endorse plausible but incorrect claims rather than a true gap in general anaemia awareness, a pattern that echoes the fragmented, experience-based understanding of anaemia identified qualitatively (Theme 1). The most critical deficits were mechanism-specific: only 10.9% correctly identified milk as an iron-absorption inhibitor rather than enhancer, and heme/non-heme discrimination was almost absent (green leafy vegetables wrongly deemed ‘easily absorbed’: 6.2% correct; beans: 8.5% correct), directly corroborating the qualitative finding that no participant spontaneously named absorption enhancers or inhibitors (Theme 3). Two-thirds of respondents (65.9%) also incorrectly believed that anaemia in pregnancy cannot be prevented. Overall, 21.7% of respondents had poor knowledge, 57.4% moderate knowledge, and 20.9% good knowledge of dietary modulation of iron absorption (Table 3), indicating that the deficit lies not in general anaemia awareness but in the specific, actionable knowledge of which foods enhance versus inhibit iron absorption.

Table 3. Knowledge of dietary modulation of iron absorption among respondents (n = 258)

Knowledge statement (established answer)	Correct, n (%)	Incorrect, n (%)
Anaemia		
Do you know how to prevent anaemia?	148 (57.4)	110 (42.6)
Anaemia is a condition of low red blood cells due to poor nutrition (True)	208 (80.6)	50 (19.4)
Anaemia during pregnancy cannot be prevented (False)	88 (34.1)	170 (65.9)
Cause		
Infections (True)	164 (63.6)	94 (36.4)
Excessive sunlight exposure (False)	76 (29.5)	182 (70.5)
Eating too little (True)	168 (65.1)	90 (34.9)
Not drinking enough tea (False)	124 (48.1)	134 (51.9)
Heavy menstrual bleeding (True)	196 (76.0)	62 (24.0)
Symptom		
Tiredness (True)	228 (88.4)	30 (11.6)
Fever (False)	44 (17.1)	214 (82.9)
Dizziness (True)	242 (93.8)	16 (6.2)
Vomiting (False)	106 (41.1)	152 (58.9)
Paleness/pallor (True)	232 (89.9)	26 (10.1)
At risk		
Girls <18 years (True)	158 (61.2)	100 (38.8)
Low family income (True)	142 (55.0)	116 (45.0)
Family history of anaemia (True)	186 (72.1)	72 (27.9)
Not using iron supplements (True)	198 (76.7)	60 (23.3)
Low educational level (True)	102 (39.5)	156 (60.5)
Complication		
Increased disease susceptibility (True)	208 (80.6)	50 (19.4)
Very big baby (False)	152 (58.9)	106 (41.1)
Risk of maternal death (True)	216 (83.7)	42 (16.3)
Premature delivery (True)	192 (74.4)	66 (25.6)

Delayed infant mental development (True)	172 (66.7)	86 (33.3)
Prevention		
Sleeping well (False)	60 (23.3)	198 (76.7)
Taking oral iron/folic acid regularly (True)	228 (88.4)	30 (11.6)
Drinking tea with meals (False)	96 (37.2)	162 (62.8)
Eating vitamin C rich foods with meals (True)	220 (85.3)	38 (14.7)
Eating iron-rich foods (True)	232 (89.9)	26 (10.1)
Heme source		
Organ meat (True)	224 (86.8)	34 (13.2)
Green leafy vegetables (False)	16 (6.2)	242 (93.8)
Insects (True)	50 (19.4)	208 (80.6)
Flesh meat (True)	200 (77.5)	58 (22.5)
Beans (False)	22 (8.5)	236 (91.5)
Inhibitor		
Tea (True)	102 (39.5)	156 (60.5)
Coffee (True)	126 (48.8)	132 (51.2)
Milk (True)	108 (41.9)	150 (58.1)
Alcohol (False)	68 (26.4)	190 (73.6)
Tomatoes (False)	148 (57.4)	110 (42.6)
Enhancer		
Tea (False)	56 (21.7)	202 (78.3)
Orange (True)	220 (85.3)	38 (14.7)
Milk (False)	28 (10.9)	230 (89.1)
Tomatoes (True)	214 (82.9)	44 (17.1)
Pineapple (True)	204 (79.1)	54 (20.9)
Overall knowledge category	**Frequency**	**Percentage**
Poor (<50%)	56	21.7
Moderate (50–74%)	148	57.4
Good (≥75%)	54	20.9

'Correct' = response matches the scientifically established answer key; 'incorrect' = wrong or 'don't know' response.

Perception towards dietary modulation of iron absorption

Respondents held a predominantly positive perception towards dietary modulation of iron absorption, with a mean aggregate perception score of 83.9% ± 13% and 98.4% of respondents classified as holding a positive overall perception. Perceived severity of IDA, ease of preparing iron-rich meals, confidence in meal preparation, and liking for the taste of iron-rich foods were all rated favourably (item means 2.81–2.90 on a 1–3 scale). By contrast, perceived personal susceptibility to anaemia was comparatively low (item mean 1.69), with only 23.3% of respondents feeling personally 'likely' to be anaemic. Under the Health Belief Model, low perceived susceptibility can blunt motivation to adopt protective dietary practices even where broader attitudes are positive, and may partly explain why favourable perception scores did not translate into a correspondingly strong dietary-practice score (Table 4).

Table 4. Perception towards dietary modulation of iron absorption among respondents (n = 258)

Perception item	**Mean score (1–3)**	**Favourable response (%)**
Perceived likelihood of being anaemic	1.69	23.3
Perceived seriousness of iron-deficiency anaemia	2.81	82.9
Perceived goodness of preparing iron-rich food	2.93	94.6
Perceived ease of preparing iron-rich meals	2.87	91.5
Confidence preparing iron-rich meals	2.88	89.9
Liking for taste of iron-rich foods	2.90	91.5
Overall perception category	**Frequency**	**Percentage**
Positive (≥50%)	254	98.4
Negative (<50%)	4	1.6

Source: field survey data, 2026. Aggregate perception score range = 6–18, re-expressed as a percentage of the achievable range.

Dietary practice related to modulation of iron absorption

The mean dietary-practice score was 51.7% ± 13.2% of the maximum obtainable score. The majority of respondents (62.8%) exhibited moderate dietary practice, more than a third (36.4%) exhibited poor practice, and less than 1% (0.8%) achieved good practice, a markedly weaker profile than the corresponding knowledge and perception distributions. Respondents performed well on alcohol

avoidance (87.6%) but poorly on practices requiring specific technical knowledge of iron-absorption dynamics: only 26.4% avoided habitual tea/coffee consumption, and only 14.0% separated tea/coffee intake from mealtimes by the recommended two-hour interval, a quantitative echo of the contested beliefs about tea, coffee and milk documented qualitatively (Theme 4). Food-frequency data showed generally frequent consumption of enhancer fruits and iron-rich animal-source foods (62–85% consumed ≥2–5 times weekly); however, consumption of iron-inhibiting dairy products was also frequent (79–92% consumed ≥2–5 times weekly), indicating that respondents were not deliberately timing or limiting inhibitor intake relative to iron-rich meals (Table 5).

Table 5. Dietary practice related to modulation of iron absorption among respondents (n = 258)

Practice indicator	Favourable practice (%)	
Total avoidance of alcoholic drinks	87.6	
Consumes citrus fruit during/after meals (enhances absorption)	39.5	
Does not habitually take tea/coffee	26.4	
Separates tea/coffee intake from meals by ≥2 hours	14.0	
Orange (enhancer, ≥2–5×/week)	68.2	
Tangerine (enhancer, ≥2–5×/week)	84.5	
Watermelon (enhancer, ≥2–5×/week)	72.1	
Pawpaw (enhancer, ≥2–5×/week)	82.9	
Pineapple (enhancer, ≥2–5×/week)	77.5	
Meat (iron-rich, ≥2–5×/week)	63.6	
Offal (iron-rich, ≥2–5×/week)	81.4	
Fresh fish (iron-rich, ≥2–5×/week)	72.1	
Chicken (iron-rich, ≥2–5×/week)	77.5	
Egg (iron-rich, ≥2–5×/week)	62.0	
Evaporated milk (inhibitor, ≥2–5×/week)	80.6	
Powdered milk (inhibitor, ≥2–5×/week)	79.8	
Cheese/wara (inhibitor, ≥2–5×/week)	92.2	
Overall dietary practice category	**Frequency**	**Percentage**
Poor (<50%)	94	36.4
Moderate (50–74%)	162	62.8
Good (≥75%)	2	0.8

Haemoglobin status and prevalence of anaemia

The mean haemoglobin concentration among respondents was 10.1 ± 1.27 g/dl (mean haematocrit 30.27 ± 3.91%). Applying World Health Organization cut-offs for anaemia in pregnancy, the overall prevalence of anaemia was 68.2%, a rate that classifies anaemia in this population as a severe public health problem by WHO prevalence thresholds (≥40%). Most anaemic respondents fell within the mild (34.9%) and moderate (31.0%) categories, with a smaller proportion (2.3%) classified as severely anaemic (Table 6). This high prevalence, occurring despite generally positive perceptions and reportedly

high haematinic adherence, suggests that anaemia in this population is unlikely to be attributable to supplement non-adherence alone, and is consistent with a substantial contribution from suboptimal iron-absorption-modulating dietary practice.

Table 6. Haemoglobin concentration and anaemia status of respondents (n = 258)

Anaemia status (WHO classification)	n	%
Not anaemic (≥11.0 g/dl)	82	31.8
Mild anaemia (10.0–10.9 g/dl)	90	34.9
Moderate anaemia (7.0–9.9 g/dl)	80	31.0
Severe anaemia (<7.0 g/dl)	6	2.3

Mean haemoglobin: 10.1 ± 1.27 g/dl. Mean haematocrit: 30.27 ± 3.91%. Classification per WHO (2011) haemoglobin thresholds for pregnancy.

Relationship between knowledge, perception, dietary practice and anaemia status

Table 7 show that there is no significant relationship between knowledge of dietary modulation of iron absorption and dietary practice. Spearman's correlation revealed a statistically significant, weak, negative relationship between knowledge and dietary-practice scores ($\rho = -0.218$, $p = 0.0004$). This inverse association, in which respondents with higher knowledge scores tended to report marginally lower practice scores, is counter-intuitive but not without precedent in the knowledge-attitude-practice literature; a plausible explanation is that respondents already identified as anaemic or nutritionally at-risk receive more intensive antenatal knowledge counselling without a corresponding opportunity or resource to translate that knowledge into practice, a possibility partly corroborated by the finding that anaemic respondents had a significantly higher median practice score than non-anaemic respondents (Mann-Whitney U, $p = 0.01$) and a significantly lower median knowledge score ($p = 0.0302$). Also there is no significant relationship between perception and dietary practice, is likewise rejected: a statistically significant, weak, positive correlation was found ($\rho = 0.159$, $p = 0.0107$), indicating that more favourable perceptions were modestly associated with better dietary practice, in the theoretically expected direction. Chi-square tests of association showed that dietary-practice category was significantly associated with anaemia status ($\chi^2 = 20.911$, $df = 2$, $p < 0.001$), whereas knowledge category showed only a borderline, non-significant association with anaemia status ($\chi^2 = 5.05$, $df = 2$, $p = 0.08$).

Table 7. Associations of knowledge, perception, and dietary practice scores with each other and with anaemia status

Variables correlated		ρ (rho)	p-value	n
Knowledge score vs. dietary practice score		−0.218	0.0004	258
Perception score vs. dietary practice score		0.159	0.0107	258
Knowledge score vs. perception score		0.193	0.0018	258
Chi-square test of association with anaemia status				
Variable	**χ²**	**df**	**p-value**	
Knowledge category	5.05	2	0.08	
Dietary practice category	20.911	2	<0.001	
Mann-Whitney U test: median scores by anaemia status				
Score	**Median, anaemic**	**Median, not anaemic**	**U**	**p-value**
Dietary practice score	55.4 (n=176)	48.2 (n=82)	8652	0.01
Knowledge score	63.6 (n=176)	72.7 (n=82)	6024	0.0302

Significance level set at p<0.05 (two-tailed).

Distribution of knowledge, perception and dietary practice categories (n = 258)

Figure 1 juxtaposes the three composite constructs on a common categorical scale, showing that while the majority of respondents cluster in the 'moderate' category for knowledge and the 'good' category for perception, the dietary-practice distribution is shifted markedly towards the 'poor' and 'moderate' categories, with almost no respondents (0.8%) achieving 'good' dietary practice; this gradient, practice lagging behind both knowledge and perception, is the clearest single illustration of the knowledge/perception-to-practice translation gap identified in the inferential analysis.

Figure 2 disaggregates anaemia severity by health facility and reveals marked facility-level variation not evident from the pooled figures in Table 6. Not-anaemic proportions ranged from 44.8% at Oke-Ilewo (52 of 116) to just 14.3% at Kugba (10 of 70), with Obada intermediate at 27.8% (20 of 72); correspondingly, moderate-to-severe anaemia was concentrated at Kugba (44 of 70, 62.9%) and Obada (34 of 72, 47.2%), against only 8 of 116 (6.9%) at Oke-Ilewo. This facility-level clustering suggests that catchment-specific factors, such as local dietary patterns, food security, or the intensity of antenatal nutrition counselling delivered at each site, may be contributing to anaemia risk over and above individual-level knowledge, perception and practice.

Convergence of qualitative and quantitative findings

The qualitative and quantitative strands showed a high degree of convergence. The qualitative finding that participants held a fragmented, experience-based understanding of anaemia (Theme 1) and showed minimal spontaneous awareness of absorption enhancers/inhibitors (Theme 3) is mirrored quantitatively in the weakest items of the knowledge scale (10.9% correct on milk as an inhibitor; 6.2% and 8.5% correct on the heme/non-heme status of green leafy vegetables and beans, respectively). Similarly, the contested lay beliefs about tea, coffee and milk documented qualitatively (Theme 4) are reflected in the low favourable-practice rates for the corresponding behavioural items (26.4% avoiding habitual tea/coffee consumption; 14.0% separating tea/coffee from meals by the recommended interval). The barriers to optimal dietary practice identified qualitatively (Theme 5) offer a plausible explanatory context for the quantitative finding that dietary practice, rather than knowledge or perception, was the construct most strongly associated with measured anaemia status.

Discussion

The mean age of respondents (27.8 ± 5.1 years) and the predominance of the 25–29-year age band (38.8%) place the sample within the peak reproductive age range, consistent with comparable Nigerian antenatal populations [15]. The near-universal married status (95.3%) and Yoruba ethnic composition (87.6%) reflect the demographic profile of Ogun Central Senatorial District, broadly consistent with sociodemographic patterns reported elsewhere in South-West Nigeria [17]. Over half of respondents (55.0%) had attained only secondary education, notable given the well-established inverse relationship between maternal education and anaemia risk documented across sub-Saharan Africa [5, 10]: low educational attainment restricts both health literacy and the effective uptake of dietary counselling messages. Adherence to routine haematinic supplementation was comparatively high (74.4% daily use); however, the residual 8.5% who reported never taking their tablets represents a small but clinically important subgroup that supplementation-based prevention strategies are not reaching, reinforcing the rationale for a complementary dietary strategy.

The qualitative findings revealed that participants' understanding of anaemia was organised around lay, experiential concepts of ‘shortage’ or ‘insufficiency’ of blood rather than the biomedical construct of iron deficiency, with the term ‘iron deficiency anaemia’ unfamiliar to most participants. This pattern mirrors findings from comparable qualitative work in Ethiopia, where pregnant women, relatives and even some health workers expressed limited biomedical understanding of anaemia despite general awareness of its everyday manifestations [32]. More striking was the contested, and in places directly counter-biomedical, beliefs regarding tea, coffee and milk (Theme 4), in which several participants held that avoiding these beverages was necessary to prevent an oversized baby and difficult delivery, rather than to prevent iron malabsorption. Such competing lay causal models are well documented in the West African qualitative literature on pregnancy nutrition: a study of food taboos and myths among mothers in South-Eastern Nigeria similarly found that avoidance behaviours were frequently grounded in beliefs about fetal size, delivery difficulty and folk aetiology rather than nutrient-absorption science, irrespective of maternal educational attainment [33]. The cultural ‘blood-building’ practices identified in Theme 6 further illustrate how, in the absence of confident biomedical understanding, pregnant women in this setting draw on

intergenerational and community knowledge systems to manage a condition they experience but do not necessarily conceptualise in clinical terms.

Overall, 57.4% of respondents demonstrated moderate knowledge and 20.9% good knowledge of dietary modulation of iron absorption, with only 21.7% classified as having poor knowledge; at the aggregate level this appears reassuring. However, the item-level analysis revealed that this aggregate figure masks a sharp and consistent divide between general anaemia awareness, which was strong (88–94% correct on signs/symptoms), and specific, mechanism-level knowledge of iron-absorption enhancers and inhibitors, which was very weak: only 10.9% of respondents correctly identified milk as an absorption inhibitor rather than an enhancer, and fewer than one in ten correctly classified green leafy vegetables (6.2%) or beans (8.5%) as non-heme rather than heme iron sources. This pattern closely replicates findings among pregnant women in a rural district of Northern Ghana, where only 16.3% of respondents knew which foods enhance iron absorption and just 9.1% knew which beverages reduce it, despite generally adequate awareness of iron-rich food sources themselves [34]. The mechanistic basis for this specific knowledge gap is well established biochemically: ascorbic acid is the principal dietary enhancer of non-heme iron absorption, while phytates, polyphenols/tannins and calcium are its principal inhibitors [35], precisely the enhancer/inhibitor mechanisms that respondents in both the qualitative and quantitative phases of this study were least able to identify. This suggests that antenatal nutrition education in this setting may be successfully conveying that iron-rich foods exist, without equally conveying how their absorption can be maximised or undermined by other components of the same meal.

Respondents held a predominantly positive overall perception (98.4% positive; mean score 83.9%), with particularly favourable attitudes toward the severity of IDA and toward the ease, affordability and enjoyment of preparing iron-rich meals, consistent with Health Belief Model-informed studies elsewhere in sub-Saharan Africa, where perceived severity of anaemia in pregnancy is typically rated highly [36]. The marked exception was perceived personal susceptibility, which was comparatively low (mean 1.69; only 23.3% felt personally ‘likely’ to be anaemic) despite the study's own biological data showing that 68.2% of the same sample were, in fact, anaemic. This susceptibility–reality gap is theoretically important: within the Health Belief Model, perceived susceptibility is one of the strongest and most consistent predictors of preventive health behaviour, and a Tanzanian study using the same framework similarly found that perceived risk of anaemia was a significant positive predictor of good dietary-diversity practice, while low perceived susceptibility was associated with poorer practice [36]. The comparatively muted perceived-susceptibility scores observed here therefore offer a plausible behavioural explanation, additional to the knowledge-specificity gap discussed above, for why generally favourable perceptions did not translate into correspondingly strong dietary practice.

Dietary practice was the weakest of the three composite constructs measured: only 0.8% of respondents achieved good practice, compared with 20.9% good knowledge and 88.4% good perception, and the mean practice score (51.7%) sat barely above the moderate threshold. This knowledge/perception-to-practice gradient is consistent with a substantial body of knowledge-attitude-practice literature on

maternal nutrition showing that knowledge is typically a necessary but insufficient condition for translating into favourable dietary behaviour [34, 37]. At the item level, respondents performed comparatively well on the single behaviour requiring simple avoidance (alcohol, 87.6% favourable) but poorly on behaviours requiring active, mechanism-specific food-pairing decisions: only 26.4% avoided habitual tea/coffee consumption and only 14.0% separated tea/coffee intake from meals by the recommended interval, despite frequent (79–92%) weekly consumption of iron-inhibiting dairy products. This is a direct behavioural echo of the contested beliefs about tea, coffee and milk documented qualitatively (Theme 4): where a competing, non-biomedical explanation for beverage avoidance already exists in the community, the biomedically correct behaviour and the culturally sanctioned behaviour can, and in this case did, diverge in practice, aligning with the broader West African evidence that food-pairing behaviour during pregnancy is frequently governed by cultural rationale rather than nutrient-absorption science [33].

The study revealed a statistically significant, weak, negative correlation between knowledge and dietary-practice scores ($\rho = -0.218$, $p = 0.0004$), a counter-intuitive direction that nonetheless has precedent in the knowledge-attitude-practice literature. A plausible explanation, partly corroborated by the Mann-Whitney findings, is a form of reverse causation common in antenatal-care settings: women already identified as anaemic or nutritionally at-risk typically receive more intensive, repeated dietary counselling from health workers precisely because of their diagnosis, elevating their measured knowledge without necessarily providing them the material means to convert that counselling into practice, a dynamic also flagged qualitatively (Theme 5, financial and physiological barriers). By contrast, perception and dietary-practice scores were significantly, positively correlated ($\rho = 0.159$, $p = 0.0107$), consistent with Health Belief Model logic [36]. Most decisively, dietary-practice category, not knowledge category, was significantly associated with measured anaemia status ($\chi^2 = 20.911$, $p < 0.001$ versus $\chi^2 = 5.05$, $p = 0.08$ for knowledge), consistent with the wider evidence that knowledge alone is rarely sufficient to alter iron status, with the Ghanaian study similarly identifying nutrition knowledge as a determinant of dietary practice specifically, rather than a direct determinant of iron status [34]. Taken together, these results indicate that interventions in this population should prioritise practice-level, skills-based nutrition counselling over purely didactic knowledge transmission.

The overall anaemia prevalence of 68.2% observed in this study classifies anaemia in this population as a severe public health problem under WHO prevalence thresholds (≥ 40%), and is markedly higher than the 55% national prevalence reported for Nigerian women of reproductive age [14], though it is broadly consistent with, and indeed lower than, the 76% facility-level prevalence previously reported for Abeokuta [15], suggesting a persistently high local burden in this specific catchment area across studies. This high prevalence, occurring despite generally positive respondent perceptions and self-reported haematinic adherence of 74.4%, reinforces the interpretation that dietary practice, rather than supplementation non-adherence or attitudinal deficit, is a key modifiable contributor to anaemia risk in this population, consistent with evidence that iron-absorption-modulating dietary behaviour can meaningfully affect iron status independently of supplementation status [12, 35].

A key contribution of this study is the demonstration of marked facility-level variation in anaemia burden that is entirely obscured by the pooled prevalence figure. Not-anaemic proportions ranged from 44.8% at Oke-Ilewo to just 14.3% at Kugba, with moderate-to-severe anaemia affecting 62.9% of respondents at Kugba compared with only 6.9% at Oke-Ilewo, despite both facilities being located within the same LGA (Abeokuta South) and administered under the same broad health system. This finding resonates with recent Nigerian evidence that dietary diversity alone insufficiently explains regional and sub-regional differences in anaemia prevalence [16], implying that catchment-specific factors beyond individual diet, such as local food security, market access, water and sanitation conditions, malaria transmission intensity, or variation in the quality and consistency of antenatal nutrition counselling delivered at each site, may be contributing independently to anaemia risk. This finding has direct implications for intervention design: a uniform, facility-blind anaemia-prevention programme risks under-serving higher-burden facilities such as Kugba, and facility-level surveillance, rather than reliance on LGA- or state-level aggregates, may be necessary to detect and respond to such variation.

Consistent with the complementarity principle in mixed-methods research, whereby qualitative data provide contextual depth that enriches quantitative breadth [19], the two strands of this study converged on a consistent overall narrative: the qualitative finding of a fragmented, experience-based understanding of anaemia and minimal spontaneous awareness of absorption enhancers/inhibitors is numerically mirrored in the weakest items of the quantitative knowledge scale; the qualitative finding of contested, non-biomedical beliefs about tea, coffee and milk is mirrored in the low favourable-practice rates for the corresponding behavioural items; and the qualitative barriers to optimal dietary iron practice offer a plausible, human-centred explanatory context for why dietary practice, despite generally favourable perception, remained the weakest construct and the one most strongly tied to anaemia status. This triangulated agreement across independently collected qualitative and quantitative data strengthens confidence in the study's central finding: that the primary barrier to anaemia prevention in this population is not a lack of general awareness or a deficit of positive attitude, but a specific, identifiable, and therefore addressable, gap in mechanism-level knowledge and its translation into food-pairing practice.

Study Implication for Practice, Policy, and towards Future Research

Antenatal nutrition counselling should move beyond generic messaging on ‘eating iron-rich foods’ to explicit, skills-based food-pairing counselling, for example practical demonstrations of consuming citrus fruit or other vitamin C sources alongside iron-rich meals, and separating tea/coffee consumption from meals by at least two hours, given that this specific enhancer/inhibitor knowledge was the narrowest gap identified in both phases of the study [34, 35]. Health education messaging should directly and respectfully engage with the competing lay beliefs identified qualitatively, particularly the belief that tea, coffee or milk avoidance relates to fetal size rather than iron absorption, rather than assuming that biomedical information alone will displace existing cultural explanations [33].

Given the low perceived personal susceptibility identified despite high measured anaemia prevalence, counselling should incorporate individualised risk communication, for example sharing and explaining each woman's own haemoglobin result, to strengthen perceived susceptibility as a motivational lever for behaviour change [36]. Given the pronounced facility-level variation in anaemia severity, facility-specific anaemia surveillance and targeted resource allocation, for example prioritising Kugba PHC for intensified counselling and supplementation follow-up, is recommended over a uniform, facility-blind approach.

Ogun State Ministry of Health antenatal care protocols should formally incorporate dietary iron-absorption modulation (food-pairing, timing of inhibitor-containing beverages) as a standard component of nutrition counselling, alongside routine haematinic supplementation. In-service training curricula for antenatal health workers should include specific content on the biochemical mechanisms of iron-absorption enhancement and inhibition [35]. Routine antenatal data systems should capture and report facility-level, rather than only LGA- or state-level, anaemia indicators, to enable early detection of the kind of localised clustering identified in this study.

A longitudinal or quasi-experimental study is recommended to test whether targeted, food-pairing-focused nutrition counselling produces measurable improvements in dietary-practice scores and haemoglobin concentration. Further research should examine the catchment-specific factors (food security, market access, water/sanitation, malaria transmission, counselling quality) underlying the facility-level variation in anaemia severity identified in this study. Future studies should incorporate ferritin or other iron-status biomarkers alongside haemoglobin, to distinguish iron-deficiency anaemia specifically from anaemia attributable to other causes. A larger, multi-senatorial-district study, sampling facilities from Ogun East and Ogun West in addition to Ogun Central, would strengthen the generalisability of these findings across Ogun State as a whole.

Limitations

Cross-sectional design phases captured knowledge, perception, dietary practice and haemoglobin status at a single point in time; causal or directional inferences, for example regarding the negative correlation between knowledge and dietary practice, should be treated as hypothesis-generating rather than confirmatory. Dietary practice was assessed via self-reported behavioural and food-frequency items, which are subject to social desirability and recall bias, particularly given that respondents were interviewed by research assistants attached to the same clinics from which they received antenatal care. All three facilities were located within Ogun Central Senatorial District (Ewekoro and Abeokuta South LGAs only); findings may not generalise to Ogun East or Ogun West Senatorial Districts, or to LGAs with different dietary, health-system or socioeconomic profiles.

Non-probability elements within a census framework: although the quantitative phase achieved total enumeration of consenting eligible attendees at each facility, the facilities themselves and the data-collection window were not randomly selected from all possible facilities and time-periods, which may

introduce a degree of selection bias. Single haemoglobin measurement: anaemia status was determined from a single point-of-care capillary haemoglobin reading per respondent, without confirmatory venous sampling or ferritin-based assessment of iron stores; the absence of ferritin measurement means the study could not distinguish iron-deficiency anaemia specifically from anaemia due to other causes (e.g., malaria, other micronutrient deficiencies) [38]. The 17 in-depth interviews, while sufficient to reach thematic saturation, were drawn from the same three facilities as the quantitative phase; transferability of the qualitative themes to pregnant women in other health systems, religions, or ethnic contexts within Nigeria should be made cautiously.

Conclusions

In this exploratory sequential mixed-methods study of pregnant women attending three Primary Health Care facilities in Ogun State, Nigeria, general knowledge and perception of dietary modulation of iron absorption were largely favourable, but dietary practice was very poor and anaemia was highly prevalent. Qualitative findings showed an experience-based understanding of anaemia and good familiarity with iron-rich foods. However, beliefs about tea, coffee and milk were limited and often contradictory, shaped by financial constraints, pregnancy-related changes, health-system factors and traditional blood-building practices. Quantitatively, only 0.8% of the 258 respondents demonstrated good dietary practice, and knowledge of iron-absorption enhancers and inhibitors was the narrowest gap across both phases. The 68.2% prevalence of anaemia meets the WHO threshold for a severe public health problem and varied considerably between facilities, which pooled estimates conceal. Dietary practice, but not knowledge, was significantly associated with anaemia status. These findings suggest that the main barrier is not a lack of general awareness but a gap between knowledge and practical food-pairing behaviour. Antenatal nutrition counselling should therefore give explicit, skills-based guidance on food pairing, and facility-level anaemia surveillance should be strengthened.

Abbreviations

ANC, antenatal care; FAO, Food and Agriculture Organization; Hb, haemoglobin; IDA, iron-deficiency anaemia; IDI, in-depth interview; KAP, knowledge, attitudes and practice; LGA, Local Government Area; PHC, Primary Health Care; WAPCNM, West African Postgraduate College of Nursing and Midwives; WHO, World Health Organization.

Declarations

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Author contribution

OMA conceived and designed the study, led data collection and the qualitative and quantitative analyses, and drafted the manuscript. DDA and EDO contributed to the conception and design of the study, supervised the analysis, and critically revised the manuscript for important intellectual content. MBB, AMO, AEO, JE, VEO, and ARO contributed to instrument development, data collection oversight and interpretation of findings. AMO, JE, and VEO contributed to data management, statistical analysis and manuscript revision. All authors read and approved the final manuscript.

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Data availability

The datasets generated and/or analysed during the current study are available from the corresponding author on reasonable request.

Ethical approval

Ethical approval was obtained from the Babcock University Ogun State and Ogun State Health Research Ethics Committee with reference numbers BUHREC 817/23 and OGHREC/467/209 respectively. Letters of introduction and permission were obtained from the office of the President of the West African Postgraduate College of Nursing and Midwives and from the Medical Officers of Health of Ewekoro and Abeokuta South Local Government Areas. Written informed consent was obtained from all participants prior to data collection, with provision for thumbprint consent from those unable to sign. All methods were carried out in accordance with relevant guidelines and regulations, including the Declaration of Helsinki.

Clinical trial number

Not applicable

Consent to participate

Prior to data collection, detailed information regarding the study objectives, procedures, potential benefits, and participants' rights was provided to all eligible mothers/caregivers. Written informed consent was obtained from all participants prior to data collection, with provision for thumbprint consent from those unable to sign. All methods were carried out in accordance with relevant guidelines and regulations, including the Declaration of Helsinki.

Consent to publish

Written informed consent for the publication of anonymised verbatim quotations was obtained from all in-depth interview participants. No identifying images or individual-level information that could identify a participant are included in this manuscript.

Competing interests

The authors declare no competing interests

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Figures

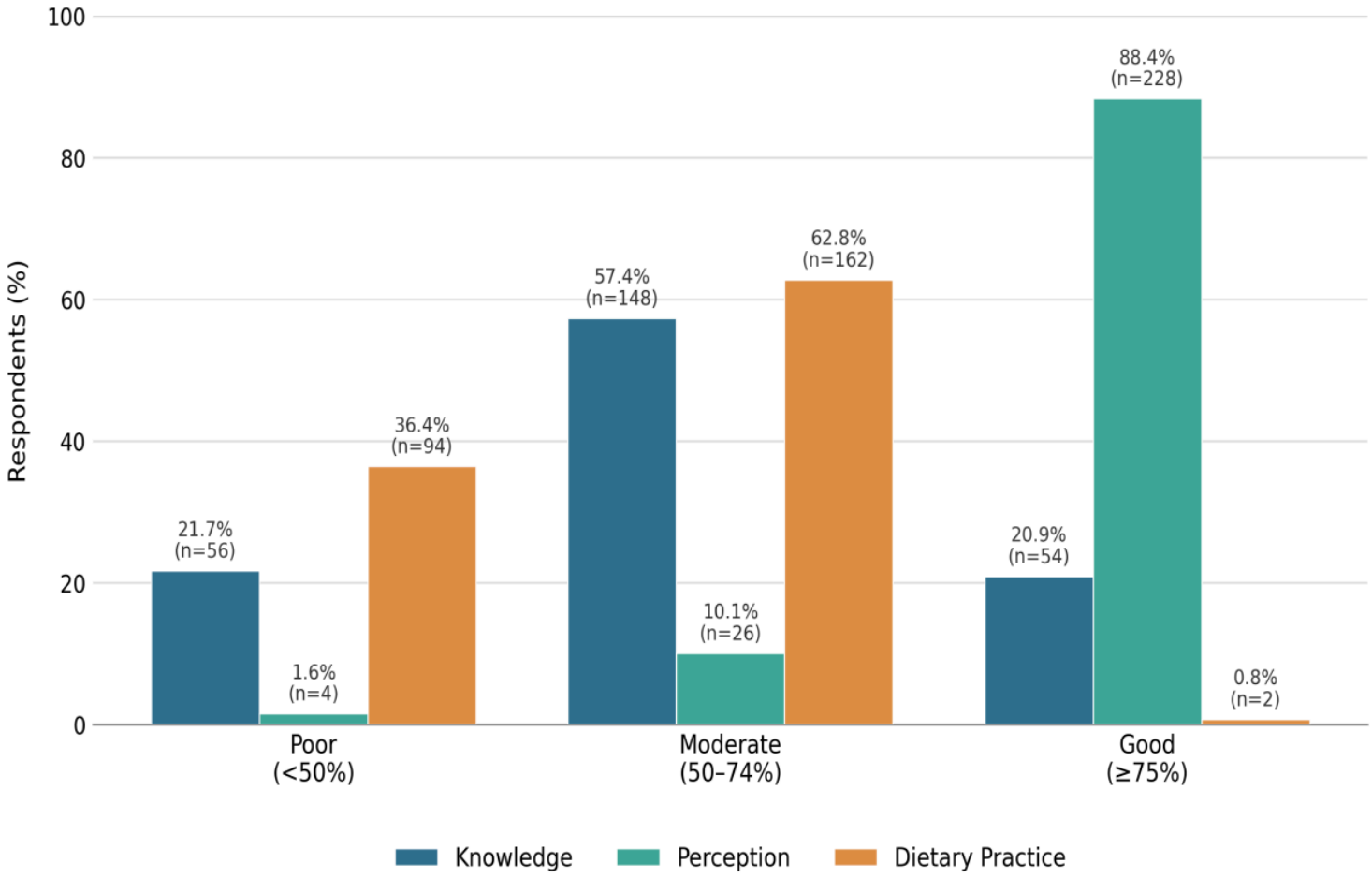


Figure 1

Distribution of knowledge, perception and dietary practice categories (n = 258).

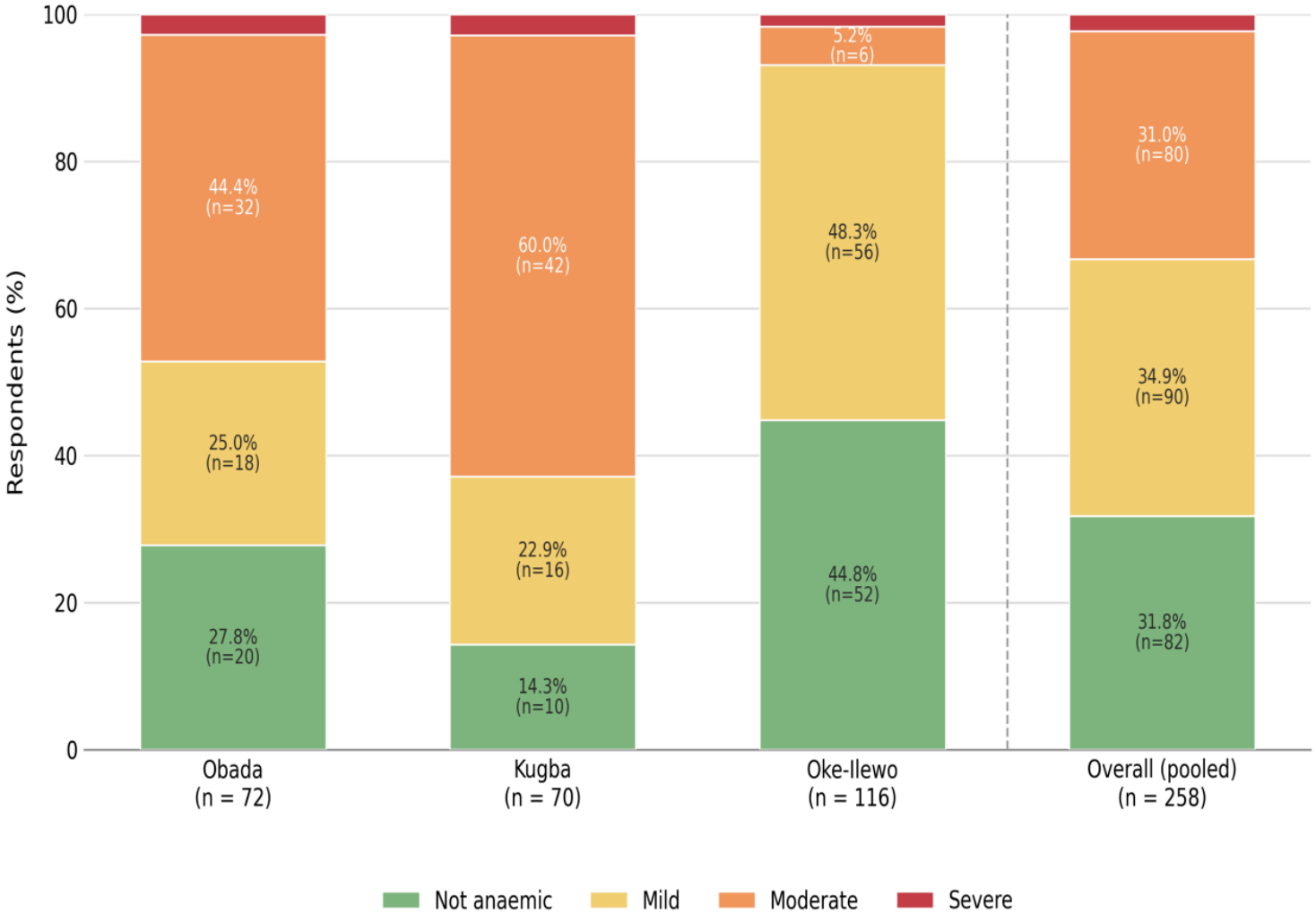


Figure 2

Anaemia severity distribution by health facility, based on haemoglobin concentration (n = 258).

Supplementary Files

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- AdditionalFileQuestionnaire.pdf