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Article

Micronutrient Intake and Its Association with Anemia Among Pregnant Women in Ogbomoso, Nigeria

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Abstract

Background/Objectives: Anemia remains a significant public health concern among pregnant women in low-income countries like Nigeria. Largely driven by micronutrient deficiencies, it leads to poor outcomes. This study examines pregnant women's micronutrient intake and evaluates its relationship with anemia to inform targeted interventions. **Methods:** This cross-sectional study involved 87 pregnant women attending antenatal clinics in Ogbomoso, Nigeria. Data on sociodemographic factors, dietary intake, and anthropometry were collected. Micronutrient intake was assessed using 24-hour recall and dietary diversity questionnaires. Hemoglobin was measured with an automated analyzer, and anemia was defined by WHO criteria. Descriptive statistics summarized participant characteristics, while logistic regression assessed associations between micronutrient intake and anemia. Ethical approval and informed consent were obtained. **Results:** Most participants were aged 25–34, self-employed, and earned less than ₦50,000 monthly. Dietary analysis revealed widespread inadequacies in key micronutrients, including vitamins A, D, B1, B2, B6, C, folate, calcium, iron, and zinc, with over 90% failing to meet recommended dietary allowances. Anemia affected 48.2%, primarily mild cases, with no severe anemia observed. No significant anthropometric or blood pressure differences were noted between anemic and non-anemic women. However, low vitamin B2 intake was significantly associated with anemia ($p = 0.021$). Strong positive correlations were found between vitamin B12 and both vitamin D ($r = 0.969$) and E ($r = 0.960$). **Conclusions:** Anemia and low micronutrient intake are common among pregnant women in Ogbomoso. Regular hemoglobin checks, early detection of deficiencies, improved antenatal care, dietary guidance, and timely interventions like dietary diversification and supplementation are essential to address related health risks effectively.

Keywords: micronutrient deficiency; anaemia; haemoglobin; pregnant women

1. Introduction

Micronutrient deficiencies, commonly referred to as “hidden hunger,” remain a pressing global health concern, disproportionately affecting low- and middle-income countries [1–3]. Among the most vulnerable groups are pregnant women, who face heightened nutritional demands to support foetal development, placental function, and maternal health [4]. These demands are often unmet in

resource-limited settings, leading to a high prevalence of micronutrient deficiencies and their associated health consequences [5,6]. Anemia, characterized by insufficient hemoglobin levels, is a well-documented outcome of micronutrient deficiencies during pregnancy, affecting an estimated 36.5% of pregnant women globally [7]. In Sub-Saharan Africa (SSA), including Nigeria, the prevalence ranges from 35% to 70%, with various factors identified as contributing aetiology to this high rate [8,9]. Anemia prevalence that varies significantly across SSA with Burkina Faso 54.4%, Ghana 50.8%, and South-Western Nigeria 56.3% [10–13].

While iron deficiency is recognized as the leading cause of anemia, contributing to approximately 50% of cases (Stevens et al., 2013), deficiencies in other essential micronutrients—such as folate, vitamin B12, zinc, and vitamin A—are increasingly acknowledged as significant contributors [14,15].

Micronutrients play a pivotal role in maternal and foetal health. Iron and folate are critical for hemoglobin synthesis and DNA replication, while vitamin B12 supports neurological development and immune function [14,16]. Zinc facilitates enzymatic reactions and cellular growth, and vitamin A contributes to immune competence and vision [17]. Deficiencies in these nutrients not only exacerbate the risk of anemia but also increase susceptibility to adverse maternal and foetal outcomes, including preterm delivery, low birth weight, and intrauterine growth restriction [1].

In Nigeria, the dietary habits of many pregnant women reflect limited diversity, with diets predominantly consisting of starchy staples and limited intake of animal-sourced foods, fruits, and vegetables [18,19]. This pattern results in inadequate intakes of bioavailable essential nutrients like iron, zinc, and vitamin B12 crucial for both optimal maternal and foetal health, which are often found in animal products. Furthermore, socio-cultural practices, such as food taboos and restrictions during pregnancy, further limit dietary diversity and micronutrient adequacy [18]. Seasonal variations in food availability also play a role in shaping dietary patterns and exacerbate nutritional deficits during critical periods [19,20].

Despite the inclusion of Iron and Folic Acid (IFA) supplementation in routine antenatal care (ANC) programs with plans to transit to Multiple Micronutrient Supplementation (MMS), compliance remains suboptimal in Nigeria, with factors such as poor awareness, side effects, and inconsistent supply chains contributing to low adherence [9,21,22]. Consequently, anemia persists as a major public health concern, underscoring the need for complementary strategies that address dietary practices and overall micronutrient intake.

Studies have established a strong link between dietary diversity and reduced anemia prevalence. Previous studies demonstrated that improved dietary diversity significantly enhances micronutrient adequacy and reduces the risk of anemia among pregnant women in resource-constrained settings [19,23]. Similarly, the potential of food-based interventions, such as fortified staples and nutrition education, to address micronutrient deficiencies in sub-Saharan Africa are highlighted [3]. However, there is a paucity of localized research examining these associations within specific populations, such as pregnant women in Ogbomoso, Nigeria.

This study seeks to bridge this gap by investigating the relationship between dietary intake of key micronutrients and anemia prevalence among pregnant women in Ogbomoso. The findings aim to contribute to the growing body of evidence needed to design culturally sensitive and sustainable interventions for improving maternal nutrition and reducing the burden of anemia in similar settings.

2. Materials and Methods

2.1. Study Design

This is a cross-sectional study designed to investigate the association between micronutrient intake and anemia among pregnant women in Ogbomoso, Nigeria. The study involved the collection of dietary intake data, biomarker assessments, and hemoglobin levels to evaluate micronutrient deficiencies and their relationship to anemia.

2.2. Sampling and Ethics

The study population comprised pregnant women aged 18–45 years, residing in Ogbomoso, who were within their second or third trimester of pregnancy. Participants were recruited from healthcare facilities providing antenatal care services within the study area. Eligible participants were pregnant women aged 18–45 years, who had attended at least one antenatal care session, and were within their second or third trimester. They must have provided informed consent and reported no pre-existing chronic illnesses (e.g., diabetes, hypertension, or kidney disease) or conditions that could affect hemoglobin levels, such as hemoglobinopathies. Exclusion criteria included women with acute or chronic infections (e.g., malaria or HIV/AIDS), those receiving iron therapy beyond standard antenatal supplementation, or those unwilling to provide blood samples or dietary information.

A total of 88 pregnant women participated in the study from 2 healthcare facilities in Ogbomoso, Nigeria.

2.3. Study Variables

- Socio-demographic and Clinical Information: A structured questionnaire was used to collect data on participants' socio-demographic characteristics (e.g., age, education, and socioeconomic status) and clinical history (e.g., gravidity, parity, and antenatal supplementation use).

- Dietary Assessment: A 24-hour dietary recall and Dietary Diversity Questionnaire (DDQ) were administered to evaluate participants' micronutrient intake using methods earlier described (39). Nutrient intake data were analyzed using food composition tables and dietary analysis software.

- Hemoglobin Measurement: Venous blood samples were collected to measure hemoglobin levels using an automated hematology analyzer.

- Anemia Classification: Anemia was defined based on World Health Organization (WHO) criteria as hemoglobin levels below 11.0 g/dL during pregnancy. The severity of anemia was further categorized as mild (10.0–10.9 g/dL), moderate (7.0–9.9 g/dL), or severe (<7.0 g/dL).

2.4. Statistical Analysis

All data were analyzed using STATA statistical software (version 17; Stata Corp LLC, College Station, TX, USA). Descriptive statistics, including means, standard deviations, and frequency distributions, were used to summarize participants' socio-demographic characteristics, dietary intake, and hemoglobin levels. Categorical variables such as anemia classification and supplementation use were presented using absolute counts (n) and percentages (%).

To examine relationships between micronutrient intake, biochemical markers, and anemia status, chi-square (χ^2) tests were used for categorical comparisons. Logistic regression models were applied to assess the strength of associations between independent variables (e.g., nutrient intakes) and the likelihood of anemia, adjusting for relevant covariates where appropriate. Interaction effects and effect sizes were evaluated, and the statistical significance threshold was set at $p < 0.05$ for all analyses.

2.5. Ethics Approval

The study protocol was approved by the Institutional Review Board (IRB) of the Oyo State Ministry of Health with approval number NHREC/OYOSHRIEC/10/11/22. Written informed consent was obtained from all participants, and all data were anonymized to protect participants' confidentiality.

3. Results

The sociodemographic data of the pregnant women presented in Table 1 reveals significant insights into their profiles. Majority of the pregnant women (60.2%) are aged 25–34, followed by 20.5% aged 35–49, and 19.3% aged 15–24. Their husbands are predominantly aged 31–40 (47.7%), with 29.5% aged ≤ 30 , and 22.7% aged 41 and above. Yoruba is the dominant ethnic group, representing 94.3% of

respondents, with minimal representation from Igbo (3.4%), Benin (1.1%), and Rivers (1.1%) tribes. Christianity is the prevailing religion (65.9%), while Islam accounts for 34.1%. Marital status indicates nearly all parents are married (98.9%), with only 1.1% being single.

Table 1. Sociodemographic Characteristics of Pregnant Women.

Variable	Categories	Frequency	Percentage (%)
Women's age	15-24	17	19.3
	25-34	53	60.2
	35-49	18	20.5
Husband's age	≤30	26	29.5
	31-40	42	47.7
	41 and above	20	22.7
Tribe	Benin	1	1.1
	Igbo	3	3.4
	Rivers	1	1.1
	Yoruba	83	94.3
Religion	Christianity	58	65.9
	Islam	30	34.1
Marital status	Married	87	98.9
	Single	1	1.1
Women's Education	B.sc /B.Ed. /HND	26	35.1
	NCE/OND	14	18.9
	PGDE and above	3	4.1
	Primary Education	31	41.9
Husband's Education	B.Sc. /B.Ed. /HND	39	44.3
	NCE/OND	13	14.8
	PGDE and above	3	3.4
	Primary Education	33	37.5
Women's Occupation	Professional	15	17.0
	Self employed	43	48.9
	Semi-professional	5	5.7
	Skilled Worker	24	27.3
	Student	1	1.1
Women's Income (Naira)	<50,000	56	63.6
	50,000 – 100,000	25	28.4
	100,000 – 150,000	6	6.8
	150,000 – 200,000	1	1.1
Parity	1	28	31.8
	2	27	30.7
	3	19	21.6
	4	5	5.7
	5	4	4.5
	6	3	3.4
Pregnant trimester	Second trimester	5	5.7
	Third trimester	78	88.6
BMI	Underweight	0	0.0
	Normal	24	36.4
	Overweight/Obesity	42	5

¹ Tables may have a footer.

Educational attainment reveals that most pregnant women hold SSCE qualifications (41.9%), while 35.1% have tertiary degrees (BSc/B.Ed./HND). Similarly, their husbands predominantly possess BSc/B.Ed./HND (35.2%), with 29.5% having SSCE. The husbands exhibit slightly higher tertiary education levels than mothers, suggesting varied socioeconomic dynamics. For pregnant women, self-employment is the most common occupation (48.9%), followed by skilled workers (27.3%) and professional roles (17%).

The income data of the women indicates a predominant low-income group, with 63.6% earning less than 50k. A smaller proportion of them earn between 50k-100k (28.4%), while only a few fall into higher income brackets, such as 100k-150k (5.7%) and 150k-200k (1.1%). This suggests that most mothers in this group have limited financial resources. In terms of parity, the distribution shows that most women have 1 or 2 children, with 31.8% having one child and 30.7% having two children. Fewer women have 3 (21.6%), 4 (5.7%), 5 (4.5%), or 6 (3.4%) children, indicating a tendency toward smaller family sizes within this group. Regarding pregnancy trimester distribution, the overwhelming majority (88.6%) are in their third trimester, while a small percentage (5.7%) are in their second trimester. This suggests that the study population is primarily composed of mothers who are in the later stages of their pregnancies.

Table 2 summarizes the hematological and blood pressure status of the study group comprising 83 participants. Among the participants, 51.8% had normal hemoglobin levels (Hb >11 g/dL), while 48.2% were anemic (Hb <11 g/dL). Of those with anemia, 44.6% had mild anemia (Hb 9.0–11 g/dL), and 3.6% had moderate anemia (Hb 7.0–8.9 g/dL), with no cases of severe anemia (Hb <7.0 g/dL). Regarding blood pressure, 14.6% of participants were pre-hypertensive based on systolic blood pressure (SBP: 120–129 mmHg), while 11.0% were hypertensive (SBP >130 mmHg). For diastolic blood pressure (DBP), 2.4% were pre-hypertensive (DBP: 90–99 mmHg), and 1.22% had hypertensive DBP (>100 mmHg). This data suggests a notable prevalence of mild anemia and elevated blood pressure parameters, highlighting potential risks for adverse maternal and foetal outcomes. Figure 1 shows the prevalence of anemia among the participants. Of the 83 participants, 40 (48.2%) were classified as anemic, while 43 (51.8%) were considered normal.

Table 2. Prevalence of Anemia and blood pressure amongst Pregnant women.

Study group	Total Frequency (%)
Normal (Hb >11g/DL)	43/83 (51.8%)
Anemia (Hb < 11g/DL)	40/83 (48.2%)
Mild Anemia (9.0 - 11g/DL)	37/83 (44.6%)
Severe Anemia (<7.0gDL)	Nil
Pre-Hypertensive Systolic Blood Pressure (SBP) (120 - 129 mmHg)	12/82 (14.6%)
Hypertensive SBP (>130 mmHg)	9/82 (11.0%)
Pre-Hypertensive Diastolic Blood Pressure (DBP) (90 -99 mmHg)	2/82 (2.4%)
Hypertensive DBP (>100 mmHg)	1/81 (1.22%)

The comparison of anthropometric and packed cell volume (PCV) parameters in Table 3 between anemic and normal groups reveals several notable findings. Mothers weight is higher in the anemic group (72.05±2.36 kg) compared to the normal group (67.01±1.76 kg), but the difference is not statistically significant (p = 0.091). Similarly, height measurements (156.76±1.05 cm vs. 157.89±1.09

cm, $p = 0.455$) did not show significant differences between the groups. Body Mass Index (BMI) is slightly higher in the anemic group (29.52 ± 1.19) compared to the normal group (26.93 ± 0.86), but this difference is also not significant ($p = 0.077$).

Table 3. Comparison of Anthropometric parameters Between Anemic and Normal Groups.

Subject	Anemic	Normal	P-Value
Mothers weight (Kg)	72.05 ± 2.36	67.01 ± 1.76	0.091
Mothers' height (cm)	156.76 ± 1.05	157.89 ± 1.09	0.455
Mothers BMI	29.52 ± 1.19	26.93 ± 0.86	0.077

Table 4 presents nutrient intake of pregnant women showing significant variability when compared to the Recommended Dietary Allowances (RDA). Carbohydrate intake was generally adequate for 83% of participants, but protein intake was insufficient for 56%. Key micronutrients such as vitamin A, B1, B2, B6, C, and folate were severely inadequate, with over 90% of participants not meeting their RDAs. Vitamin D and calcium inadequacies were also notable, with 92% and 96% of participants failing to meet the RDAs, respectively. Iron and zinc deficiencies were observed in 90% and 87% of participants. Conversely, selenium and phosphorus intake showed better results, with 26% and 25% adequacy, respectively. Overall, the findings highlight a significant gap in meeting RDAs, particularly for vitamins and minerals critical for maternal and infant health justifying the need for pregnant women in Nigeria to consume a more diverse diet or for Supplementation during pregnancy to prevent adverse health outcomes due to these micronutrient deficiencies.

Table 4. Micronutrient Intake and Adequacy of pregnant women in relation to their Recommended Dietary Allowance (RDA).

Nutrient	RDA	Intake (Mean \pm SD)	%Adequacy	%Inadequacy
Carbohydrate	175g/d	332.78 ± 244.24	72/88 (83.0%)	17.0%
Protein	71g/d	75.75 ± 44.84	38/88 (44.2%)	55.8%
Vitamin A	770 μ /g	30 [3.61-250.05]	1/77 (1.3%)	98.70%
Vitamin B1	1.4mg/d	0.38 [0.1-1.55]	4/82 (4.9%)	95.1%
Vitamin B2	1.4mg/d	0.46 ± 0.41	4/82 (4.9%)	95.1%
Vitamin B3	18mg/d	10.58 ± 8.78	16/82 (19.5%)	80.5%
Vitamin B6	1.9mg/d	0.65 [0.31-3.37]	4/82 (5.1%)	94.9%
Vitamin B12	2.6 μ /g	1.23 [0.01-3.26]	31/77 (40.3%)	59.7%
Vitamin C	85mg/d	1.62 [0.01-15.1]	4/79 (5.1%)	94.9%
Vitamin D	15 μ /g	0.32 [0.01-4.68]	7/87 (8.1%)	92.0%
Vitamin E	15mg/d	1.81 [0.81-7.14]	4/78 (5.3%)	94.7%
Folate	600 μ /g	77.48 [18.23 -205.84]	2/77 (2.6%)	97.4%
Copper	1000 μ /g	12.20 [4.96 -30.1]	0/86 (0.0%)	100.0%
Iron	27mg/d	10.43 [6.99 -16.79]	9/88 (10.2%)	89.8%
Zinc	12mg/d	4.90 [3.21 -7.99]	11/87 (12.6%)	87.4%
Calcium	1300mg/d	172.43 [91.37 -308.49]	4/88 (4.5%)	95.5%
Selenium	60 μ /g	47.12 ± 43.63	20/76 (26.3%)	73.4%
Iodine	220 μ /g	528.09 ± 514.63	0/7 (0.0%)	100.0%
Phosphorus	700mg/d	368.97 [158.64 -678.60]	19/77 (24.7%)	75.3%

Dietary diversity of the pregnant women based on their consumption of various food groups from the DDQ was summarized in Table 5. Most participants consumed grains, white roots/tubers/plantains (76.1%) and other vegetables (77.8%). However, consumption was notably low for vitamin A-rich fruits and vegetables (6.8%), nuts and seeds (20.3%), and other fruits (13.6%). Overall, the data indicate limited dietary diversity, with many participants not consuming nutrient-rich food groups essential for optimal nutrition. The mean Minimum Dietary Diversity for Women (MDD-W) score was 3.55 ± 2.38 . Most of the pregnant women (65.9%) had a minimum dietary

diversity threshold (MDD-W < 5), indicating suboptimal dietary diversity and risk of micronutrient deficiency.

Table 5. Minimum dietary diversity scores (MDD-W) of food groups consumed by the pregnant women.

Food groups	Yes (consumed)	No (not consumed)
Grains, white roots and tubers, plantains	67 (76.1%)	21 (23.9%)
Pulses (beans, peas and lentils)	25 (41.7%)	35 (58.3%)
Nuts and seeds ^(a)	12 (20.3%)	47 (79.7%)
Dairy	32 (36.4%)	56 (63.6%)
Meat, poultry and fish	48 (54.6%)	40 (45.4%)
Eggs	24 (38.7%)	38 (61.3%)
Dark green leafy vegetables ^(b)	36 (40.9%)	52 (59.1%)
Other vitamin A-rich fruits and vegetables ^(c)	6 (6.8%)	82 (93.2%)
Other vegetables ^(d)	49 (77.8%)	14 (22.2%)
Other fruits ^(e)	12 (13.6%)	76 (86.4%)

a - Groundnut, ogbono, melon seed, cashews etc. b- Ewedu, water leave, bitter leave, zobo leave, zobo leaves, okazi, afang, etc c- carrots, mango, pumpkin, pawpaw, etc. d - Tomato, garden egg, okro, cucumber, cabbage, etc. e -Grapes, orange, guava, tangerine, watermelon, etc.

	Minimum score	Maximum score	Mean ± SD
MDD-W	1.0	10.0	3.55 ± 2.38
N (%)	MDD-W < 5 58 (65.9%)	MDD-W ≥ 5 30 (34.1%) ¹	

The comparison of blood pressure, and Micronutrient intake between anemic and normal groups in Table 6 showed notable differences. Blood pressure readings reveal no significant differences, with the systolic blood pressure averaging 106.98±1.65 in the anemic group and 111.00±2.50 in the normal group (p = 0.183), and the diastolic blood pressure averaging 61.32±1.64 in the anemic group and 63.46±1.86 in the normal group (p = 0.389). Vitamin B2 intake was significantly lower in the anemic group (0.36±0.05) compared to the normal group (0.57±0.07, p = 0.021). Although not statistically significant, Vitamin A and carbohydrate intakes were lower in the anemic group compared to the normal group. Conversely, Vitamin B6 intake was slightly higher in the anemic group (0.91±0.19) than in the normal group (0.81±0.13), but the difference was not significant. Other nutrients, including protein, Vitamin B1, Vitamin B3, Vitamin B12, Vitamin C, Vitamin D, and Vitamin E, showed no notable differences between the two groups. Folate levels were also comparable between the anemic (144.27±27.97) and normal groups (145.19±29.74, p = 0.982).

Table 6. Comparison of Micronutrient Intake, Blood Pressure between Anaemic and Normal Groups.

Parameters	Anaemic	Normal	P-Value
Protein (g)	75.10±6.29	76.43±7.47	0.892
Carbohydrate (g)	347.46±47.18	317.04±20.20	0.565

Vitamin A (µg)	71.55±18.32	87.92±26.97	0.615
Vitamin B1 (mg)	0.44±0.07	0.45±0.08	0.960
Vitamin B2 (mg)	0.36±0.05	0.57±0.07	0.021
Vitamin B3 (mg)	9.90±1.46	11.23±1.30	0.495
Vitamin B6 (mg)	0.91±0.19	0.81±0.13	0.673
Vitamin B12(mg)	2.73±0.57	2.78±0.61	0.956
Vitamin C (mg)	12.51±4.66	18.21±7.32	0.511
Vitamin D (mg)	3.17±0.85	3.76±1.09	0.668
Vitamin E (mg)	4.54±0.83	4.39±1.02	0.911
Folate (µg)	144.27±27.97	145.19±29.74	0.982
Calcium (mg)	241.12±34.63	603.83±197.09	0.067
Copper (mg)	24.37±7.77	787.51±764.95	0.316
Iodine (µg)	16.59±13.84	3.23±2.19	0.164
Iron (mg)	13.86±2.09	69.35±56.02	0.314
Phosphorus (mg)	488.21±71.58	566.95±92.96	0.506
Selenium (µg)	45.09±7.26	49.17±6.97	0.686
Zinc (mg)	8.24±2.15	38.87±32.38	0.342
Systolic blood pressure (mmHg)	106.98±1.65	111.00±2.50	0.183
Diastolic blood pressure (mmHg)	61.32±1.64	63.46±1.86	0.389

Calcium intakes were higher in the normal group (603.83±197.09) compared to the anemic group (241.12±34.63, $p = 0.067$). Iodine levels were higher in the anemic group (16.59±13.84) than in the normal group (3.23±2.19, $p = 0.164$). Similarly, iron levels were higher in the normal group (69.35±56.02) compared to the anemic group (13.86±2.09, $p = 0.314$). Zinc levels were also higher in the normal group (38.87±32.38) than in the anemic group (8.24±2.15, $p = 0.342$). Copper, phosphorus, and selenium levels showed no significant differences between the groups.

Table 7 presents the association between nutrient adequacy and anemic status of pregnant women. The results indicate a significant association between anemia status and adequacy of Vitamin B2 and calcium intake, with none of the anemic women meeting adequacy for these nutrients, compared to 4.5% of non-anemic women ($\chi^2 = 4.385$, $p = 0.036$). These were the only micronutrients showing a statistically significant relationship with anemia. No significant associations were found between anemia status and intake adequacy of other micronutrients including iron, zinc, selenium, Vitamin A, Vitamin B12, and folate ($p > 0.05$). Inadequacy in these nutrients was widespread across both anemic and non-anemic groups.

Table 7. Nutrient Adequacy amongst Anaemic and Normal Pregnant Women.

Variable	Categories	Anemic (%)	Normal (%)	Total (%)	(χ^2)	P-value
Carbohydrate	Adequate	34 (38.6%)	38 (43.2%)	72 (81.8%)	2.428	0.119
	Inadequate	11 (12.5%)	5 (5.7%)	16 (18.2%)		
Protein	Adequate	21 (23.9%)	17 (19.3%)	38 (43.2%)	0.456	0.500
	Inadequate	24 (27.3%)	26 (29.5%)	50 (56.8%)		
Vitamin A	Adequate	0 (0.0%)	1 (1.1%)	1 (1.1%)	1.059	0.304
	Inadequate	45 (51.1%)	42 (47.7%)	87 (98.9%)		

Vitamin B1	Adequate	2 (2.3%)	2 (2.3%)	4 (4.5%)	0.002	0.963
	Inadequate	43 (48.9%)	41 (46.6%)	84 (95.5%)		
Vitamin B2	Adequate	0 (0.0%)	4 (4.5%)	4 (4.5%)	4.385	0.036
	Inadequate	45 (51.1%)	39 (44.3%)	84 (95.5%)		
Vitamin B3	Adequate	8 (9.1%)	8 (9.1%)	16 (18.2%)	0.010	0.920
	Inadequate	37 (42.0%)	35 (39.8%)	72 (81.8%)		
Vitamin B6	Adequate	2 (2.3%)	2 (2.3%)	4 (4.5%)	0.002	0.963
	Inadequate	43 (48.9%)	41 (46.6%)	84 (95.5%)		
Vitamin B12	Adequate	15 (17.0%)	16 (18.2%)	31 (35.2%)	0.145	0.704
	Inadequate	30 (34.1%)	27 (30.7%)	57 (64.8%)		
Vitamin C	Adequate	3 (3.4%)	1 (1.1%)	4 (4.5%)	0.955	0.328
	Inadequate	42 (47.7%)	42 (47.7%)	84 (95.5%)		
Vitamin D	Adequate	4 (4.5%)	3 (3.4%)	7 (8.0%)	0.110	0.740
	Inadequate	41 (46.6%)	40 (45.5%)	81 (92.0%)		
Vitamin E	Adequate	2 (2.3%)	2 (2.3%)	4 (4.5%)	0.002	0.963
	Inadequate	43 (48.9%)	41 (46.6%)	84 (95.5%)		
Folate	Adequate	1 (1.1%)	1 (1.1%)	2 (2.3%)	0.001	0.974
	Inadequate	44 (50.0%)	42 (47.7%)	86 (97.7%)		
Copper	Inadequate	45 (51.1%)	43 (48.9%)	88 (100.0%)	-	-
Calcium	Adequate	0 (0.0%)	4 (4.5%)	4 (4.5%)	4.385	0.036
	Inadequate	45 (51.1%)	39 (44.3%)	84 (95.5%)		
Iron	Adequate	4 (4.5%)	5 (5.7%)	9 (10.2%)	0.180	0.672
	Inadequate	41 (46.6%)	38 (43.2%)	79 (89.8%)		
Zinc	Adequate	4 (4.5%)	7 (8.0%)	11 (12.5%)	1.098	0.295
	Inadequate	41 (46.6%)	36 (40.9%)	77 (87.5%)		
Selenium	Adequate	9 (10.2%)	11 (12.5%)	20 (22.7%)	0.390	0.532
	Inadequate	36 (40.9%)	32 (36.4%)	68 (77.3%)		
Iodine	Inadequate	45 (51.1%)	43 (48.9%)	88 (100.0%)	-	-
Phosphorus	Adequate	10 (11.4%)	9 (10.2%)	19 (21.6%)	0.022	0.883
	Inadequate	35 (39.8%)	34 (38.6%)	69 (78.4%)		

4. Discussion

The main findings from our study reveals that, an association exists between Vitamin B2 intake and anemia status, with pregnant women with anemia exhibiting notably lower Vitamin B2 intake compared to their non-anemic counterparts. While Ca adequacy was also associated with maternal anemic status, no significant associations were observed between anemia status and the intake of key minerals like copper, iron, selenium and zinc.

Exploring the socio-economic status of the pregnant women revealed that the mean maternal age was 29.47 ± 6.00 years, with an average parity of two, aligning with national fertility patterns. The older mean age of husbands (36.52 ± 7.20 years) mirrors broader demographic trends observed in marital dynamics across many societies. The average maternal BMI of 28.14 ± 5.94 reflects a high prevalence of overweight, consistent with the growing burden of overweight and obesity among

urban Nigerian women. Educationally, both mothers and fathers had predominantly secondary-level education (51.72%), with few attaining postgraduate qualifications. Notably, a significant proportion of mothers (62.8%) reported earning less than ₦50,000 per month, underscoring persistent economic hardship in the population studied. These findings collectively highlight the intersection of low socioeconomic status, limited educational advancement, and increasing nutritional challenges—factors which compound maternal and child health risks and underscore the urgent need for context-specific interventions in similar low-resource urban settings.

The prevalence of anemia in this study was 48.2%, with the majority being cases of mild anemia (44.6%) and a small percentage (3.6%) classified as moderate anemia. There were no cases of severe anemia. These findings are consistent with the World Health Organization's (WHO) 2021 report (7), which estimates a global prevalence of anemia among pregnant women to be approximately 36.5%, with variations based on geographic regions and socioeconomic factors. In comparison to other studies, the prevalence in this study aligns closely with findings from a study conducted in Nigeria by Latinos et al., which reported a 54.5% prevalence of anemia in pregnant women, predominantly mild cases [25]. The lower prevalence of moderate and no severe anemia observed here is in keeping with findings from Southern Ethiopia where 66.6% of pregnant women had mild anemia and 33.3% having moderate anemia, but no severe cases were reported despite differences in dietary pattern and locations [26]. Moreover, studies have highlighted that mild anemia is more common in settings where iron deficiency is prevalent [15]. The absence of severe anemia is consistent with findings from a review that reported reductions in cases of severe anemia in resource-limited settings [27].

The results of this study highlight significant nutritional inadequacies among the participants, particularly in the intake of vitamins and minerals critical for maternal health. The observed dietary gaps, especially in vitamins A, B1, B2, B6, C, D, and folate, where over 90% of participants failed to meet the RDAs, are consistent with findings in other studies conducted in low- and middle-income countries (LMICs). For instance, a study on pregnant women in sub-Saharan Africa (37) reported widespread inadequacies in vitamins A, C, D, and folate due to poor dietary diversity and limited access to fortified foods. Similarly, a study in South Asia (38) documented significant micronutrient deficiencies among pregnant women in South Asia, linking these deficiencies to adverse maternal and foetal outcomes. The inadequate protein intake observed in 56% of participants aligns with findings from a previous study in Nigeria which reported insufficient protein consumption among pregnant women in similar location in rural Nigeria. due to reliance on carbohydrate-rich staples [28]. Additionally, the low levels of calcium and iron adequacy (4.5% and 10.2%, respectively) reflect broader trends in LMICs, where diets are often deficient in dairy products and iron-rich foods [29]. Interestingly, selenium and iodine intake showed better adequacy compared to other micronutrients, with 26% and 100% adequacy rates, respectively. This aligns with studies in regions where iodine supplementation programs or naturally high selenium levels in soil exist [30]. However, the stark inadequacy of zinc (87.4%) and iron (89.8%) intake raises concerns, as these are essential for foetal development and immune function [31,32]. These findings suggest that interventions, such as dietary diversification, food fortification, and micronutrient supplementation programs, are urgently needed to address these gaps.

Dietary diversity among the pregnant women in this study was notably low, with a mean MDD-W score of 3.55 ± 2.38 and 65.9% scoring below the minimum threshold of five food groups. Most consumed staples like grains, tubers, and vegetables (76.1–77.8%), but intake of vitamin A-rich produce (6.8%), nuts and seeds (20.3%), and other fruits (13.6%) was substantially limited. The study aligns with a previous study in Ethiopia which reported that only 25.4% of pregnant achieved adequate dietary diversity, which was significantly associated with higher maternal education, increased household income, livestock ownership, husband's emotional support, and women's participation in shopping (40). This study also aligns with another Ethiopian study (41), which reported a mean MDD-W of ~ 4.0 among Ethiopian women, with 56.6% exhibiting inadequate diversity. In study in Vietnam, it was reported that over half of the pregnant women failed to meet RNI for key nutrients and predominantly consumed cereals with low fruit and vegetable intake

This study highlights the complex interplay between micronutrient intake and anemia among pregnant women, underscoring anemia as a persistent public health concern in resource-constrained settings. Although no significant differences in blood pressure were observed between anemic and non-anemic women, marked disparities in dietary micronutrient intake emerged, particularly for Vitamin B2 (riboflavin) and calcium. The significantly lower intake of Vitamin B2 among anemic participants reinforces its pivotal role in hemoglobin synthesis and iron metabolism, aligning with evidence that riboflavin deficiency can impair iron mobilization and contribute to anemia [33]. Similarly, although calcium intake differences were not statistically significant, its higher intake among non-anemic women suggests a potential indirect role in supporting hematological status [34].

Adequacy analysis further emphasized these findings: none of the anemic participants met the adequacy threshold for calcium or Vitamin B2, while 4.5% of the non-anemic group did ($\chi^2 = 4.385$, $p = 0.036$). These results support existing literature on the importance of riboflavin and calcium in hematopoiesis and overall nutritional health. Interestingly, iodine intake was slightly higher in the anemic group, though its relevance remains uncertain without biochemical confirmation. While iron and zinc are traditionally emphasized in anemia research, our findings showed no significant differences in their dietary intake between groups. This observation is consistent with previous studies that suggest dietary iron and zinc intake may not always correspond with anemia risk due to factors like poor absorption, low bioavailability, or the presence of inhibitors [36]. The higher Vitamin B6 intake seen among anemic participants may reflect unique dietary habits, warranting further exploration. These results align with global findings linking inadequate intake of essential nutrients—particularly Vitamin A, riboflavin, and calcium—with increased anemia risk [31,32,35]. Our study supports the view that anemia is multifactorial, involving both dietary and non-dietary determinants such as infections, inflammation, and genetic factors.

Collectively, these findings emphasize that addressing anemia in pregnant women requires comprehensive nutritional strategies that go beyond Iron supplementation or Multiple Micronutrient Supplementation. Nutritional interventions must prioritize improving overall diet quality, incorporating diverse, nutrient-dense foods and fortified products. Furthermore, addressing broader determinants such as infections, inflammation, and genetic predispositions, while enhancing nutrient bioavailability, remains essential for reducing anemia burden in low-resource populations.

5. Conclusions

In conclusion, this study underscores the significant association between inadequate Vitamin B2 and calcium intake and anemia among pregnant women, highlighting the critical role of dietary quality in maternal health. Addressing micronutrient deficiencies through dietary diversification, targeted supplementation, and context-specific public health strategies is essential for improving maternal nutritional status and reducing anemia prevalence in resource-limited settings.

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Abbreviations

The following abbreviations are used in this manuscript:

ANC	Antenatal Clinics
FFQ	Food Frequency Questionnaire
RDA	Recommended Dietary Allowance
	Hemoglobin
Hb	World Health Organization
WHO	Statistical Analysis Software
STATA	Multiple Micronutrient Supplementation
MMS	Iron and Folic Acid
IFA	Sub-Saharan Africa
SSA	Minimum Dietary Diversity questionnaire
MDDQ	Institutional Review Boards
IRB	National Health Research Ethics Committee
NHREC	Packed cell volume
PCV	Systolic blood pressure
SBP	Diastolic blood pressure
DBP	Human Immunodeficiency Virus/Acquired Immunodeficiency Syndrome
HIV/AIDS	

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