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Dietary Practices, Obstetric Characteristics and Serum Micronutrient Status of Pregnant Women in Ondo State, Nigeria: A Cross-Sectional Study

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ABSTRACT

Background: Maternal micronutrient deficiencies remain a major public health concern globally. This study assessed dietary practices, obstetric characteristics and serum micronutrient status among pregnant women attending antenatal clinics in selected sub-urban communities of Ondo State, Nigeria.

Methods: A descriptive cross-sectional study was conducted among 433 pregnant women attending primary health care facilities across selected local government areas in Ondo State. Data were collected using a validated interviewer-administered questionnaire. Dietary diversity was assessed using the Minimum Dietary Diversity for Women (MDD-W) questionnaire. Venous blood samples were collected for the determination of haemoglobin concentration, packed cell volume (PCV) and serum micronutrient levels including retinol, folate, zinc, selenium, iron and copper. Data were analysed using descriptive statistics and Chi-square tests at a significance level of $p < 0.05$.

Results: Majority of respondents were aged 20–29 years (64.2%), 81.3% reported receiving nutrition education during while nearly half (48.0%) were in their second trimester. More than half (52.4%) had good dietary practices, 65.4% achieved adequate dietary diversity. Anaemia prevalence was 54.7% and deficiencies were observed in retinol (52.7%), selenium (75.1%), copper (70.7%), iron (41.1%). zinc (27.9%) and folate (3.2%). Significant associations were observed between age and serum iron ($p < 0.001$), zinc ($p = 0.001$) and copper levels ($p = 0.001$). Dietary diversity was significantly associated with serum copper status ($p = 0.047$) while folate status insignificant ($p = 0.055$).

Conclusion: Dietary practices and diversity were relatively optimal, multiple micronutrient deficiencies remain significant public health concern. Nutrition education combined with improved access to micronutrient-rich foods, routine nutritional screening, and targeted supplementation programmes to improve maternal and foetal health outcomes are needed

Keywords: Pregnancy, Dietary practices, Dietary diversity, Micronutrient Status, Maternal Nutrition

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INTRODUCTION

Micronutrients perform vital physiological functions during pregnancy. Iron is essential for haemoglobin synthesis and oxygen transport, while folate plays a crucial role in DNA synthesis, cell division, and neural tube development. Zinc contributes to immune function, protein synthesis, and foetal growth, whereas vitamin A supports vision, immune competence, and cellular differentiation. Selenium and copper function as important antioxidant micronutrients that protect maternal and foetal tissues from oxidative stress[1]. Deficiencies of these nutrients can adversely affect maternal health and pregnancy outcomes, making adequate micronutrient intake an important public health priority.

Globally, approximately 37% of pregnant women are anaemic and 9.8 million pregnant women are vitamin A deficient (World Health Organization [WHO], 2024)[2,3]. Similarly, deficiencies of iron, vitamin A, zinc, iodine, and other essential micronutrients continue to affect more than two billion women of reproductive age due to their increased physiological demands and iron deficiency alone cause for 447,000 million maternal deaths.[4,5]. In sub-Saharan Africa, maternal under-nutrition remains a major public health challenge. The region experiences a high burden of micronutrient deficiencies resulting from inadequate dietary quality, recurrent infections, food insecurity and socioeconomic inequalities. The prevalence of micronutrient deficiency of iron, vitamin A, iodine, zinc, calcium, and folate among pregnant women in Nigeria, Kenya and South Africa ranges 46% to 76%, 21% to 48% and 3% to 12% respectively[6].

Dietary practices during pregnancy significantly influence maternal nutritional status and micronutrient adequacy. Healthy dietary practices involve regular meal consumption, adequate meal frequency, consumption of fruits and vegetables, dietary diversity, sufficient fluid intake, and adherence to recommended micronutrient supplementation[2]. Studies have demonstrated significant associations between dietary diversity and improved nutritional status among pregnant women[7,8]. Women who consume a wider variety of foods are more likely to meet their nutritional requirements and achieve better pregnancy outcomes. Poor dietary practices may lead to inadequate nutrient intake, thereby increasing the risk of micronutrient deficiencies and adverse pregnancy outcomes such as anaemia, hypertension, labour complications and even death on the mother. Poor maternal micronutrient status can result to stillbirth, pre-term delivery, congenital malformations, reduced immune-competence and abnormal foetal growth patterns such as small for gestational age (SGA <10% birth weight for gestational age), foetal growth restriction (FGR), macrosomia (>44.5 kg), large for gestational age (LGA) (>90% birth weight for gestational age) and low birth weight (LBW <2500 g)9. However, several factors can negatively affect dietary practices among pregnant women, including food taboos, cultural beliefs, pregnancy-related discomforts, food insecurity, low socioeconomic status, and inadequate nutrition knowledge[10,11].

Obstetric characteristics also influence maternal nutritional status during pregnancy. Factors such as parity, gravidity, birth spacing, gestational age, antenatal care attendance and nutrition counselling have been shown to affect dietary behaviours and micronutrient status among pregnant women[12,13]. Regular antenatal care attendance provides opportunities for nutritional screening, health education, micronutrient supplementation, and early identification of nutritional problems.

Although several studies have examined dietary practices and maternal nutrition in different parts of Nigeria, evidence on the relationship between dietary practices, obstetric characteristics, dietary diversity, and biochemical micronutrient status among pregnant women remains limited, particularly in Ondo State. Most available studies have relied primarily on dietary assessments and self-reported information without incorporating biochemical measurements of micronutrient status. Consequently, there is limited evidence on the actual burden of micronutrient deficiencies among pregnant women in the state and the factors associated with these deficiencies. Therefore, this study assessed dietary practices, obstetric characteristics, dietary diversity, and serum micronutrient status among pregnant women attending antenatal clinics in selected sub-urban communities of Ondo State, Nigeria.

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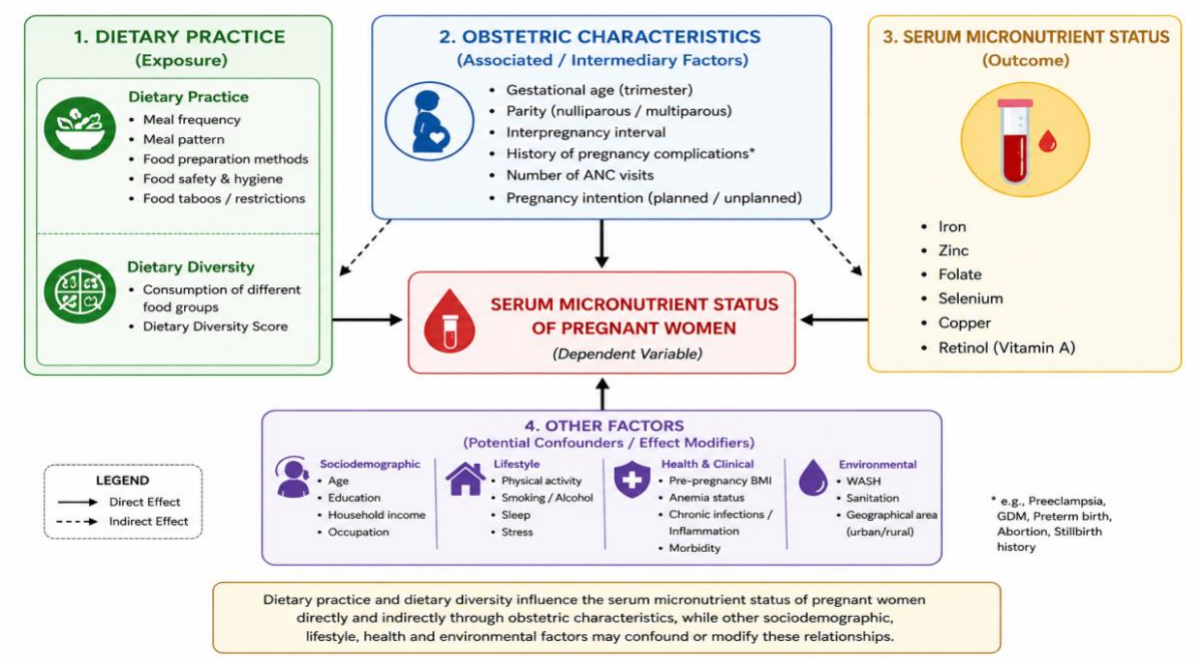

Figure 1: Conceptual framework of study variables

METHODOLOGY

Study Area: The study was conducted in Ondo State, located in the South-West geopolitical zone of Nigeria. Ondo State lies between latitudes 5°45'N and 7°52'N and longitudes 4°20'E and 6°05'E, with Akure serving as the state capital. The state comprises eighteen Local Government Areas (LGAs) distributed across three senatorial districts: Ondo North, Ondo Central, and Ondo South. The predominant ethnic group is Yoruba, although other ethnic groups reside within the state. The major occupations of residents include farming, trading, fishing, civil service, and artisan work. Primary healthcare facilities provide antenatal and maternal health services across urban, semi-urban, and rural communities in the state.

Study Design: This study employed a descriptive cross-sectional design

Study Period: Data were collected between July and December 2025

Study Population: The study population comprised pregnant women aged 15-49 years attending antenatal clinics in selected primary healthcare centres within the study area.

Study Setting: Antenatal clinics in selected primary healthcare facilities in Ondo State

Eligibility Criteria: Pregnant women were eligible to participate if they were aged between 15 and 49 years, residents of the study communities for at least six months before the commencement of the study, attended antenatal care services at the selected health facilities and provided written informed consent to participate in the study. Pregnant women were excluded if they were younger than 15 years or older than 49 years, had known chronic medical conditions, had pregnancy-related complications such as eclampsia and declined to provide informed consent.

Sample Size Determination: The minimum sample size was determined using Cochran's formula for cross-sectional studies: $n = \frac{Z^2Pq}{d^2}$

Where: n = minimum sample size

Z = standard normal deviate at 95% confidence level (1.96)

p = prevalence of malnutrition among women of reproductive age in Ondo State (44.5%)[14]

q = 1 – p

d = margin of error (0.05)

After adjusting for a 10% non-response rate, a total sample size of 433 pregnant women was obtained and included in the study.

Sampling Technique: A multistage sampling technique was used to select study participants. In stage one, the three senatorial districts in Ondo State (Ondo North, Ondo Central, and Ondo South) were

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purposively selected. In stage two, two Local Government Areas were selected from each senatorial district using simple random sampling, giving a total of six LGAs. In stage three, two communities with functional primary healthcare centres providing antenatal care services were randomly selected from each selected LGA. In stage four, eligible pregnant women attending antenatal clinics in the selected health facilities were recruited through systematic random sampling until the required sample size of 433 was attained as shown in Figure 2.

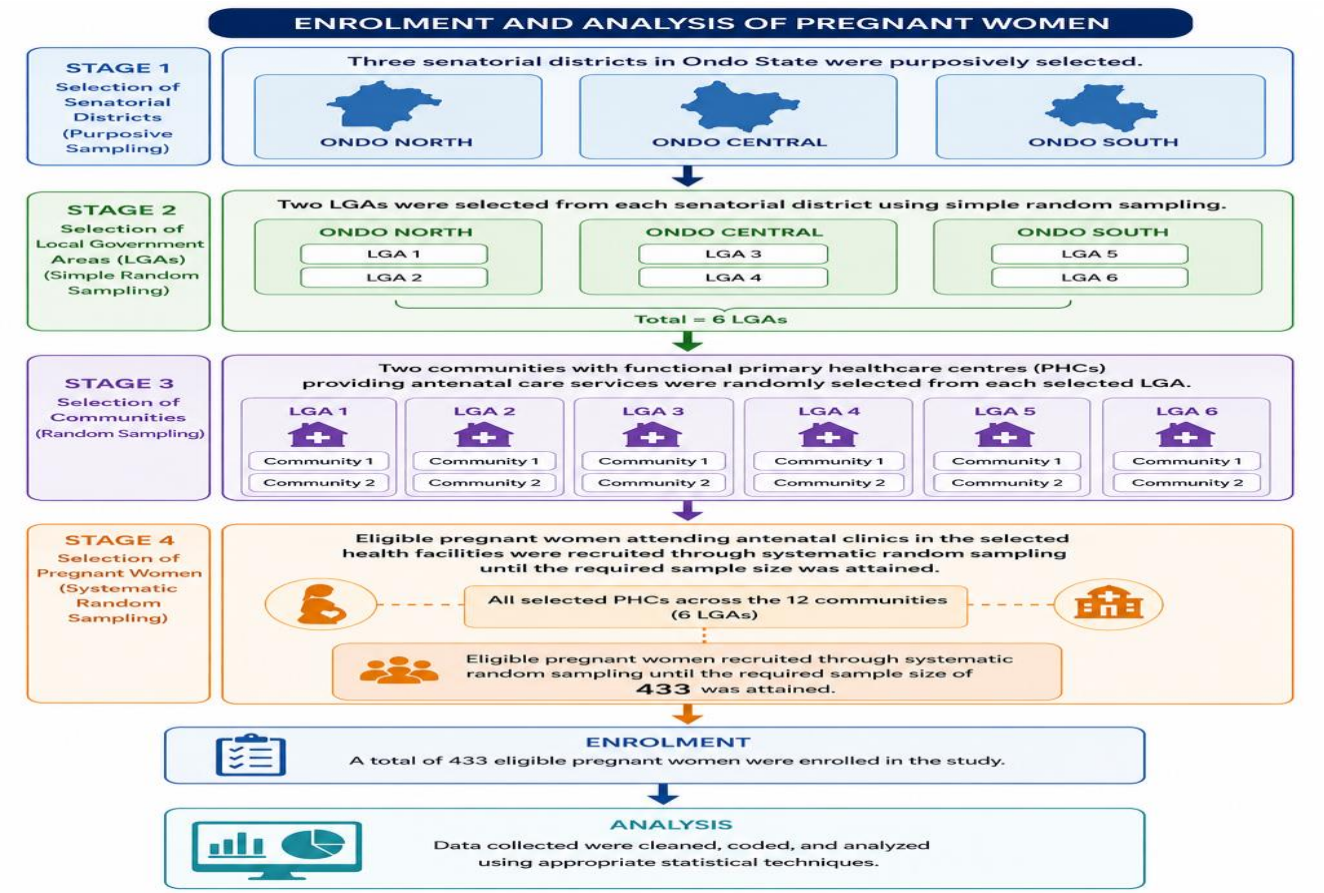

Figure 2: Flowchart showing enrolment and analysis of pregnant women

Data Enumerators: Six (6) research assistants were recruited based on their qualifications, experience in similar studies and their ability to speak English and Yoruba

Ethical Considerations: Ethical approval for the study was obtained from the Health Research Ethics Committee of Ondo State Ministry of Health following approval from the College of Medicine and Health Sciences, Afe Babalola University, Ado-Ekiti. Ethical clearance was granted with protocol number **OSHREC/25/09/2024/759** and registration number **NHREC/18/08/2016**.

Written informed consent was obtained from all participants before enrolment. Confidentiality, privacy, anonymity, and voluntary participation were maintained throughout the study. Participants were informed of their right to withdraw from the study at any stage without any consequences.

Data Collection: Data were collected using a validated interviewer-administered questionnaire, divided into sections covering socio-demographic characteristics, obstetric and pregnancy-related characteristics, dietary practices, dietary diversity of pregnant women

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Six trained research assistants who were fluent in English and Yoruba assisted with data collection after undergoing intensive training on study procedures and ethical conduct.

Assessment of Dietary Practices: Dietary practices were assessed using structured questions adapted from previously validated maternal nutrition questionnaires. Information obtained included meal frequency, meal skipping behaviour, type of meal skipped, snack consumption, fruit and vegetable intake, alcohol consumption, fluid intake, use of iodized salt[15]

Assessment of Dietary Diversity: Minimum dietary diversity for women questionnaire was used to assess dietary diversity. Participants were asked to recall all foods consumed within the previous 24 hours. Foods were categorized into ten standard food groups: (1) Grains, white roots and tubers and plantain, (2) Pulses (beans, peas and lentils), (3) Nuts and seeds (4) Dairy (5) Meat, Poultry and fish (6) Eggs (7) Dark green leafy vegetables (8) Other vitamin A-rich fruits and vegetables (9) Other vegetables (10) Other fruits[16]. Consumption of a food group was scored as "1" while non-consumption was scored as "0". Scores were summed to obtain the dietary diversity score. Women who consumed foods from five or more food groups were classified as having achieved minimum dietary diversity, while those consuming fewer than five food groups were classified as having inadequate dietary diversity[16].

Determination of Packed Cell Volume: Approximately 5 mL of venous blood was collected aseptically from each participant by a trained phlebotomist using sterile disposable syringes and needles. Blood samples were transferred into appropriately labelled ethylenediaminetetraacetic acid (EDTA) tubes and transported under cold-chain conditions to the laboratory for analysis. Samples were centrifuged to separate serum from whole blood and then read using a microhematocrit reader card. PCV >33%=Normal while <33% indicated anemia[17]

Determination of Haemoglobin Concentration: Haemoglobin concentration was determined using the haemoglobin paper scale. The fingers of the respondents were pricked for blood samples using a lancet. The blood samples were dropped on the haemoglobin paper, allowed to dry and matched against the given color standards and the corresponding value recorded. Haemoglobin concentration of <7.0g/dl=severe anaemia, 7.0 and 9.9g/dl =moderate and 10.0 to 10.9g/dl =mild[18].

Micronutrient Test: Prior to serum element determination, the collected blood samples were digested using the conventional wet acid method [19]. About 0.5ml of whole blood was taken into a Pyrex flask, and three (3) millilitres of a freshly prepared mixture of concentrated nitric acid and hydrogen peroxide (2:1 V/V) were added and allowed to stand for 10 minutes. The sample was heated at 60–70^{o}C for 1-2 hours. The digest was treated with 2ml of nitric acid and a few drops of hydrogen peroxide and heated at about 80^{o}C until a clear digested solution was obtained. The digest was transferred into a 100ml volumetric flask and diluted using distilled water. Zinc, selenium, folate and copper were determined using an atomic absorption spectrophotometer (AAS)[17].

Determination of Serum Iron Serum iron was determined according to the method described by Makino et al., (1988)[20] where transferrin-bound iron was released at an acidic pH and reduced from ferric to ferrous ions. These ions react with ferrozine to form a violet-coloured complex. About 50 litres of the sample, standard and distilled, was added to 1000 litres of reagent (guanidine hydrochloride pH 4.0–4.4) in separate tubes, and the contents was mixed and incubated at 25°C for 10 minutes. The absorbance of the mixture was measured at 560 nm, which was proportional to serum iron. Iron was calculated as follows:

$$\text{Iron concentration (umol/L)} = \frac{absorbance\ of\ sample\ x\ concentration\ of\ standard}{Absorbance\ of\ standard}$$

Data Analysis: Data were coded, cleaned and entered into Microsoft Excel before exportation to the Statistical Package for Social Sciences (SPSS) version 25 for analysis. Descriptive statistics, including frequencies, percentages, means, and standard deviations, were used to summarize study variables. Chi-square tests were used to determine associations between selected socio-demographic variables, dietary diversity, and serum micronutrient status. Statistical significance was established at $p < 0.05$.

RESULTS

Socio-demographic Characteristics of Pregnant Women

Table 1 shows the socio-demographic characteristics of pregnant women. About two-thirds (64.2%) of the respondents were between 20 and 29 years of age, 44.8% had one to two children, 18.2% had three to four

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children, while 7.0% had five or more children. The majority of the respondents (71.4%) were of Yoruba while 18.0% and 10.6% were Igbo and Hausa respectively. Christianity was the predominant religion (76.0%) while 24.0% practiced Islam. Most respondents (93.3%) were married while only 6.7% were single. Almost half (48.5%) of respondents lived in households comprising of 1-3 members, 41.8% lived in households with 4-6 members while 9.7% lived in households with seven or more members

Table 1: Socio-demographic Characteristics of Pregnant Women

Variables	Frequency	Percentage 100%)
Age (Years)		
15 – 19	33	7.6
20 – 24	151	34.9
25 – 29	127	29.3
30 – 34	65	15.0
35 – 39	38	8.8
40 and above	19	4.4
Number of children		
None	130	30.0
1 – 2	194	44.8
3 – 4	79	18.2
5 and above	30	7.0
Ethnicity		
Yoruba	309	71.4
Hausa	46	10.6
Igbo	78	18.0
Religion		
Islam	104	24.0
Christianity	329	76.0
Marital Status		
Single	29	6.7
Married	404	93.3
House hold size		
1-3	210	48.5
4-6	181	41.8
7 and above	42	9.7

Obstetric and Pregnancy Characteristics of the Pregnant Women

The obstetric characteristics of the pregnant women are presented in Table 2. Nearly half (48.0%) of the respondents were in their second trimester while 40.4% and 11.5% were in the third and first trimesters respectively. Most respondents (72.1%) had experienced previous pregnancies whereas 27.9% reported no previous pregnancy. Among those who had been pregnant before, 38.5% reported having been pregnant more than three times, 36.5% had experienced two pregnancies while 25.0% had experienced one previous pregnancy. A quarter (30.7%) reported an interval of two to three years between pregnancies, 26.6% had intervals of four years or more and 14.8% reported intervals of less than two years. About a quarter (31.2%) had two children, 20.6% had one child and 20.3% had three or more children. A high proportion (84.8%) had attended antenatal care clinics during previous pregnancies, while 15.2% had never attended antenatal clinics before. Similarly, 81.3% reported receiving nutrition education during antenatal visits. Almost half (48.3%) commenced antenatal attendance during the second trimester, 47.8% during the first trimester and only 3.9% initiated care during the third trimester. The majority of respondents (82.7%) reported hospitals as their preferred place of delivery while 9.5%, 5.8%, and 2.1% preferred home delivery, mission houses and traditional birth attendants, respectively. Only 19.2% reported a history of illness during pregnancy, with headache (60.2%) and malaria (39.8%) being the most commonly reported illnesses.

Table 2: Obstetric and Pregnancy Characteristics of Pregnant Woman

Variables	**Frequency**	**Percentage**
Stage of your pregnancy		
First Trimester	50	11.5
Second Trimester	208	48.0
Third Trimester	175	40.4
Have you ever been pregnant before		
Yes	312	72.1
No	121	27.9
If Yes, how many times have you been pregnant?		
1 time	78	25.0
2 times	114	36.5
>3 times	120	38.5
Interval between the pregnancies?		
Less than 2	64	14.8
2-3 years	133	30.7
4 years and above	115	26.6
How many children do you have now?		
Nil	121	27.9
1 child	89	20.6
2 children	135	31.2
3 children and above	88	20.3

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Visited an antenatal clinic before		
Yes	367	84.8
No	66	15.2
Received any nutritional talk in the antenatal clinic before		
Yes	352	81.3
No	81	18.7
You normally start antenatal visit during		
First Trimester	207	47.8
Second Trimester	209	48.3
Third Trimester	17	3.9
Normal place of delivery babies		
Hospital	358	82.7
Home	41	9.5
Mission	25	5.8
TBA	9	2.1
Any history of illness		
Yes	83	19.2
No	350	80.8
Total	**433**	**100**
If yes, specify		
Malaria	33	39.8
Headache	50	60.2

Dietary Practices of Pregnant Women

Table 3 presents the dietary practices of the pregnant women. The majority (81.1%) reported experiencing food cravings during pregnancy while 18.9% did not. More than half (54.0%) reported avoiding certain foods during pregnancy whereas 46.0% did not avoid any food. Almost half (46.0%) consumed meals more than three times daily, 43.4% consumed meals three times daily while 10.6% consumed meals fewer than three times daily. Most respondents (69.3%) reported consuming snacks between meals, 52.4% reported that they did not skip meals during pregnancy whereas 47.6% skipped at least one meal. Among respondents who skipped meals, lunch (18.2%) was the most frequently skipped meal, followed by breakfast (18.0%) and dinner (11.3%). Majorities (94.7, 90.3%, 97.9%) reported regular consumption of fresh fruits and vegetables, iodized salt and added salt during cooking respectively. Most respondents (83.1%) reported taking iron and folic acid or multiple micronutrient supplements during pregnancy. Among those who did not take supplements, the most commonly reported reasons included high cost (16.2%), dislike of supplements (13.6%) and lack of availability at health facilities (5.3%). Although most respondents (74.6%) reported not consuming alcohol, approximately one-quarter (25.4%) acknowledged alcohol intake during pregnancy. In addition, 82.4% reported consuming adequate quantities of fluid daily

Table 3: Dietary Practices of Pregnant Woman

Variables	Freq	Percent (%)
Craving for food		
Yes	351	81.1
No	82	18.9
Avoidance of food during pregnancy		
Yes	234	54.0
No	199	46.0
Meal Frequency		
Less than 3 times	46	10.6
3 times	188	43.4
More than 3 times	199	46.0
Do you have a habit of eating snacks?		
Yes	300	69.3
No	133	30.7
Do you skip any meal during current pregnancy?		
Yes	206	47.6
No	227	52.4
Which meal do you skip?		
Nil	227	52.4
Breakfast	78	18.0
Lunch	79	18.2
Dinner	49	11.3
Do you have a habit of eating fresh fruits and vegetables?		
Yes	410	94.7
No	23	5.3
Which type of salt do you use in your food?		
Iodized salt	391	90.3
Not Iodized salt	42	9.7
What stage do you add salt to your food?		
During cooking	424	97.9
During serving	9	2.1
Do you have iron and folic acid/multiple micronutrient supplement during current pregnancy?		
Yes	360	83.1
No	73	16.9
If no, why		

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Not Applicable	281	64.9
Not available in the clinic	23	5.3
I don't like it	59	13.6
Too expensive	70	16.2
Do you drink alcohol?		
Yes	110	25.4
No	323	74.6
Do you drink adequate amount of fluid per day?		
Yes	357	82.4
No	76	17.6

Dietary Diversity Score of the Respondents

The dietary diversity scores of the respondents are presented in Figure 1. Results showed that 65.4% of the pregnant women achieved the minimum dietary diversity score while 34.6% failed to meet the minimum dietary diversity requirement

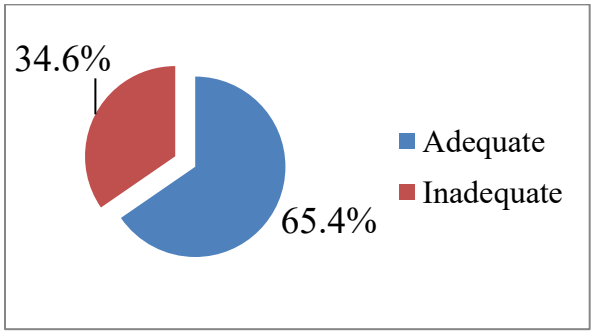

Figure 1: Dietary Diversity Score of the pregnant women

Micronutrient Status of Pregnant Women

The biochemical assessment of respondents is presented in Table 4. Almost half (49.0%) of the pregnant women had normal haemoglobin levels while 24.7%, 21.5% and 4.8% had mild, moderate and severe anaemia respectively. More than half (54.7%) were anaemic while 45.3% had normal PCV values. Serum retinol showed that 52.7% of respondents were deficient whereas 47.3% had normal levels. Folate deficiency was relatively low affecting only 3.2% of respondents while 96.8% had normal folate concentrations. Zinc deficiency was observed among 27.9% of respondents whereas 72.1% had normal serum zinc levels. A high prevalence of selenium deficiency was observed (75.1%) while only 24.9% had normal selenium status. Iron deficiency was identified in 41.1% whereas 58.9% had normal serum iron concentrations. Copper deficiency was the most prevalent micronutrient deficiency observed affecting 70.7% of respondents while only 29.3% had normal serum copper levels

Table 4: Biochemical Assessment of the Pregnant Woman

Biochemical Assessment	Freq	Percent (%)
Haemoglobin (g/dL)		
Normal (>10.9)	212	49.0
Mild Anaemia (10.0-10.9)	107	24.7
Moderate Anaemia (7.0-9.9)	93	21.5
Severe Anaemia (<7.0)	21	4.8
Packed cell volume		
Anaemic (<33%)	237	54.7
Normal (>33%)	196	45.3
Retinol (mg/L)		
Normal (>0.30mg/L)	205	47.3
Deficiency (<0.30mg/L)	228	52.7
Folate (ng/mL)		
Normal (>6.0ng/mL)	419	96.8
Deficiency(<5.9ng/mL)	14	3.2
Zinc (µg/dL)		
Normal (>70 µg/dL)	312	72.1
Deficiency (<60-70 µg/dL)	121	27.9
Selenium (µg/dL)		
Normal (>60 µg/dL)	108	24.9
Deficiency (<45-60 µg/dL)	325	58.9
Copper (µg/dL)		
Normal (100-250 µg/dL)	127	29.3
Deficiency(<100µg/dL)	306	70.9

Association between Age, Dietary Diversity and Serum Micronutrient Status

Table 5 presents the association between selected serum micronutrients, age and dietary diversity scores. There was no statistically significant association between age and serum retinol status ($p = 0.851$), folate status ($p = 0.186$) or selenium status ($p = 0.102$). However, significant associations were observed between age and serum zinc ($\chi^2 = 20.049$; $p = 0.001$), iron ($p < 0.001$) and copper ($p = 0.001$). Similarly, dietary diversity was not significantly associated with retinol ($p = 0.693$), zinc ($p = 0.484$), selenium ($p = 0.339$) or iron status ($p = 0.924$). Nevertheless, dietary diversity showed a statistically significant association with serum copper status ($p = 0.047$). Folate status also demonstrated a borderline association with dietary diversity ($p = 0.055$).

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Table 5: Association between Serum Micronutrient Status, Age and Dietary Diversity

Serum Micronutrient	Age X^2; P-value	Dietary Diversity X^2; P-value
Retinol	1.983; 0.851	0.733; 0.693
Folate	7.504; 0.186	5.801; 0.055*
Zinc	20.049; 0.001*	1.453; 0.484
Selenium	9.196; 0.102	2.161; 0.339
Iron	47.388; 0.000*	0.157; 0.924
Copper	20.362; 0.001*	14.888; 0.047*

DISCUSSION

This study assessed the dietary practices, obstetric characteristics, dietary diversity and serum micronutrient status of pregnant women attending antenatal clinics in selected sub-urban communities of Ondo State, Nigeria. The findings revealed generally favourable dietary practices among the respondents. More than half of the pregnant women reported that they did not skip meals during pregnancy, while the majority consumed meals at least three times daily and regularly consumed fruits and vegetables. These findings are comparable to those reported among pregnant women in Lagos, Nigeria, where a substantial proportion of women maintained regular meal consumption during pregnancy[6]. Similarly, Adeoye and Okekunle (2022) reported relatively good dietary practices among pregnant women in Ibadan, attributing the findings to increased exposure to antenatal nutrition education and improved awareness of maternal nutritional requirements[8]. The relatively high proportion of women who did not skip meals may be associated with the high antenatal care attendance and nutrition counselling observed in this study. Nutrition education delivered during antenatal visits has been shown to improve maternal dietary behaviours and encourage adherence to recommended feeding practices during pregnancy [12, 21]. This finding suggests that antenatal care services remain an important platform for promoting healthy dietary behaviours among pregnant women.

Despite these positive findings, nearly half of the respondents still reported skipping meals during pregnancy, with lunch being the most frequently skipped meal. Similar observations have been reported in studies conducted in Enugu and Ethiopia, where meal skipping was associated with work-related constraints, reduced appetite, pregnancy discomforts, food insecurity, and economic limitations [2, 22]. Meal skipping during pregnancy may compromise nutrient intake and increase the risk of maternal nutrient depletion, particularly among women with elevated nutritional requirements. The persistence of meal skipping among a substantial proportion of respondents underscores the need for targeted nutrition counselling that addresses practical barriers to adequate food intake during pregnancy. Food cravings and food avoidance were common among the respondents, affecting more than three-quarters and over half of participants, respectively. Similar findings have been reported in several African settings where cultural beliefs, food taboos, religious practices, sensory changes, and pregnancy-related discomforts influence dietary choices [10, 11]. While some food aversions may be harmless, avoidance of nutrient-dense foods such as animal-source foods, fruits, and vegetables can contribute to inadequate micronutrient intake. This finding highlights the importance of culturally sensitive nutrition education that addresses misconceptions and harmful food taboos during pregnancy.

Although the majority of women reported consuming fruits and vegetables, approximately one-quarter admitted consuming alcohol during pregnancy. This prevalence is concerning because no level of alcohol consumption during pregnancy is considered safe. Prenatal alcohol exposure has been associated with foetal alcohol spectrum disorders, impaired neurodevelopment, growth restriction, and adverse pregnancy outcomes[23]. The finding suggests that nutrition and health education programmes should place greater emphasis on alcohol avoidance during pregnancy and strengthen awareness of its potential consequences for foetal health.

The study revealed a high level of antenatal care utilization, with more than four-fifths of respondents reporting previous antenatal clinic attendance and receipt of nutrition education. Additionally, most respondents initiated antenatal care during the first or second trimester, while the majority preferred hospital delivery. These findings reflect encouraging maternal healthcare-seeking behaviour and are consistent with recent national reports showing improvements in maternal healthcare utilization in Nigeria [24]. Early antenatal care attendance provides opportunities for nutritional assessment, health education, micronutrient supplementation, disease screening, and management of pregnancy-related complications[25]. Consequently, the high level of antenatal care utilization observed in this study may partly explain the high uptake of iron and folic acid supplementation among respondents. However, despite these positive healthcare behaviours, substantial micronutrient deficiencies and anaemia were still observed. This suggests that access to antenatal care alone may not be sufficient to ensure optimal nutritional status where underlying socioeconomic and dietary constraints persist.

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Dietary diversity is widely recognized as an important indicator of diet quality and micronutrient adequacy. In the present study, approximately two-thirds of respondents achieved the minimum dietary diversity score, indicating relatively good dietary diversity among the study population. This finding is comparable to reports from Kenya and Tanzania where more than half of pregnant women achieved adequate dietary diversity[7]. Similarly, studies conducted in Nigeria have reported moderate to high dietary diversity among pregnant women attending antenatal clinics[8]. The relatively high dietary diversity observed may reflect the availability of diverse food items in the study area and the positive influence of antenatal nutrition counselling. Nevertheless, despite achieving minimum dietary diversity, significant levels of micronutrient deficiencies were still observed among respondents. This finding suggests that dietary diversity alone may not guarantee micronutrient adequacy. Food quality, portion size, nutrient bioavailability, infection burden, and household food security also influence nutritional status. Therefore, maternal nutrition programmes should focus not only on dietary diversity but also on improving access to nutrient-dense foods and enhancing the quality of maternal diets.

Anaemia remains one of the most significant nutritional challenges affecting pregnant women globally. In this study, more than half of the respondents were anaemic based on packed cell volume assessment, while slightly over half were classified as anaemic based on haemoglobin concentration. These findings indicate that anaemia remains a major public health problem among pregnant women in Ondo State. The prevalence observed in this study is comparable to reports from other parts of Nigeria, including Katsina and Bayelsa States, where high levels of maternal anaemia have also been documented [26, 27]. Similar high prevalence rates have been reported across sub-Saharan Africa, reflecting persistent nutritional deficiencies, infectious diseases, poor dietary quality, and socioeconomic inequalities[28]. The high burden of anaemia observed has important public health implications. Maternal anaemia increases the risk of preterm birth, low birth weight, maternal mortality, postpartum haemorrhage, reduced work productivity, and impaired foetal growth[29]. The persistence of anaemia despite high antenatal attendance suggests the need for improved adherence to iron supplementation, enhanced malaria prevention strategies, deworming interventions, and improved dietary intake of iron-rich foods among pregnant women.

The study identified varying levels of micronutrient deficiencies among respondents. Retinol deficiency affected more than half of the participants, while selenium and copper deficiencies were particularly widespread. Iron deficiency affected over two-fifths of respondents, whereas zinc deficiency was present among more than one-quarter of the study population. In contrast, folate deficiency was relatively low. The low prevalence of folate deficiency may be attributed to the high uptake of folic acid supplementation reported among respondents. Folic acid supplementation is routinely provided during antenatal care in Nigeria and has been shown to significantly reduce the risk of folate deficiency and neural tube defects[30]. This finding demonstrates the effectiveness of antenatal supplementation programmes in improving folate status among pregnant women. Conversely, the high prevalence of deficiencies in iron, selenium, copper, and vitamin A suggests persistent inadequacies in maternal diets and possible limitations in current supplementation programmes. Similar findings have been reported among pregnant women in Tanzania and other African countries, where multiple micronutrient deficiencies commonly coexist[1]. Multiple micronutrient deficiencies are particularly concerning because they may interact synergistically to worsen pregnancy outcomes and compromise maternal immune function. The widespread deficiencies observed in this study have important implications for maternal and child health. Iron deficiency contributes to anaemia and impaired oxygen transport, vitamin A deficiency increases susceptibility to infection and visual impairment, while zinc, selenium, and copper deficiencies compromise immune function, antioxidant defence, and foetal growth[31]. These findings support growing evidence that maternal nutrition interventions should move beyond iron-folic acid supplementation and consider broader multiple micronutrient supplementation approaches, particularly in resource-limited settings.

The study found significant associations between age and serum iron, zinc, and copper concentrations. This suggests that maternal age may influence nutritional status during pregnancy. Similar findings have been reported among pregnant women in Ethiopia and the United States, where age-related differences in dietary habits, physiological requirements, and socioeconomic circumstances influenced micronutrient status [32, 33]. Dietary diversity was significantly associated with serum copper status and showed a borderline association with folate status. Women consuming more diverse diets are generally more likely to meet their nutritional requirements and obtain a wider range of essential micronutrients[34]. However, the absence of significant associations between dietary diversity and several micronutrients suggests that factors beyond dietary

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diversity, including nutrient bioavailability, infection burden, supplementation practices, and household food security, may also play important roles in determining micronutrient status[35].

Strengths and Limitations of the Study

A major strength of this study is the comprehensive assessment of maternal nutritional status using both dietary and biochemical indicators. Unlike many previous studies that relied solely on dietary intake assessments or self-reported information, this study incorporated laboratory analyses of serum micronutrients, including iron, zinc, copper, selenium, folate, and retinol. The study also included a relatively large sample size drawn from multiple local government areas across the three senatorial districts of Ondo State, thereby improving the representativeness and generalizability of the findings within the study setting. Furthermore, the assessment of dietary practices, dietary diversity, obstetric characteristics and micronutrient status within the same population provided a holistic understanding of factors influencing maternal nutrition during pregnancy. Another strength lies in the use of standardized data collection procedures and validated assessment tools which allows comparison of findings with similar studies conducted nationally and internationally.

Despite its strengths, the study has some limitations. The cross-sectional design limits the ability to establish causal relationships between dietary practices, obstetric characteristics, and micronutrient status. Dietary information was obtained through self-report and may be subject to recall bias and social desirability bias, particularly regarding food intake, alcohol consumption, and supplement use. Additionally, dietary diversity was assessed using a 24-hour recall which may not fully reflect habitual dietary intake. Although several important micronutrients were assessed, other nutrients of public health importance during pregnancy, such as vitamin B12, iodine, calcium and vitamin D were not measured. Furthermore, factors such as parasitic infections, inflammatory conditions, genetic haemoglobin disorders and dietary bioavailability, which may influence micronutrient status, were not investigated. Notwithstanding these limitations, the study provides valuable evidence regarding the nutritional status of pregnant women in Ondo State and contributes to the growing body of literature on maternal nutrition in Nigeria.

Recommendations

1. Health authorities should strengthen maternal nutrition programmes by integrating routine micronutrient assessment and counselling into antenatal care services.
2. Consideration should be given to the adoption of multiple micronutrient supplements in antenatal care settings to address the coexistence of multiple micronutrient deficiencies observed among pregnant women.
3. Nutrition education should focus not only on dietary diversity but also on the consumption of nutrient-dense foods, appropriate meal frequency, and avoidance of harmful practices such as alcohol consumption during pregnancy.
4. Government and development partners should implement food security and social protection programmes targeted at vulnerable pregnant women to improve access to nutritious foods.
5. Longitudinal studies are recommended to investigate causal relationships between dietary practices, micronutrient status, and pregnancy outcomes. Future studies should also assess additional micronutrients such as iodine, vitamin B12, calcium, and vitamin D.

CONCLUSION

Favourable maternal health-seeking behaviours as evidenced by high antenatal care attendance, early antenatal booking and widespread exposure to nutrition education was noted in the study. Although, dietary practices and dietary diversity were satisfactory, micronutrient deficiencies were still prevalent. Age and dietary diversity were factors found to impact micronutrient status. Comprehensive maternal nutrition interventions that combine nutrition education, improved dietary quality, food security initiatives, routine nutritional screening, and effective micronutrient supplementation are required to improve maternal and foetal health outcomes in Ondo State

Declarations

Authors' Contribution: Adedayo E.O: Designed, collected data and wrote the first draft of the manuscript **Dada I.O and Ajayi K:** Supervised the study, reviewed and edited the manuscript. **Gwadza P. M and Onyekweli-Ugeh C.N:** Assisted in data collection, methodology, statistical analysis and review of the manuscript

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