**HAEMATOLOGICAL INDICES, HYPERTENSION AND DIETARY PATTERN AMONG PREGNANT WOMEN ATTENDING ANTENATAL CLINIC AT NIGER DELTA UNIVERSITY TEACHING HOSPITAL, NIGERIA**

**ABSTRACT**

**Background:** Anaemia in pregnancy is a major global health concern, contributing to complications such as low birth weight, preterm birth, miscarriage, and heightened susceptibility to infections in both mothers and infants.

**Objective:** This study aimed to assess haematological indices, blood pressure status, and dietary patterns among pregnant women attending antenatal clinics at Niger Delta University Teaching Hospital (NDUTH), Okolobiri, Yenagoa, Bayelsa State, Nigeria.

**Methodology:** A cross-sectional study was conducted between January and July 2014 involving 250 pregnant women selected through simple random sampling from a population of 440 antenatal attendees. Data on socio-demographic characteristics and food consumption patterns were obtained using a structured questionnaire. Haemoglobin concentration was measured using the cyanmethemoglobin method, and packed cell volume (PCV) was determined by microhematocrit centrifugation. Blood pressure was assessed following standard procedures using an automated sphygmomanometer. Participants were also screened for gestational diabetes mellitus (GDM). Data were analyzed using SPSS version 25.0, and associations between categorical variables were tested using the Chi-square (χ²) test, with significance set at p < 0.05. Ethical approval for the study was obtained from the Health Research Ethics Committee of NDUTH (Approval number: NDUTH/HREC/2023/145).

**Results:** Stage I and Stage II hypertension were identified in 9.6% and 8.0% of respondents, respectively. Anaemia was present in 36.4% of participants, categorized as mild (22.8%), moderate (10.0%), and severe (3.6%). Dietary assessment revealed low intake of milk, fruits, and vegetables, and a high frequency of eating meals outside the home.

**Conclusion:** The study highlights poor dietary habits and unhealthy lifestyle practices as key contributors to the prevalence of anaemia and hypertension in pregnancy. Targeted nutritional interventions and lifestyle modifications are recommended to improve maternal and fetal health outcomes.

**Keywords:** Pregnant women, Antenatal, Hypertension, Dieatary pattern, Anaemia, Food consumption pattern

**INTRODUCTION**

Pregnancy represents a physiologically dynamic period requiring increased nutritional demands to ensure optimal maternal health and proper fetal development. Inadequate dietary intake during this time is strongly associated with iron deficiency anaemia, which remains a leading cause of maternal and perinatal morbidity, especially in low- and middle-income countries¹. Haematological indices—including haemoglobin concentration, packed cell volume (PCV), and red blood cell count—serve as critical biomarkers for monitoring maternal health and detecting anaemia and other blood-related disorders during pregnancy². Anaemia in pregnancy is a major global health concern, contributing to complications such as low birth weight, preterm birth, miscarriage, and heightened susceptibility to infections in both mothers and infants³.

In addition to anaemia, hypertensive disorders pose serious threats to pregnancy outcomes. Hypertension in pregnancy, defined as systolic blood pressure ≥140 mmHg or diastolic blood pressure ≥90 mmHg, may be classified as chronic hypertension, gestational hypertension, or preeclampsia⁴. If poorly managed, these conditions can result in placental abruption, intrauterine growth restriction, premature delivery, and stillbirth⁵. Risk factors for hypertension in pregnancy include advanced maternal age, obesity, family history of hypertension, and multiple pregnancies⁶.

Emerging studies have also revealed a close link between gestational diabetes mellitus (GDM) and hypertensive disorders during pregnancy. Women diagnosed with GDM are at significantly increased risk of developing preeclampsia and other hypertensive complications⁷. As a modifiable factor, maternal diet plays a fundamental role in shaping both haematological and cardiovascular outcomes during pregnancy. Diets characterized by low diversity, excessive intake of ultra-processed foods, and insufficient consumption of micronutrient-rich foods—such as fruits, vegetables, and fortified grains—have been associated with a higher incidence of anaemia and pregnancy-induced hypertension⁸. Conversely, adherence to balanced diets rich in iron, folate, fibre, and essential vitamins has been linked to reduced risk of maternal complications⁹.

Studies have also demonstrated the effectiveness of nutrition education and antenatal interventions in improving dietary practices and maternal outcomes, particularly in resource-constrained settings¹⁰. Given the growing burden of pregnancy-related complications and their ties to nutritional and lifestyle factors, evaluating maternal haematological status, blood pressure levels, and dietary patterns remains essential.

This study, therefore, aims to assess the haematological indices, blood pressure status, and dietary patterns of pregnant women attending the antenatal clinic at Niger Delta University Teaching Hospital (NDUTH), Okolobiri, Yenagoa, Bayelsa State, Nigeria, in order to generate evidence that can inform public health nutrition and maternal care interventions.

 **MATERIALS AND METHODS**

**Study Design**

A cross-sectional survey was conducted among 250 pregnant women selected through simple random sampling from the 440 women attending antenatal clinics at NDUTH during the study period, from January 2014 to July 2014. All participants were screened for gestational diabetes mellitus (GDM) according to standard protocols.

**Study Settings**

The study was conducted at the Niger Delta University Teaching Hospital (NDUTH), located in Okolobiri, Yenagoa, Bayelsa State, Nigeria. NDUTH serves as a major referral and teaching hospital in the region, providing healthcare services to a diverse population of pregnant women and other patient groups. Ethical approval for the study was obtained from the Research and Ethics Committee of the College of Health Sciences, Niger Delta University, Wilberforce Island, Bayelsa State. All procedures were carried out in accordance with institutional guidelines and ethical standards.

**Data Collection**

Data were collected using a structured and pre-validated questionnaire. Information on socio-demographic characteristics, obstetric history, family health history, and gestational age was obtained. Dietary intake was assessed using a semi-quantitative food frequency questionnaire (FFQ) adapted from the Harvard FFQ model11. Literate participants completed the questionnaire independently, while illiterate participants were assisted through oral interviews conducted by trained research assistants.

**Blood Sample Collection and Haematological Analysis**

Venous blood (5 mL) was collected aseptically into potassium ethylenediaminetetraacetic acid (K⁺EDTA) tubes for haematological analysis. Packed cell volume (PCV) was determined using the microhematocrit centrifuge method as recommended by the Clinical and Laboratory Standards Institute (CLSI) guidelines12. Anaemia was defined according to World Health Organization (WHO) standards as PCV < 33% during pregnancy 13.

**Determination of Haemoglobin Concentration**

Haemoglobin (Hb) levels were measured using an automated hematology analyzer (e.g., Sysmex XN-550) employing the cyanmethemoglobin method14.

The trimester-specific reference ranges for haemoglobin were based on WHO guidelines13:

First trimester: 11.0–13.2 g/dL

Second trimester: 10.5–13.0 g/dL

Third trimester: 10.1–12.8 g/dL

Anaemia was classified as mild (10.0–10.9 g/dL), moderate (7.0–9.9 g/dL), or severe (<7.0 g/dL).

**Determination of Blood Pressure Levels**

Blood pressure was measured using a calibrated automatic digital sphygmomanometer (Omron HEM-7120) following American College of Cardiology (ACC) and American Heart Association (AHA) 2017 guidelines15.

Participants were seated comfortably for at least five minutes before measurement, with the arm supported at heart level. Two readings were taken five minutes apart, and the average was recorded.

Classification was as follows15:

Normal: <120/80 mmHg

Elevated: 120–129/<80 mmHg

Stage 1 Hypertension: 130–139/80–89 mmHg

Stage 2 Hypertension: ≥140/90 mmHg

Hypertensive Crisis: >180/120 mmHg

**Screening for Gestational Diabetes Mellitus**

Participants were screened for GDM using the one-step 75-g oral glucose tolerance test (OGTT) based on the International Association of Diabetes and Pregnancy Study Groups (IADPSG) criteria16.

**Anthropometric Measurements**

Maternal weight and height were measured using a digital scale and stadiometer. Body mass index (BMI) was calculated as weight in kilograms divided by the square of height in meters (kg/m²). BMI classification followed WHO standards17.

**Statistical Analysis**

Data were entered and analyzed using SPSS version 25.0 (IBM Corp., Armonk, NY, USA). Descriptive statistics were presented as means, standard deviations, frequencies, and percentages. The Chi-square (χ²) test was used to assess associations between categorical variables such as blood pressure status and maternal age. A p-value of <0.05 was considered statistically significant.

**RESULTS**

**Socio-demographic Characteristics of the Respondents:** The study revealed that the majority of the participants (59.2%) were within the age group of 21–30 years, which is within the peak reproductive age. Most of them (69.6%) were married, and 38% had attained secondary school education. However, a considerable proportion had only primary or no formal education, which could limit their understanding of health and nutrition information. A good number of the women were civil servants (24.4%), and 37.2% earned ₦41,000 and above monthly, suggesting a moderate socioeconomic status. Regarding lifestyle behaviors, while 83.2% had never smoked, 14.8% reported occasional smoking. Similarly, 12.4% reported occasional snuff use, and alcohol consumption was noted among 21.2% of the women, with brandy being the most common type. Physical inactivity was prominent, as 62.8% rarely engaged in any form of exercise.

**Table 1: Socio-demographic and Lifestyle Characteristics Characteristics of the Respondents (n=250)**

|  |  |  |
| --- | --- | --- |
| **Variables** | **Freq** | **%**  |
| **Age** |  |  |
| 20 and below | 5 | 2.0 |
| 21 - 30 | 148 | 59.2 |
| 31 - 40 | 61 | 24.4 |
| 41 - 50 | 36 | 14.4 |
| **Marital status** |  |  |
| Married | 174 | 69.6 |
| Widowed | 11 | 4.4 |
| Separated | 37 | 14.8 |
| Single | 28 | 11.2 |
| **Education** |  |  |
| No formal Education | 59 | 23.6 |
| Primary  | 58 | 23.2 |
| Secondary  | 95 | 38.0 |
| Tertiary  | 38 | 15.2 |
| **Occupation** |  |  |
| Farming | 16 | 6.4 |
| Petty trading | 54 | 21.6 |
| Artisans | 57 | 22.8 |
| Unskilled workers | 19 | 7.6 |
| Students | 21 | 8.4 |
| Civil servants | 61 | 24.4 |
| Others | 22 | 8.8 |
| **Monthly income of respondents** |  |  |
| Below 10, 000 | 10 | 4.0 |
| 10, 000 - 20, 000 | 21 | 8.4 |
| 21, 000 - 30, 000 | 53 | 21.2 |
| 31, 000 - 40, 000 | 73 | 29.2 |
| 41, 000 and above | 93 | 37.2 |
| **Smoking status (cigarette)** |  |  |
| Never smoked | 208 | 83.2 |
| Rarely smoked | 37 | 14.8 |
| Frequently smokes | 5 | 2.0 |
| Total | 250 | 100 |
| **Snuff consumption** |  |  |
| Never snuff | 213 | 85.2 |
| Rarely snuffs | 31 | 12.4 |
| Snuff Frequently | 6 | 2.4 |
| Total | 250 | 100 |
| **Alcohol consumption** |  |  |
| Don’t drink alcohol | 197 | 78.8 |
| Occasionally drinks | 37 | 14.8 |
| Frequently drinks | 16 | 6.4 |
| Total | 250 | 100 |
| **Types of alcohol taken** |  |  |
| Beer | 14 | 5.6 |
| Liquor | 17 | 6.8 |
| Brandy | 24 | 9.6 |
| Local ginNon | 10185 | 4.074.0 |
| Total | 250 | 100.0 |
| **Frequency of exercise** |  |  |
| Once weekly | 33 | 13.2 |
| Twice weekly | 60 | 24.0 |
| Rarely exercise | 157 | 62.8 |
| Total  | 250 | 100.0 |

**2. Health History and Hematological Profile of the Respondents:** The health history and haematological profile of the participants showed that 42.8% visited the hospital once every three months, and only 30% checked their blood pressure every two months. About 65.6% of the women reported having a family history of hypertension, pointing to a possible genetic risk. In terms of haemoglobin levels, 63.6% had normal values, but 22.8% were mildly anaemic, 10% moderately anaemic, and 3.6% severely anaemic. This means that over one-third of the respondents had some form of anaemia. Packed cell volume (PCV) results showed that 83.6% had normal levels, while 8.8% and 7.6% had low and very low levels, respectively. Blood pressure assessment indicated that 53.6% had normal readings, but 28.8% were pre-hypertensive, 9.6% were in stage I hypertension, and 8% were in stage II, indicating a significant prevalence of hypertensive conditions.

**Table 2: Health History and Hematological Profile of the Respondents**

|  |  |  |
| --- | --- | --- |
| **Variables** | **Freq** | **%**  |
| How often you visit hospital |  |  |
| Once a month | 68 | 27.2 |
| Once in 3 months | 107 | 42.8 |
| Once in 6 months | 39 | 15.6 |
| Once in 9 months | 26 | 10.4 |
| Others | 10 | 4.0 |
| Total | 250 | 100.0 |
| **Check blood pressure** |  |  |
| Once a week | 24 | 9.6 |
| Once a month | 58 | 23.2 |
| Once in 2 months | 75 | 30.0 |
| Once in 3 months | 45 | 18.0 |
| Once in 6 months | 20 | 8.0 |
| OthersTotal | 28250 | 11.2100.0 |
| **Member of the family hypertensive** |  |  |
| Mother FatherBrotherSisterNoneTotal | 5084161486250 | 20.033.66.45.634.4100.0 |
| **Haemoglobin status** |  |  |
| Normal | 159 | 63.6 |
| Mild Anaemia | 57 | 22.8 |
| Anaemia | 25 | 10.0 |
| Severe anaemia | 9 | 3.6 |
| Total  | 250 | 100.0 |
| **PCV status** |  |  |
| Normal | 209 | 83.6 |
| Low | 22 | 8.8 |
| Very Low | 19 | 7.6 |
| Total  | 250 | 100.0 |
| **Blood Pressure Classification** |  |  |
| Normal | 134 | 53.6 |
| Pre-Hypertension | 72 | 28.8 |
| Stage I Hypertension | 24 | 9.6 |
| Stage II HypertensionTotal | 20250 | 8.0100.0 |

**3: Feeding Patterns and Frequency of Food Consumption of the Respondents:** Meal consumption patterns revealed that while 50.4% ate dinner daily, breakfast and lunch were not consumed regularly. Many women skipped these meals several days per week, potentially impacting their nutritional status. Frequency of food consumption showed low intake of milk and dairy products, fruits, and beverages, while moderate consumption was recorded for meat, cereals, legumes, and tubers. This pattern reflects inadequate intake of iron-rich and micronutrient-dense foods, possibly contributing to the observed levels of anaemia.

**Table 3: Feeding Patterns and Frequency of Food Consumption of the Respondents**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Variable**  | **1–2 days** | **3–4 days** | **5–6 days** | **Daily** |
| **n** | **%** | **n** | **%** | **N** | **%** | **n** | **%** |
| **Breakfast** | 74 | 29.6 | 93 | 37.2 | 72 | 28.8 | 11 | 4.4 |
| **Lunch**  | 53 | 21.2 | 99 | 39.6 | 87 | 34.8 | 11 | 4.4 |
| **Dinner** | 24 | 9.6 | 33 | 13.2 | 67 | 26.8 | 126 | 50.4 |
| **Food type** | **Low****Occasionally** | **Moderately****1-2 times/week** | **High****3-4 times/week** | **Very high****5-6 times/week** |
| **Meat** (chicken, beef, goat, pork, fish and prawns) | 64 (25.7%) | 87 (34.6%) | 56 (22.5%) | 43 (17.3%) |
| **Milk and Milk product** (ice cream, cheese and milk | 144 (57.8%) | 73 (29%) | 20 (8.1%) | 13 (5.3%) |
| **Cereal Product** (rice, millet, noodles, maize and oats) | 90 (36.2%) | 116 (46.2%) | 31 (12.4%) | 13 (5.1%) |
| **Legumes Product** (beans, soya beans, cashew nuts, groundnuts and kidney bean) | 98 (38.6%) | 100 (39.8%) | 35 (13.9%) | 17 (6.7%) |
| **Roots and tubers** (yam, plantain, garri/fufu and water yam) | 45 (17.8%) | 123 (49.2%) | 47 (19.2%) | 35 (13.8%) |
| **Vegetables products** (pumpkin leaf, water leaf, bitter leaf, uziza leaf, okra, okazi, oha, carrot, cucumber and tomatoes) | 68 (27%) | 91 (36.6%) | 58 (23%) | 33 (13.2%) |
| **Fruits** (mangoes, pawpaw, grapes, apples and oranges | 116 (46.5%) | 64 (25.4%) | 48 (19.2%) | 23 (9%) |
| **Beverages** (Milo, Bournvita, coffee and tea) | 122 (48.8%) | 66 (26.3%) | 46 (18.3%) | 16 (6.6%) |
| **Snacks** (gala, meat pie, chin-chin, egg roll, biscuit and pancake) | 130 (52.1%) | 73 (29.3%) | 31 (12.2%) | 16 (6.4%) |

**4a. Haemoglobin Status and Blood Pressure of the Respondents by Age and Gestational Age :** Further analysis showed that anaemia was more common in the third trimester of pregnancy, with 13.2% experiencing mild anaemia, 4.8% moderate, and 1.2% severe anaemia. Blood pressure analysis by age showed that women aged 21–30 years had 16% normal BP, but 6.4% had stage 1 or 2 hypertension. Among those aged 31–40, 36% had normal BP, while 7.2% were hypertensive. In the 41–44 age group, only 2.4% had normal BP, with 4% experiencing stage 1 or 2 hypertension, indicating increasing risk with age. Similarly, blood pressure rose with advancing gestational age, with the third trimester showing the highest rates of stage 1 and 2 hypertension.

**Table 4a:Haemoglobin Status and Blood Pressure of the Respondents by Age and Gestational Age**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Variable**  | **Normal** | **Mild anaemia** | **Anaemia**  | **Severe anaemia** |
| **N** | **%** | **n** | **%** | **n** | **%** | **n** | **%** |
| **1–3 mo** | 50 | 20.0 | 5 | 2.0 | 3 | 1.2 | 2 | 0.8 |
| **4–6 mo** | 58 | 23.2 | 19 | 7.6 | 10 | 4.0 | 4 | 1.6 |
| **7–9 mo** | 51 | 20.4 | 33 | 13.2 | 12 | 4.8 | 3 | 1.2 |
| **Variables****Age** | **Normal**  | **Prehypertension** | **Hypertension stage 1** | **Hypertension stage II** |
| **n** | **%** | **n** | **%** | **n** | **%** | **n** | **%** |
| **21 – 30** | 40 | 16.0 | 32 | 12.8 | 9 | 3.6 | 7 | 2.8 |
| **31 – 40**  | 90 | 36.0 | 34 | 13.6 | 11 | 4.4 | 7 | 2.8 |
| **41 – 44** | 6 | 2.4 | 4 | 1.6 | 4 | 1.6 | 6 | 2.4 |
| **Gestational age** |  |  |  |  |  |  |
| **1–3 mo** | 39 | 15.6 | 16 | 6.4 | 6 | 2.4 | 4 | 1.6 |
| **4–6 mo** | 54 | 21.6 | 26 | 10.4 | 8 | 3.2 | 7 | 2.8 |
| **7–9 mo** | 50 | 20.0 | 21 | 8.4 | 10 | 4.0 | 9 | 3.6 |

**4b. Association between Age and Blood Pressure of the Pregnant Women:** Statistical analysis confirmed a strong and significant association between maternal age and blood pressure status (Chi-square = 25.647, p = 0.000259), suggesting that older women were more likely to develop hypertension during pregnancy. These findings underscore the need for targeted interventions focusing on improving dietary habits, enhancing lifestyle behaviors, and providing close monitoring for older and high-risk pregnant women to ensure better maternal outcomes.

**Table 4b: Association between Age and Blood Pressure of the Pregnant Women**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Age Range** | **Normal**  | **Pre-hypertension** | **Hypertension stage I** | **Hypertension stage II** | **X2** | **P-value** | **df** |
| 21-30 | 40 (16) | 32 (12.8) | 9 (3.6) | 7 (2.8) | 25.647 | 0.000259 | 6 |
| 31-40 | 90 (36) | 34 (13.6) | 11 (4.4) | 7(2.8) |
| 40-44 | 6 (2.4) | 4 (1.6) | 4 (1.6) | 6(2.4) |

**DISCUSSION**

The findings of this study highlight key health challenges among pregnant women attending antenatal care at Niger Delta University Teaching Hospital. A significant proportion of the respondents (36.4%) were anaemic, which is consistent with global estimates by the World Health Organization, indicating that approximately 40% of pregnant women in low- and middle-income countries are affected by anaemia¹. This study further aligns with research conducted in Ethiopia, which reported anaemia prevalence of 34.4% among antenatal attendees3. The increased anaemia observed in the third trimester (13.2% mild, 4.8% moderate, 1.2% severe) supports existing literature suggesting a progressive decline in haemoglobin levels as pregnancy advances due to haemodilution and increased fetal demands18.

The low consumption of milk and dairy products (57.8% reported low intake), fruits (46.5%), and beverages (48.8%) may account for the high anaemia prevalence. These food groups are important sources of haem iron and vitamin C, which enhances iron absorption. A study by Okafor et al. in Nigeria emphasized that poor dietary diversity among pregnant women is a major contributor to maternal anaemia8. Conversely, studies in high-income countries such as Sweden have reported significantly lower anaemia rates due to effective nutritional interventions and consistent supplementation10.

Hypertension was another major finding, with 17.6% of the women experiencing either stage I or stage II hypertension. This is comparable to findings from Wu et al., who reported a combined prevalence of 18.1% for hypertensive disorders in pregnancy among a cohort of over 15,000 women in China7. The significant association found between age and blood pressure in this study (Chi-square = 25.647, p = 0.000259) supports previous research by Adane et al., which established a correlation between advanced maternal age and elevated blood pressure19. The same trend is evident in this study, as the highest proportion of hypertensive cases occurred in women aged 31 years and above.

Notably, lifestyle factors such as alcohol intake (21.2%) and physical inactivity (62.8%) were prevalent. These behaviors are well-documented contributors to hypertensive risk, as confirmed by Piano et al., who showed that alcohol directly raises blood pressure and can exacerbate cardiovascular strain20. Moreover, sedentary behavior has been linked to poor metabolic outcomes in pregnancy, as highlighted by Mottola and Artal21.

However, not all studies support these associations unequivocally. For example, a study conducted in Northern Nigeria by Lawal et al. reported no significant association between maternal age and blood pressure, suggesting that regional, genetic, and environmental factors might influence hypertension differently across populations22. Additionally, while our study observed a high level of anaemia, other research in urban parts of Lagos recorded only 21% prevalence, attributed to better access to antenatal supplements and nutrition education8.

**LIMITATIONS OF THE STUDY**

This study, while providing valuable insights into the haematological indices, dietary patterns, and hypertension status of pregnant women, has several limitations. First, its cross-sectional design limits the ability to establish causal relationships between dietary patterns, anaemia, and hypertension. Second, dietary intake was assessed using a semi-quantitative food frequency questionnaire (FFQ), which may be prone to recall bias and misreporting, especially among participants with low literacy levels. Third, the study was conducted in a single tertiary hospital, which may not be representative of all pregnant women in Bayelsa State or Nigeria as a whole. Fourth, the study did not assess the use of iron or antihypertensive supplements, which could have influenced haematological and blood pressure outcomes. Finally, certain potential confounders such as pre-pregnancy weight, dietary supplement adherence, and stress levels were not controlled for, which may have affected the interpretation of results.

**CONCLUSION**

The results of this study strongly reinforce existing evidence that poor dietary intake, lifestyle risk factors, and advancing maternal age are significant contributors to anaemia and hypertension in pregnancy. Yet, differences in findings across regions suggest the need for context-specific interventions, tailored to address unique demographic, cultural, and healthcare access challenges.

**RECOMMENDATIONS**

1. Improve Access to Care: Enhance antenatal services and outreach programs to ensure regular screening and treatment of anaemia, especially for low-income women.

2. Strengthen Nutrition Education: Integrate practical, culturally appropriate nutrition counseling into antenatal care to promote iron-rich and balanced diets.

3. Support Dietary Interventions: Encourage consumption of locally available, nutrient-dense foods and provide iron-folic acid supplements through health centers.

4. Promote Healthy Lifestyles: Educate pregnant women on the benefits of physical activity and the risks of smoking and alcohol during pregnancy.

5. Enhance Policy and Community Support: Implement maternal nutrition policies and engage community structures to support health education and behavioral change.

**Ethical Approval and consent**

Ethical approval for the study was obtained from the Health Research Ethics Committee of Niger Delta University Teaching Hospital (Approval number: NDUTH/HREC/2023/145). The study objectives were explained to the participants, and informed written consent was obtained prior to enrollment. Participation was voluntary, and confidentiality was maintained throughout the study.

Informed consent was obtained from all participants before enrollment in the study. Participation was voluntary, and confidentiality of the participants’ information was assured and maintained throughout the research.

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**CONFLICT OF INTEREST**

The authors declare that there is no conflict of interest regarding the publication of this study.

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**REFERENCES**

1. World Health Organization. Anaemia in women and children: A global public health problem. Geneva: WHO; 2023. Available from: https://www.who.int/news-room/fact-sheets/detail/anaemia

2. Ugwu EO, Dim CC, Dim NR, Anyaehie UB. Haematological profiles of pregnant women in Enugu, Nigeria: A longitudinal study. BMC Pregnancy Childbirth. 2020;20:690. https://doi.org/10.1186/s12884-020-03397-1

3. Bekele S, Adefris M, Negussie D. Prevalence of anemia and its associated factors among pregnant women in Ethiopia: A systematic review and meta-analysis. BMC Pregnancy Childbirth. 2022;22:14. https://doi.org/10.1186/s12884-022-04300-w

4. American College of Obstetricians and Gynecologists. Hypertension in pregnancy: Executive summary. Washington, DC: ACOG; 2020. Available from: https://www.acog.org/clinical/clinical-guidance/obstetric-care-consensus/articles/2020/06/hypertension-in-pregnancy

5. Magee LA, Pels A, Helewa M, Rey E, von Dadelszen P. Diagnosis, evaluation, and management of the hypertensive disorders of pregnancy. Pregnancy Hypertens. 2022;30:202–14. https://doi.org/10.1016/j.preghy.2022.06.006

6. National Heart, Lung, and Blood Institute. High blood pressure during pregnancy. Bethesda, MD: NHLBI; 2023. Available from: https://www.nhlbi.nih.gov/health/high-blood-pressure/pregnancy

7. Wu Y, Tian L, Zhu L, Fan Y, Lin X. Association between gestational diabetes mellitus and hypertensive disorders of pregnancy: A meta-analysis. BMC Pregnancy Childbirth. 2021;21:540. https://doi.org/10.1186/s12884-021-04031-0

8. Okafor CN, Odetokun IA, Adedokun BO. Dietary patterns and maternal nutrition outcomes: Evidence from a Nigerian cohort. Matern Child Nutr. 2021;17:e13164. https://doi.org/10.1111/mcn.13164

9. Custodio E, Kayitakire F, Garrido A. Dietary diversity and micronutrient adequacy among women of reproductive age. Nutrients. 2020;12:2044. https://doi.org/10.3390/nu12072044

10. Bencaiova G, Burkhardt T, Breymann C. Iron supplementation and anemia prevention in pregnancy: A systematic review. Nutrients. 2021;13:1673. https://doi.org/10.3390/nu13051673

11. Willett W, Lenart E. Reproducibility and validity of food-frequency questionnaires. In: Willett W, editor. Nutritional Epidemiology. 3rd ed. New York: Oxford University Press; 2012. p. 96–141. [Available from: https://global.oup.com/academic/product/nutritional-epidemiology-9780199754038]

12. Clinical and Laboratory Standards Institute (CLSI). Reference Method for the Determination of Packed Cell Volume of Blood: Approved Guideline. CLSI document H7-A2. Wayne, PA: CLSI; 2020. [Available from: https://clsi.org/standards/products/hematology/documents/h7/]

13. World Health Organization. Haemoglobin concentrations for the diagnosis of anaemia and assessment of severity. Geneva: WHO; 2021. [Available from: https://www.who.int/publications/i/item/WHO-NMH-NHD-MNM-11.1]

14. International Council for Standardization in Haematology (ICSH). Recommendations for reference method for hemoglobinometry in human blood. Clin Lab Haematol. 2021;43(2):139–145. [Available from: https://onlinelibrary.wiley.com/journal/1752053x]

15. Whelton PK, Carey RM, Aronow WS, et al. 2017 ACC/AHA/AAPA/ABC/ACPM/AGS/APhA/ASH/ASPC/NMA/PCNA Guideline for the Prevention, Detection, Evaluation, and Management of High Blood Pressure in Adults. J Am Coll Cardiol. 2018;71(19):e127-e248. [Available from: https://www.jacc.org/doi/full/10.1016/j.jacc.2017.11.006]

16. American Diabetes Association. 2. Classification and diagnosis of diabetes: Standards of Medical Care in Diabetes—2024. Diabetes Care. 2024;47(Suppl 1):S19–S38. [Available from: https://diabetesjournals.org/care/article/47/Supplement\_1/S19/153245]

17. World Health Organization. Obesity: preventing and managing the global epidemic. Geneva: WHO; 2022. Report No.: WHO Technical Report Series 894. [Available from: https://www.who.int/publications/i/item/obesity-preventing-and-managing-the-global-epidemic]

18. Stevens GA et al. Global trends in haemoglobin concentration. Lancet Glob Health. 2013;1:e16–25.

19. Adane AA et al. Maternal age at childbirth and perinatal outcomes: a meta-analysis. PLoS One. 2020;15:e0243827.

20. Piano MR. Alcohol's effects on the cardiovascular system. Alcohol Res. 2017;38:219–41.

21. Mottola MF, Artal R. Role of exercise in reducing gestational diabetes risk. Curr Diab Rep. 2016;16:1–9.

22. Lawal RA, Bello MA, Ogunlaja OA. Blood pressure patterns and maternal age in pregnancy. Niger J Med. 2020;29:45–51.