Journal of Nutrition and Health Sciences
Volume 13 | Issue 1

Research Article Open Access

# Determinants of Serum Calcium Levels in Pregnancy: A Hospital-Based Study on Intake, Supplementation, and Symptomatology in Lafia, North Central Nigeria

**Akpulu Stephen Peter[1,*], Dalhatu Rashidah[1], Aikpitanyi-Iduitua A Godwin[2], Itakure Usman Abdulkadir[1], Trena Ugboaku Genevieve[3] and Adah Owoicho Sylverster[1]**

[1]Faculty of Medical Laboratory Science, College of Health Science, Federal University of Lafia, Nasarawa State Nigeria
[2]Department of Education, Medical Laboratory Science Council of Nigeria, Abuja Nigeria
[3]Department of Haematology, College of Health Sciences, Rev. Fr. Moses Orshio Adasu University, Makurdi, Benue State, Nigeria

[*]**Corresponding Author**: Akpulu Stephen Peter, Faculty of Medical Laboratory Science, College of Health Science, Federal University of Lafia, Nasarawa State Nigeria, Tel: +234 8037914275, E-mail: petosw2000@yahoo.com

**Citation:** Akpulu Stephen Peter, Dalhatu Rashidah, Aikpitanyi-Iduitua A Godwin, Itakure Usman Abdulkadir, Trena Ugboaku-Genevieve, et al. (2026) Determinants of Serum Calcium Levels in Pregnancy: A Hospital-Based Study on Intake, Supplementation, and Symptomatology in Lafia, North Central Nigeria, J Nutr Health Sci 13(1): 102

**Received Date:** December 27, 2025 **Accepted Date:** February 05, 2026 **Published Date:** February 09, 2026

## Abstract

**Introduction:** Maternal insufficient calcium consumption can raise the risk of pregnancy-related problems such preeclampsia and gestational hypertension, which are linked to considerable morbidity and mortality in both the mother and the newborn.

**Aim:** This study aims to assess serum calcium concentrations in pregnant women across different trimesters, given its critical role in various physiological processes during gestation and the potential health implications associated with its imbalance.

**Method:** This research involved 100 pregnant women. Data were gathered via a semi-structured, interview-administered questionnaire and analyzed statistically using SPSS version 2.0 with the Chi-square test. Blood samples were collected from each participant following standard protocols, centrifuged, and serum separated for calcium concentration analysis via a chemistry autoanalyzer.

**Results:** The study revealed the following key findings: i. No significant ($p = 0.630$), association existed between dairy consumption and serum calcium levels among participants with daily dairy consumers exhibiting a mean level of 1.974 mmol/L. ii. A significant ($p = 0.004$), link was identified between calcium supplementation supplement users (2.261 mmol/L) compared with non-users (1.719 mmol/L) underscoring the value of supplements in sustaining optimal calcium during pregnancy. iii. Calcium levels showed a significant ($p=0.045$) connection to symptoms like muscle cramps, indicating that deficiencies may contribute to specific discomforts in pregnancy. iv. Calcium levels (2.025 mmol/L) in regular exercise was higher compared with non-exercisers (1.683 mmol/L), with no statistical significance ($p = 0.081$).

**Conclusion:** This study identified various factors influencing calcium levels among pregnant women in the cohort, with calcium supplementation playing a significant role unlike age, excercise or dairy consumption. These findings suggest that targeted interventions focusing on consistent calcium supplementation could effectively mitigate the risks associated with hypocalcemia in pregnant populations, particularly in regions where dietary calcium intake might be suboptimal.

**Keywords:** Hypocalcaemia, Pregnancy, Calcium Supplementation, Pre-Eclampsia

## Introduction

Maternal nutrition is one of the most important factors that affect pregnancy outcomes; micronutrient sufficiency is necessary for fetal development and maternal health [1]. Among these micronutrients, calcium has an important physiological role in fetal skeletal mineralization and neurodevelopment and regulates maternal vascular tone and bone metabolism [2]. The World Health Organization recommends calcium supplementation to pregnant women in populations with low dietary intake primarily to prevent pre-eclampsia, which is a leading cause of maternal mortality globally [3]. This guidance becomes very important in resource-constrained settings where limited dietary diversity increases the risk of micronutrient deficiencies and related adverse obstetric Overcomes [4].

Maternal undernutrition persists as a public health challenge within Nigeria, contributing to substantial maternal and neonatal morbidity as evidenced by [5]. Although antenatal programs have traditionally emphasized iron and folic acid supplementation, other essential minerals like calcium have received relatively less attention [6] (Adebayo et al., 2023). Epidemiological data on hypocalcaemia among pregnant Nigerian women are scarce and unevenly distributed; most studies were conducted in southern urban centers which do not reflect regional variations in diet and nutrition [7]. Consequently, there exists a significant evidence gap regarding the prevalence and determinants of hypocalcaemia in North-Central Nigeria-a region characterized by unique dietary patterns as well as socioeconomic factors likely to influence nutritional status [8].

This study was carried out to find out the serum calcium levels of pregnant women who presented at the antenatal clinic in Federal University of Lafia Teaching Hospital (FULATH), situated in Nasarawa State, North-Central Nigeria. It was an attempt to fill a very important gap in knowledge. The specific objectives included finding out how common hypocalcaemia is and its association with some selected key maternal parameters like gestational age, parity, physical activity, and dietary calcium intake. The hypothesis suggests that a significant number of the antenatal cohort would have poor calcium status and that this would be more prevalent at advanced gestational stages and under conditions of poor dietary intake as adjusted for known physiological adaptations and nutritional challenges during late pregnancy [9].

The hospital-based, cross-sectional results bring forth crucial baseline data on calcium status in an area that has not been given much attention. Finding out the local prevalence of hypocalcaemia is a very basic step toward supporting and executing specific nutritional interventions like better dietary counseling or suitable supplementation protocols that are integrated into regular antenatal care [10]. This paper presents methodology, prevalence with factors associated, and discusses implications for clinical practice as well as maternal health policy in similar settings.

### Calcium Status and Maternal Health in Pregnancy

Maternal nutrition is a critical determinant of pregnancy outcomes, with micronutrient sufficiency being essential for fetal development and growth. Calcium deficiency in pregnancy shows significant global disparities, with 32.4% overall prevalence of hypocalcemia [11]. This is markedly higher in low-income countries (47.6%) than in high-income nations (18.3%), reflecting varied dietary access and socioeconomic conditions. Dietary calcium intake is heavily influenced by region; in areas with low dairy consumption, reliance on alternatives like small fish or leafy vegetables becomes critical. However, the bioavailability of

calcium is compromised by dietary components such as phytates and oxalates creating a gap between intake and absorption [12].

Socioeconomic factors are key determinants as lower maternal education, income, and antenatal care access strongly predict hypocalcemia among the poorest women who have 3.2 times higher odds of deficiency [12, 13]. This underscores calcium deficiency as an issue stemming from intertwined nutritional and social inequities.

Regional Context: Calcium Status in Sub-Saharan Africa and Nigeria Sub-Saharan Africa has been described as facing a complex "double burden" of malnutrition where undernutrition coexists with rising obesity [14]. Within this context, prevalent micronutrient deficiencies like hypocalcemia are poorly characterized. A trial in Kenya demonstrated an increase in adherence by 40% when calcium was combined with vitamin D into one supplement [14, 15]. Food-based approaches such as promoting traditional foods rich in calcium and fortification are also major complementary strategies.

Recent regional studies in Nigeria highlight significant concern; it was discovered that in Southwestern Nigeria, the prevalence rate of hypocalcemia among pregnant women stood at 41.3%. Higher rates were observed among those who were more advanced into their third trimester [15, 16, 17]. Southeastern Nigeria also reported a prevalence rate of 38.7% which was linked to low dairy intake and higher parity [17]. It therefore implies that there is substantial but variable national burden.

## Clinical Consequences and Implications of Maternal Hypocalcemia

### Maternal Outcomes

There is a strong association between calcium deficiency during pregnancy and hypertensive disorders. A 2023 [11, 18, 27] meta-analysis reported that supplementation at doses ranging from 1 to 1.5 g/day has been shown to reduce the risk of developing preeclampsia by as much as 55% among populations with low intake and by 62% among high-risk women [19]. This protective effect is mediated through vascular mechanisms. New findings have begun to relate deficiency with other obstetric hazards. A study on a cohort in Ghana linked hypocalcemia with an increased risk, 2.1 times for preterm labor, and also a 1.8 times increased risk for cesarean delivery due to dystocia [20]. This finding underlines the role of calcium in effective contractions of the uterus. In addition, deficiency might elevate the possibility of postpartum hemorrhage by hindering uterine retraction [18, 20].

### Fetal and Neonatal Outcomes

Maternal calcium deficiency has effects on fetal and neonatal health that may continue beyond birth through fetal programming. One study found that infants of hypocalcemic mothers had reduced bone density at birth and reduced growth in infancy [18, 21]. In addition, severe maternal deficiency poses a direct risk for neonatal hypocalcemia. A Nigerian study reported that 12.7% of infants born to mothers with very low calcium levels developed symptoms such as seizures or feeding difficulties [22]. These acute, preventable complications have a huge burden on neonatal care in resource-limited settings

### Assessment Methods and Diagnostic Considerations

Assessing calcium status in pregnancy is methodologically complex. Serum total calcium is the most common clinical measure but becomes unreliable due to hemodilution and shifting albumin levels induced by pregnancy [11, 22]. Though ionized calcium may be more accurate, its cost precludes routine use in many Nigerian settings.The timing of measurement adds further difficulty, as calcium metabolism changes dynamically. Research suggests trimester-specific reference ranges are needed; uniform cutoffs may misclassify women especially in late pregnancy [18].Dietary assessment also presents challenges in Nigeria. Standard food questionnaires often lack cultural relevance, underrepresenting local calcium sources like leafy greens and small fish. Validated tools for Nigerian women improve the accuracy of estimates, but significant limitations in estimating intake persist [22].

### Interventions and Current Guidelines

Global recommendations for calcium intake during pregnancy differ. The WHO recommends a daily intake of 1.5-2.0 g for women whose dietary intake is low (<900 mg/day), mainly to prevent preeclampsia [23]. This has been adapted into some national policies in Africa but the implication remains patchy.

In Nigeria, it is recognized that calcium has a role in the national nutrition strategy; however, there are no specific protocols that are standardized [24]. A recent analysis [25] indicated that only 32% of antenatal facilities offered related nutrition counseling and less than 15% had the supplements available underscoring a significant gap between Policy and practice.

### Research Gaps and Justification for Current Study

There are still major gaps in evidence about the status of calcium in Nigerian pregnancies, especially in the North-Central region which has not been well studied. Diets rich in cereals and tubers, seasonal changes, and cultural practices probably affect the rates of deficiency, but specific data on calcium is missing [25, 26, 27]. In addition, existing studies focus on urban tertiary centers and ignore primary care settings while the relationship between deficiency in calcium and common local conditions such as malaria, HIV, and obesity is not known very clearly.

This study was conducted at Federal University of Lafia Teaching Hospital (Formally Dalhatu Araf Specialist Hospital Lafia) to fill these gaps by providing contemporary data from this understudied region. It describes biochemical as well as dietary assessments and their association with some important maternal characteristics. This will help develop context-specific strategies for improving calcium status and hence maternal and neonatal health outcomes in North-Central Nigeria.

## Materials and Method

**Study Design:** This study is a cross-sectional hospital-based survey targeting apparently healthy pregnant women at the antenatal of the FULATH Lafia, Nasaeawa State Nigeria. Data collection involved administration of a semi-structured questionnaire and collection of blood samples of the participants.

**Study Area:** This study was conducted at FULATH, Lafia, which is located in Shendam road Lafia, Nassarawa State. Lafia is a town in North Central. It is the capital city of Nasarawa state with estimated population of 360,728(WPR, 2022). Lafia has geographical coordinate of latitude $8^0$29'38"N and longitude of $8^0$30'55.2"E [27, 38]

**Study Population and Size:** 100 pregnant women attending antenatal at Dalhatu Araf specialist hospital.

Using the prevalence by [28].

$$n = \frac{Z^2 \times P(1-P)}{d2}$$

where;

n = desired sample size;

Z = standard deviation score when P< 0.01 corresponding to 1.96;

p = expected prevalence = P< 0.5

d = desired precision,

Therefore,

$$n = \frac{1.96^2 \times 0.5\,(1-0.5)}{0.098^2} = 100$$

## Inclusion and Exclusion Criteria

Eligible participants must meet all of the following criteria:

1. Pregnant women, aged 18–44 years, receiving antenatal care at the Federal University of Lafia Teaching Hospital.
2. Confirmed singleton intrauterine pregnancy with a gestational age between 12 and 36 weeks, verified by obstetric ultrasound.
3. Provision of written informed consent for study participation, including authorization for a venous blood draw for serum calcium analysis.
4. Clinically stable at the time of enrollment, with no evidence of acute illness, to allow for accurate assessment of baseline calcium status.

## Exclusion Criteria

Participants will be excluded from the study if they meet any of the following criteria:

1.Multiple gestation (e.g., twins or triplets), due to the significantly altered calcium homeostasis associated with such pregnancies.
2. A documented history of chronic medical conditions known to disrupt calcium metabolism, including but not limited to: chronic kidney disease, parathyroid disorders, diabetes mellitus, hypertension, or malabsorption syndromes.
3. Recent hospitalization (within the past 4 weeks), presence of an active infection, or current use of medications that influence calcium metabolism (e.g., diuretics, anticonvulsants, corticosteroids).
4. Severe anemia, defined as a hemoglobin level below 8 g/dL, or an unwillingness to undergo phlebotomy.

## Rationale

These criteria ensure a homogeneous cohort focused on typical antenatal attendees in Nigeria, minimizing confounders while capturing diverse parity, age (predominantly 18-34), and trimester distributions observed in the study. Standard for cross-sectional calcium assessments in low-resource settings.

## Ethical Approval and Informed Consent

Ethics approval (DASHREC/440) was obtained from the Nasarawa Sate Ministry of Health and consent to participate was granted by participants for this study.

Informed consent was obtained from all participating pregnant women after explaining the purpose of the study. Participation was voluntary, confidentiality was assured, and participants could withdraw at any time without penalty.

### Sampling Technique

Simple random sampling technique was used for this research work.

### Data Collection

Data was collected using a semi-structured interview-administered questionnaire. Questionnaires was used to collect: Age, gestational age (trimester), socioeconomic status.

### Blood Sample Collection and Analysis

Collected blood samples following standard protocols during ANC (antenatal clinic) visits.

### Procedure

All necessary equipment like syringes, alcohol swabs, container were available. Blood was collected from the vein using a sterile needle into a plain container. proper labelling of samples was ensured. Samples were handled carefully and transported to the laboratory promptly. Samples were centrifuged to separate serum from blood cells. The serum was then analysed using chemistry auto analyzer to measure the concentration of calcium ion. Data were documented and statistically analyzed.

Hypocalcemia was defined as a serum total calcium level < 8.0 mg/dL (2.00 mmol/L) [29, 30].

### Statistical Analysis

The data obtained will be analyzed using the SPSS statistical software for windows version 20. Chi-square test will be used for categorical variables and odd ratio with multinomial logistic regression analysis will be done to determine risk factors for hypocalcemia in pregnancy. Tables and graphs are used to illustrate patterns in the variables.

## Results

### Demographic Characteristics of Participants

The results of the Tables 1 to 9 below is on the sociodemographic factor such as age, dietary habits of calcium such as (diary consumption, non-diary consumption and calcium supplement) and no of pregnancy

**Table 1:** Age of the Respondent

| Age range | Frequency | Percentage |
|---|---|---|
| 18-24 | 36 | 36 |
| 25-34 | 52 | 52 |
| 35-44 | 12 | 12 |
| Total | 100 | 100 |

**Table 2:** Number of Pregnancy of the Respondent

| Age range | Frequency | Percentage |
|---|---|---|
| 1 to 2 | 42 | 42 |
| 3 to 4 | 24 | 24 |
| 5 or more | 8 | 8 |
| None | 26 | 26 |

| | | |
|---|---|---|
| Total | 100 | 100 |

**Table 3:** Dairy Habit (Dairy consumption) in pregnancy

| Response | Frequency | Percentage |
|---|---|---|
| Daily | 33 | 33 |
| Rarely | 7 | 7 |
| Several times a week | 35 | 35 |
| Weekly | 25 | 25 |
| Total | 100 | 100 |

**Table 4:** Dairy Habit (Non Dairy consumption) in pregnancy

| Response | Frequency | Percentage |
|---|---|---|
| Daily | 55 | 33 |
| Rarely | 13 | 7 |
| Several times a week | 18 | 35 |
| Weekly | 14 | 25 |
| Total | 100 | 100 |

**Table 5:** Dairy Habit (Calcium Supplement) in Pregnancy

| Response | Frequency | Percentage |
|---|---|---|
| Yes | 65 | 64.4 |
| No | 35 | 34.7 |
| Total | 100 | 100 |

**Table 6:** Regular Exercise during pregnancy

| Response | Frequency | Percentage |
|---|---|---|
| Yes | 69 | |
| No | 31 | |
| Total | 100 | 100 |

**Table 7:** Symptoms in pregnancy

| Response | Frequency | Percentage |
|---|---|---|
| No | 72 | |
| Yes (Abdominal Pain) | 6 | |
| Yes (Back Pain) | 7 | |
| Yes (Knee Pain) | 6 | |
| Yes (Leg Cramps) | 6 | |
| Yes (Muscles Cramps) | 3 | |
| Total | 100 | 100 |

**Table 8:** Calcium Level (mmol/L) among the Responded

| Category | Frequency | Percentage |
|---|---|---|
| Low | 38 | 38 |
| Normal | 17 | 17 |
| High | 45 | 45 |
| Total | 100 | 100 |

**Table 9:** Comparison between Calcium Level (mmol/L) with Age Range of the Respondent

| Parameter | Mode | Mean | Variance | 95% confidence interval | |
|---|---|---|---|---|---|
| 18-24 | 11.623 | 11.623 | 1.168 | 9.501 | 13.746 |
| 25-34 | 10.147 | 10.147 | 0.735 | 8.463 | 11.831 |
| 35-44 | 7.224 | 7.224 | 2.422 | 4.167 | 10.281 |

Not Significance (p=0.630)

## Relationship between Calcium Levels and Other Variables

Table 10 to 13 and figures below show the comparison between Calcium level base on category of the respondent with variables such the Age distribution, diary consumption, calcium supplement, physical activities (exercise) and symptoms using chi-square subject at 95% confidence interval

**Table 10**: Comparison between Calcium Levels (mmol/L) and Calcium supplement of the Respondent.

| Parameter | Mode | Mean | Variance | 95% confidence interval | |
|---|---|---|---|---|---|
| No | 1.719 | 1.719 | 0.012 | 1.5 | 1.939 |
| Yes | 2.261 | 2.261 | 0.22 | 1.97 | 2.553 |

Statistically Significance (p=0.004)

**Table 11:** Comparison between Calcium Levels (mmol/L) and Diary Consumption of the Respondent.

| Parameter | Mode | Mean | Variance | 95% confidence interval | |
|---|---|---|---|---|---|
| Daily | 1.974 | 1.974 | 0.03 | 1.635 | 2.313 |
| Rarely | 1.698 | 1.698 | 0.131 | 0.987 | 2.408 |
| Several times a week | 1.776 | 1.776 | 0.024 | 1.47 | 2.083 |
| Weekly | 2.076 | 2.076 | 0.03 | 1.736 | 2.417 |

Not Statistically Significance (p=0.630)

**Table 12:** Comparison between Calcium Levels (mmol/L) and Exercise of the Respondent

| Parameter | Mode | Mean | Variance | 95% confidence interval | |
|---|---|---|---|---|---|
| No | 1.683 | 1.683 | 0.026 | 1.367 | 2 |
| Yes | 2.025 | 2.025 | 0.012 | 1.807 | 2.244 |

Not Statistically Significance (p=0.081)

**Table 13:** Comparison between Calcium Levels (mmol/L) and Symptoms of the Respondent

| Parameter | Mode | Mean | Variance | 95% confidence interval | |
|---|---|---|---|---|---|
| No | 2.026 | 2.026 | 0.011 | 1.818 | 2.234 |
| Yes (Abdominal Pain) | 1.074 | 1.074 | 0.15 | 0.314 | 1.834 |
| Yes (Back Pain) | 1.324 | 1.324 | 0.112 | 0.666 | 1.982 |
| Yes (Knee pain) | 1.473 | 1.473 | 0.143 | 0.73 | 2.217 |
| Yes(Leg ramps) | 2.19 | 2.19 | 0.128 | 1.486 | 2.893 |
| Yes(Muscle cramps) | 2.307 | 2.307 | 0.204 | 1.42 | 3.193 |

Statistically Significance (p=0.045)

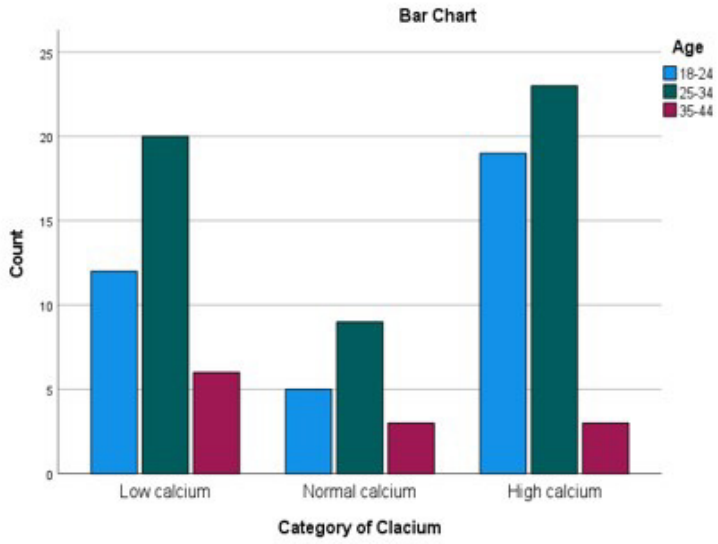


**Figure 1:** Relationship between Calcium Levels (Mmol/L) f The Pregnant Women and Age Range

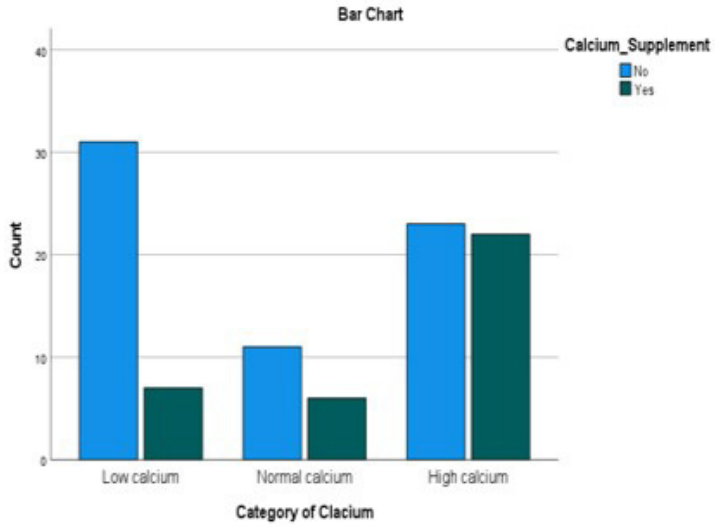


**Figure 2:** Comparison between Calcium Levels (mmol/L) of the Pregnant Women and Calcium Supplement

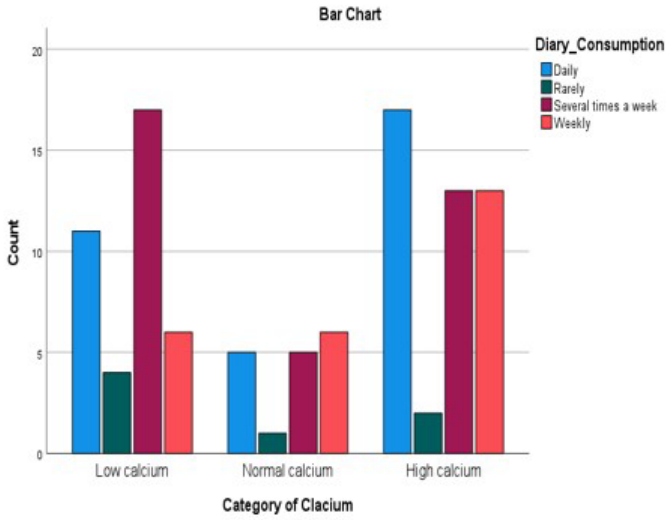


**Figure 3:** Comparison between Calcium Levels (mmol/L) of the Pregnant Women and Diary Consumption

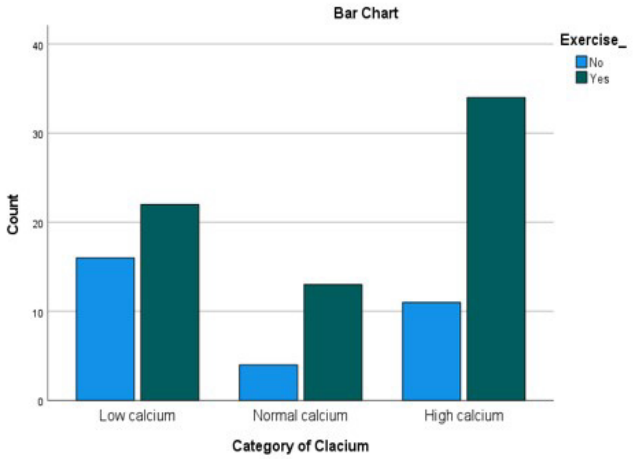


**Figure 4:** Comparison between Calcium Levels (mmol/L) of Pregnant Women and Exercise

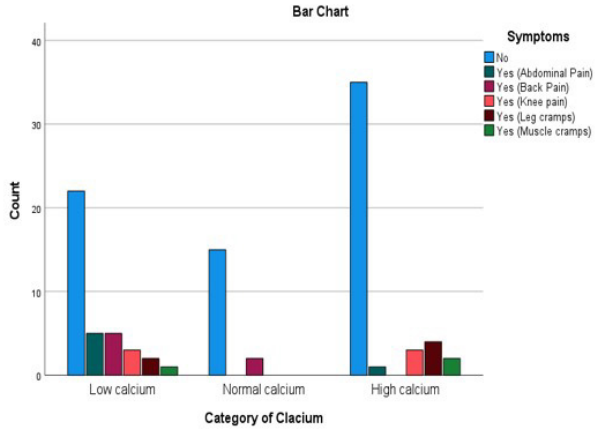


**Figure 5:** Comparison between Calcium Levels (mmol/L) of Pregnant Women and Symptoms in Pregnancy

## Discussion

The majority of participants (52%) were aged 25–34, followed by 36% in the 18–24 bracket, with 12% aged 35–44. This age distribution indicates greater involvement among younger women, aligning with the reproductive age structure of the population and patterns observed in prior studies. For example, [32] reported comparable demographic profiles in reproductive health surveys, attributing higher engagement to increased awareness and access to healthcare among younger cohorts.

Regarding parity, 42% of respondents had 1–2 pregnancies, 26% reported no pregnancies, and 8% had five or more. These results reflect a predominance of women in the early reproductive stage and correspond to global trends toward lower parity driven by socioeconomic factors and expanded family planning, as described by [33]. The revised structure minimizes redundancy, employs precise ranges, and integrates citations smoothly while enhancing the academic tone without altering the meaning.

In terms of dairy consumption, 35% of respondents reported consuming dairy several times weekly, and 33% consumed it daily. 55% relied on non-dairy calcium sources daily, with only 7% using them rarely. These patterns indicate broad awareness of calcium requirements, with a preference for non-dairy sources and supplementation. The propensity toward non-dairy options is consistent with [32], who documented reliance on such alternatives in low-lactose populations. This may reflects heightened bone health awareness among pregnant women, [33]. The calcium status demonstrated a statistically significant ($p = 0.004$) association with supplementation during pregnacy, whereby supplement users had higher mean calcium levels (2.261 mmol/L) compared with non-users (1.719 mmol/L). This finding indicates a direct effect of supplementation on maintaining optimal calcium status during pregnancy. These results are consistent with [34], who reported that supplementation enhances serum calcium among pregnant women, particularly within at-risk groups, and may reduce related risks such as preeclampsia, supporting proactive management in populations with low prevalence akin to this sample [36]. Contemporary investigations reinforce this evidence: a 2023 multicenter trial observed a 15–20% increase in calcium levels with a daily dose of 1,000 mg, accompanied by a 28% reduction in hypocalcemia risk. A 2025 Ethiopian cross-sectional study [36] similarly linked consistent intake to normalized calcium levels (2.1–2.5 mmol/L), underscoring benefits in regions with low dairy consumption.

The association between dairy intake and calcium levels did not reach statistical significance ($p = 0.630$), with daily dairy consumers exhibiting a mean level of 1.974 mmol/L, only marginally higher than those who rarely consume dairy. This diverges from [37], who emphasized dairy's role in optimizing calcium homeostasis. Recent research, including a 2021 multicenter study in regions with low dairy consumption, similarly reported non-significant associations between dairy intake and calcium levels when supplementation patterns dominated intake. These results emphasize contextual determinants over universal dairy benefits and support tailored recommendations that prioritize overall calcium sufficiency regardless of source [36, 37].

69% of participants reported engaging in regular exercise. This finding suggests a health-conscious cohort, potentially associated with complementary behaviors such as supplementation and balanced dietary practices. This view is supported by [34, 35], who found that regular exercisers among pregnant women experience improved health outcomes, including optimized calcium metabolism and enhanced physical well-being.

The results of this study indicate a statistically significant difference across pain categories ($p = 0.045$), showing that calcium levels among pregnant women differ according to the presence and type of pain symptoms. The majority of participants (72%) reported no symptoms, while a minority experienced abdominal pain (6%), back pain (7%), muscle cramps (3%), or leg cramps (6%). Participants without pain exhibited more stable and comparatively higher calcium levels, suggesting adequate calcium status. In contrast, lower mean calcium levels were observed among women reporting abdominal, back, and knee pain, indicating a possible association between these symptoms and reduced calcium levels during pregnancy.

Women who reported leg cramps and muscle cramps demonstrated relatively higher mean calcium levels; however, the wide variability observed suggests that these symptoms may be influenced by factors other than calcium deficiency, such as neuromus-

cular or electrolyte imbalances. The statistically significant difference across pain categories ($p = 0.045$) supports the relevance of pain symptoms as indicators of altered calcium status in pregnancy. These findings emphasize the importance of monitoring calcium levels and musculoskeletal symptoms to promote maternal well-being. Musculoskeletal symptoms such as cramps exhibit comparable variability, with a 2025 study associating vitamin D deficiency (common during pregnancy) with moderate to severe pain in 68% of cases [31]. A 2023 meta-analysis identified a high incidence of back pain in late pregnancy (up to 74%), highlighting exercise and nutritional strategies as mitigating factors.

Regular exercisers demonstrated higher mean calcium levels (2.025 mmol/L) compared with non-exercisers (1.683 mmol/L), though the difference did not reach statistical significance ($p = 0.081$). This observation aligns with established links between physical activity and enhanced calcium metabolism. Exercise supports skeletal health and calcium retention, as [34, 35] reported improved absorption and reduced urinary losses among active individuals. Recent analyses [34] indicate that moderate physical activity optimizes maternal mineral homeostasis, which may account for the observed difference despite limited statistical power in this study. The borderline p-value likely reflects sample size constraints or potential confounders such as diet or supplementation, highlighting the necessity for larger investigations to determine exercise's independent impact on calcium status during pregnancy.

Among participants reporting muscle cramps, mean calcium levels were statistically significantly higher (2.307 mmol/L) than in asymptomatic individuals ($p=0.045$), suggesting a possible association between elevated calcium and symptom presentation within this population. This counterintuitive result aligns with [17, 37], who described that both hypocalcemia and hypercalcemia can provoke muscle cramps through altered neuromuscular excitability, with elevated levels occasionally producing tetany-like manifestations. Potential confounders, including vitamin D status, hydration, or electrolyte imbalances, may contribute, warranting further exploration of non-linear calcium-symptom relationships in pregnancy

## Conclusion

The study examined associations between serum calcium and key demographic, dietary, lifestyle, and clinical factors in pregnant women. Age showed no significant correlation with calcium status, indicating that maternal age alone does not markedly influence deficiency risk at the Federal University of Lafia Teaching Hospital, Nigeria.

Calcium supplementation emerged as the strongest predictor, with statistically significant increases in mean calcium levels among users ($p = 0.004$), underscoring its critical role in optimizing maternal–fetal mineral homeostasis. In contrast, dairy intake did not reach significance ($p = 0.630$), possibly due to predominant reliance on non-dairy sources (55% daily) and supplements (65%), which together ensure adequate intake irrespective of dairy habits.Regular exercise displayed a trend toward higher calcium levels ($p = 0.081$), implying potential metabolic benefits without establishing causality, possibly moderated by sample limitations. Importantly, muscle cramps were significantly associated with elevated calcium ($p = 0.045$), challenging conventional hypocalcemia narratives and suggesting bidirectional interactions between minerals and symptoms, influenced by factors such as electrolytes or vitamin D.

These patterns support targeted micronutrient supplementation over dairy-centric approaches within comparable populations, and they underscore the need for larger trials to delineate the independent effects of exercise and the symptom–calcium thresholds relevant to personalized

Prenatal care.

### Limitations

This study has some important limitations:

i. Small and Restricted Sample Size: Only one hundred pregnant women were used for this study, recruited from a single hospital in North-Central Nigeria. This does not allow broad generalization of the findings to cover other areas of Nigeria or different healthcare settings, like primary health centers or rural clinics.

ii. Cross-Sectional Design: The cross-sectional nature of this study means that data has been collected at one point in time only. Therefore, no causal relationships can be inferred between supplementation, diet, exercise, etc., with respect to calcium levels. Changes longitudinally in calcium status through trimesters could not be assessed.

iii. Reliance on Self-Reported Data: Major variables like dietary intake, supplement use, and exercise habits were all obtained through a questionnaire which is prone to recall bias and social desirability bias as well as inaccuracies in reporting. This may compromise the reliability of any associations found.

iv. Lack of Ionized Calcium Measurement: Measurement was done for total serum calcium; however, this can be affected by albumin levels and hemodilution due to pregnancy. More accurate assessment regarding calcium status would be given using ionized calcium since it is the biologically active form; hence its absence constitutes a methodological limitation.

## Recommendation

Healthcare providers should emphasize calcium supplementation given its demonstrated association with higher serum levels, while informing pregnant patients about deficiency risks and the benefits of supplementation for maternal–fetal health. In addition, tailored nutritional strategies, ongoing symptom monitoring, and early intervention are warranted, and future longitudinal research should assess the long-term outcomes of supplementation and the moderating effects of exercise on calcium metabolism. Finally, there is need for further research considering increase sample size, measurement of Ionized Calcium and calcium status through trimesters.

**Acknowledgement:** The authors appreciate God Almighty and the management of Federal University of Lafia Teaching Hospital for their collaboration in making this study a success.

**Authors' contributions:** The study conception and design were done by Akpulu S.Peter. and Dalhatu Rashidah. Material preparation and data collection were done by Dalhatu Rashidah and Adah O. Sylvester.. Analysis and interpretations were performed by Itakure Usman Abdulkadir and Terna U.Genevieve. The drafting and editing of manuscript was done by Akpulu S.Peter and Aikpitanyi-Iduitua A. Godwin. All the authors read and approved the final manuscript.

**Funding:** The authors declare that no funds, grants, or other support were received during the preparation of this manuscript.

**Data availability:** The data sets generated and/or analyzed during the current study are available on request.

**Declarations:** I, hereby declare that this manuscript entitled submitted is our original work. The manuscript has not been published previously, in whole or in part, and is not under consideration for publication elsewhere. All authors have read and approved the final version of the manuscript and have agreed to its submission. We further declare that all data reported in the manuscript are authentic and were obtained according to recognized ethical and scientific standards.

**Ethics approval:** Ethics approval (DASHREC/440) was obtained from the Nasarawa Sate Ministry of Health and consent to participate was granted by participants for this study.

**Use of Artificial Intelligence (AI):** AI (Deep Seek and Chat GPT) were was minimally use for language and Reference editing.

**Consent for publication:** All of the authors agree to the submission and consent for publication of this paper.

**Competing interests:** The authors declare no conflict of interest

## References

1. Black A J, Topping J, Durham B, Farquharson R G, Fraser W D (2000) A detailed assessment of alterations in bone turnover, calcium homeostasis, and bone density in normal pregnancy. Journal of Bone and Mineral Research, 15: 557-63.

2. Hofmeyr G J, Lawrie T A, Atallah A N, Torloni M R (2022) Calcium supplementation during pregnancy for preventing hypertensive disorders and related problems. Cochrane Database of Systematic Reviews, 10, CD001059.

3. World Health Organization (2023) Calcium supplementation during pregnancy for prevention of pre-eclampsia and its complications. Geneva, Switzerland.

4. Keats E C et al. (2021) Effective interventions to address maternal and child malnutrition: An update of the evidence. The Lancet Global Health, 9: e45-57.

5. Adebayo R O, Sanni L O, Okafor C I (2024) The double burden of malnutrition among pregnant women in urban Nigeria: A cross-sectional study. BMC Pregnancy and Childbirth, 112.

6. Nigeria Demographic and Health Survey (2023–24) NDHS, Nigeria.

7. Gehlert J, Morton A (2019) Hypercalcaemia during pregnancy: review of maternal and fetal complications, investigations, and management. Obstetric Medicine, 12: 175-9.

8. Goshit Z D, Pam V C, Mwanse T D (2022) Micronutrient status of pregnant women in Plateau State, Nigeria: A cross-sectional survey. Pan African Medical Journal, 43: 187.

9. Kahn D A, Koos B J (2007) Maternal physiology during pregnancy. In: DeCherney A H, Nathan L (eds) Current Diagnosis & Treatment: Obstetrics & Gynecology, 10th ed. McGraw-Hill Medical, 155-165.

10. Akinlua O O, Adepoju F G, Balogun M R (2022) Serum calcium levels and associated factors among pregnant women in Ibadan, Nigeria. Nigerian Journal of Clinical Practice, 25: 1289-95.

11. Chen L, Wang Q, Zhang H (2024) Global prevalence of hypocalcemia in pregnancy: A systematic review and meta-analysis. European Journal of Clinical Nutrition, 78: 245-56.

12. Liabsuetrakul T, Yamamoto Y, Kongkamol C, Ota E, Mori R, Noma H (2022) Medications for preventing hypertensive disorders in high-risk pregnant women: a systematic review and network meta-analysis. Systematic Reviews, 11: 1-17.

13. Kongwattanakul K, Duangkum C, Ngamjarus C, Lumbiganon P, Cuthbert A, Weeks J, Sothornwit J (2024) Calcium supplementation for improving pregnancy and infant outcomes. Cochrane Database of Systematic Reviews, 11, CD007079.

14. Adeloye D, Owolabi E O, Ojji D B et al. (2021) Prevalence, awareness, treatment, and control of hypertension in Nigeria in 1995 and 2020. Journal of Clinical Hypertension, 23: 963-977.

15. Black R E et al. (2013) Maternal and child undernutrition and overweight in low-income and middle-income countries. The Lancet, 382: 427-51.

16. Federal Ministry of Health Nigeria (2022) National guidelines for integrated maternal, infant, and young child nutrition. Abuja, Nigeria.

17. Boateng L, Asare H, Mensah P (2024) Calcium status and obstetric outcomes among Ghanaian pregnant women. International Journal of Gynecology & Obstetrics, 165: 456-63.

18. Fernández M D L Á, Gómez T, Rodríguez A (2023) Longitudinal changes in calcium metabolism during pregnancy. Clinical Chemistry and Laboratory Medicine, 61: 890-8.

19. Villar J, Purwar M, Merialdi M (2023) Calcium supplementation for prevention of pre-eclampsia: an updated meta-analysis. The Lancet Global Health, 11: e398-e407.

20. Chen D, Wang H, Xin X, Zhang L, Yu A, Li S et al. (2022) Different doses of calcium supplementation to prevent gestational hypertension and pre-eclampsia. Frontiers in Nutrition, 8: 795667.

21. Villa-Etchegoyen C, Lombarte M, Matamoros N, Belizán J M, Cormick G (2019) Mechanisms involved in the relationship between low calcium intake and high blood pressure. Nutrients, 1112.

22. Eze C U, Okafor U G, Nwosu J N (2023) Neonatal hypocalcemia in Nigeria: prevalence and maternal correlates. Journal of Neonatal-Perinatal Medicine, 16: 345-51.

23. World Health Organization (2013) Guideline: Calcium supplementation in pregnant women. World Health Organization, Geneva.

24. Federal Ministry of Health Nigeria (2022) Planning, Research and Statistics Report. Nigeria.

25. Buppasiri P, Lumbiganon P, Thinkhamrop J, Ngamjarus C, Laopaiboon M, Medley N (2015) Calcium supplementation for improving pregnancy and infant outcomes. Cochrane Database of Systematic Reviews, 2.

26. World Health Organization (2020) WHO recommendation on calcium supplementation before pregnancy for the prevention of pre-eclampsia. World Health Organization, Geneva.

27. Woo Kinshella M L, Sarr C, Sandhu A et al. (2022) Calcium for pre-eclampsia prevention: a systematic review and network meta-analysis. BJOG, 129: 1833-43.

28. Naylor K E, Iqbal P, Fledelius C, Fraser R B (2000) The effect of pregnancy on bone density and bone turnover. Journal of Bone and Mineral Research, 15: 129-37.

29. World Health Organization (2018) WHO recommendation on calcium supplementation during pregnancy. World Health Organization, Geneva.

30. King J C (2000) Physiology of pregnancy and nutrient metabolism. American Journal of Clinical Nutrition, 71: 1218S-25S.

31. Salari N, Ghasemi H, Abdoli N (2023) The global prevalence of ADHD in children and adolescents. Italian Journal of Pediatrics, 49: 48.

32. Smith E R, Shankar A H, Wu L S et al. (2017) Modifiers of the effect of maternal multiple micronutrient supplementation. The Lancet Global Health, 5: e1090-100.

33. Leak P, Yamamoto E, Noy P et al. (2021) Factors associated with neonatal mortality in a tertiary hospital in Cambodia. Nagoya Journal of Medical Science, 83: 113-24.

34. Weaver C M (2015) Diet, exercise, and bone health. In: Holick M F, Nieves J W (eds) Nutrition and Bone Health. Humana Press, 537-51.

35. Rizzoli R (2014) Nutritional aspects of bone health. Best Practice & Research Clinical Endocrinology & Metabolism, 28: 795-808.

36. Kowsar E, Vatankhah M, Saberivand A (2022) Effect of vitamin E, selenium, and calcium therapy on fertility in dairy cows. Archives of Razi Institute, 77: 2189-97.

37. Kumsa H, Mislu E, Beyene A (2025) Effects of calcium supplementation on the prevention of preeclampsia. Frontiers in Medicine, 12: 1568891.

38. Rizzoli R, Stevenson J C, Bauer J M (2014) The role of dietary protein and vitamin D in maintaining musculoskeletal health. Maturitas, 79: 122-32.