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# Predictors of maternal hypocalcemia among pregnant women attending at a tertiary referral hospital in Tanzania: a cross-sectional study

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## Abstract

**Background** Hypocalcemia is a problem among pregnant women mainly caused by pregnancy physiology, and poor dietary calcium intake, especially in African countries due to low socio-economic status. Worldwide, the prevalence of hypocalcemia varies from 25.5 to 70.6%. This study was designed to determine the prevalence of maternal hypocalcemia and its predictors among pregnant women attending Bugando Medical Centre, a tertiary referral hospital in Mwanza, Tanzania.

**Methods** This was a cross-sectional study. Socio-demographic, clinical and laboratory data were collected using a standardized, pre-tested, and coded questionnaire, and laboratory form. Venous blood was taken for laboratory investigation to measure the serum calcium level. Data were entered into a computer using Microsoft Excel 2013, and analyzed using STATA version 15. We used univariate logistic regression followed by multivariate logistic regression models to determine the predictors of maternal hypocalcemia. Predictors with a p-value of less than 0.05 were considered statistically significant.

**Results** A total of 651 pregnant women were enrolled. Their mean age was 29.5 ± 5.6 years, and the majority, 79.7% (519/651) aged less than 35 years. The prevalence of maternal hypocalcemia was 23.2% (151/651) [95% CI 20.0% – 26.4%]. The independent predictors of maternal hypocalcemia were multiple pregnancy (OR 11.8; 95% CI 5.1–27.5; p-value <0.001), previous history of preeclampsia-eclampsia (PE-E) (OR 2.1; 95% CI 1.1–4.1; p-value 0.028), lack of calcium supplementation during antenatal visits (OR 11.8; 95% CI 2.4–57.8; p-value 0.002), number of antenatal visits less than 4 (OR 1.8; 95% CI 1.1 – 2.9; p-value 0.013), residing in rural (OR 2.8; 95% CI 1.5–5.4; p-value 0.002), and use of MgSO4 and/or Calcium channel blocker (CCB) (OR 18.6; 95% CI [6.1–57.0]; p-value <0.001).

**Conclusion** We found that one out of five pregnant women had maternal hypocalcemia. The independent predictors of maternal hypocalcemia were, having multiple pregnancies, previous history of PE-E, lack of calcium supplementation during antenatal visits, having less than 4 antenatal visits, residing in rural areas and use of MgSO4 and/or Calcium channel blocker. Routine screening for maternal hypocalcemia during antenatal clinic visits, routine

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calcium supplementation during antenatal visits should be strictly adhered, and education on nutrition regarding calcium-rich food should be emphasized.

**Keywords** Prevalence, Predictors, Maternal hypocalcemia, Calcium, pregnancy

## Introduction

Hypocalcemia, a condition characterized by low levels of serum calcium is a problem among pregnant women mainly caused by pregnancy physiology, and poor dietary calcium intake, especially in African counties due to poverty. Worldwide the prevalence of hypocalcemia is estimated to be 25.5 – 70.6% [1–6], with prevalence rates significant higher in developing countries. In Africa, several studies have been conducted in Algeria, Cameroon, and Nigeria with variation of prevalence [3–6].

In physiological changes of pregnancy, total serum calcium levels normally fall throughout pregnancy due to the increased demand of the fetus. The maternal demand for calcium is elevated by as much as 300–350 mg/day to provide the calcium required for fetal bone mineralization. Also, low dietary calcium intake decreases plasma calcium concentration [7, 8]. The usual physiological pregnancy changes combined with low dietary calcium intake can lead to maternal serum calcium deficiency. Mostly mother adapts in various ways to meet the additional calcium needs including; changes in intestinal dietary calcium absorption and excretion, and mobilization of calcium from the maternal skeleton. Pregnant women are more at risk to meet the normal calcium demand during pregnancy when they already have hypocalcemia [7, 8].

Studies have shown the decrease in plasmatic calcium concentration stimulating the release of parathyroid hormone, parathyroid hypertensive factor, the synthesis of calcitriol, and the activation of the renin–angiotensin–aldosterone system resulting in increased intracellular calcium concentration which causes vasoconstriction and raises peripheral vascular resistance as well as the blood pressure [7]. Also, hypocalcemia has been associated with decreased antioxidant capacity [9], the role of oxidative stress has been implicated in the pathogenesis of preeclampsia as calcium is essential for the synthesis of Nitric oxide, a potent vasodilator and an important antioxidant that prevents PE-E. Depending on ethnicity and geographic area, since 2013, WHO has recommended 1.5–2.0 g oral elemental calcium daily in populations with poor dietary calcium consumption in order to minimize the risk of PE-E. This was adopted by the Tanzania Antenatal Care (ANC) guidelines in 2018 [10, 11].

Despite the known links between hypocalcemia and adverse pregnancy outcomes, there is limited data on prevalence and predictors of hypocalcemia in many low- and middle-income countries (LMICs). Our study aims to fill this gap by determining the prevalence among pregnant women attending at Bugando Medical Center (BMC), a tertiary referral hospital in Mwanza, Tanzania and identify key predictors of the condition. This study is crucial in shedding light on the specific factors that contribute to maternal hypocalcemia. By identifying and addressing these predictors, we aim to provide evidence that will help guide the development of targeted interventions and policies to reduce the associated risks of adverse pregnancy outcomes.

## Materials and methods

### Study design and period

A cross-sectional study was conducted from June 2022 to January 2023 to determine the prevalence and predictors of maternal hypocalcemia among pregnant women at BMC in Mwanza, Tanzania.

### Study setting

BMC is one of the four tertiary referral hospitals in the country and serves as a referral center for specialized and super-specialized care for a catchment population of approximately 20 million people from neighboring regions which are Kagera, Geita, Shinyanga, Mara, Simiyu, Tabora and Kigoma. Mwanza being one of the major regions in Northwestern Tanzania, has a diverse population, with significant numbers of rural residents, making an ideal location for studying the prevalence and predictors of maternal hypocalcemia.

### Participants

Eligibility criteria include all pregnant women who consent to participate in this study with gestational age ≥ 20 weeks attending ANC at BMC or admitted in the BMC-labour ward and exclusion criteria were all pregnant women with known thyroid/parathyroid diseases and those who underwent thyroidectomy/parathyroidectomy.

### Sample size

The sample size was calculated using the Leslie Kish formula [12], using the prevalence of hypocalcemia in pregnant women of 29.2% in study done in Nigeria [4].

$$N = \frac{z^2 p\ (1-p)}{d^2}$$

Where: z = z score for 95% confidence interval = 1.96, p = prevalence, d = tolerable error = 5%, p = Prevalence of 0.2920.

$$N = \frac{1.96^2 \times 0.2920 \times (1 - 0.2920)}{0.05^2}$$

Minimum Sample size = 318 + 20% for missing data or non-response = 382.

### Sampling procedure

Patients who met the inclusion criteria were enrolled serially into the study until the sample size was reached within the study period.

### Variables

*The independent variables analyzed were* age, level of education, residency, occupation, number of pregnancies (gravidity), number of previous deliveries (parity), multiple pregnancy, interpregnancy interval, gestational age, previous history of PE-E, history of calcium supplementation, and number of ANC visits, being in Calcium channel blocker (CCB) or MgSO4.

*The dependent variable was* Calcemic state.

### Data collection and measurements

Data were collected using a standardized pretested and coded questionnaire. Detailed history was taken and thorough general and physical examination was done. The gestational age was extrapolated from the last normal menstrual period or extrapolated from the ANC card and sometimes obstetric ultrasound was used for those who did not remember their last normal menstrual period. Based on the National Medical Standard Operating Procedures, the minimum amount of blood to be collected is 3–5mls [13]. The 3mls of blood were obtained from all study participants from antecubital vein using sterile disposable syringe and placed in green top vacutainer test tubes. Samples were stored in a cooler box maintained by ice packs at a temperature of + 2 °C to + 8 °C and transported to a diagnostic laboratory at BMC within 4 h of collection for processing to find out the serum calcium levels. The serum calcium measurement was performed using the Roche COBAS Integra 400 Plus analyzer at BMC in Mwanza.

### Statistical data analysis

Data collected were entered into a computer using Microsoft Excel 2013 and then analyzed using STATA version 15. Data were summarized in the form of proportions, percentages, and frequency tables for categorical variables. For continuous variables, data were reported as mean ± standard deviation (SD) or median ± interquartile range (IQR) depending on their distribution. To determine predictors of maternal hypocalcemia among pregnant women we used univariate logistic regression analysis followed by multivariate logistic regression models. Predictors found to have a p-value less than 0.25 in the initial univariate logistic regression analysis model were subjected to multivariate logistic regression analysis model. The measure of the strength of association, the odds ratio (OR), was determined with its respective 95% confidence interval (95% CI), and the significance of the association was determined at a statistical level of a p-value less than 0.05.

## Results

### Socio socio-demographic and obstetrics characteristics of the study participants

The study enrolled 651 participants with a mean age of 29.49 ± 5.61 years. The majority of the participants was aged less than 35 years 79.7% (519/651) and most of the participants were from urban 91.4% (595/651), married 91.6% (596/651) self-referred 88.2% (574/651) with secondary education level 44.1% (287/651). The majority of the participants were multigravidas 72.8% (474/651), with singleton pregnancy 94.8% (617/651) at gestational age ≥ 28 weeks (Table 1).

### Prevalence of hypocalcemia among pregnant women

The prevalence of hypocalcemia among pregnant women was 23.2% (151/651) [95% CI 20.0% – 26.4%], as shown in Fig. 1.

### Factors associated with hypocalcemia among pregnant women

Table 2 presents the odds ratio and adjusted odds ratio of the predictors of maternal hypocalcemia among pregnant women. In univariate logistic regression analysis, significant predictors were: age of more than 35 years (OR 1.4; 95% CI 0.9–2.1; p-value 0.142), multiple pregnancy (OR 8.0; 95% CI 3.8–16.8; p-value ˂0.001), short interpregnancy interval of less than 3 years (OR 1.4; 95% CI 1.0–2.0; p-value 0.068), previous history of PE-E (OR 2.5; 95% CI 1.4–4.5; p-value 0.001), lack of calcium supplementation during antenatal visits (OR 11.8; 95% CI 2.9–49.3; p-value 0.001), duration of calcium supplementation less than 4 months (OR 9.9; 95% CI 1.3–73.2; p-value 0.025), number of antenatal visits less than 4 (OR 2.5; 95% CI 1.7–3.7; p-value ˂0.001), residing in rural (OR 3.3; 95% CI 1.9–5.7; p-value ˂0.001), and being on MgSO4 and/or CCB (OR 27.0; 95% CI 9.3–78.6; p-value ˂0.001).

After adjusting for these factors in multivariate logistic regression analysis model: multiple pregnancy (aOR 11.8; 95% CI 5.1–27.5; p-value ˂0.001), previous history of PE-E (aOR 2.1; 95% CI 1.1–4.1]; p-value 0.028), calcium supplementation during antenatal visits (aOR 11.8; 95% CI 2.4–57.8; p-value 0.002), number of antenatal visits less than 4 (aOR 1.8; 95% CI 1.1–2.9]; p-value 0.013), residing in rural (aOR 2.8; 95% CI 1.5–5.4; p-value 0.002), and being on MgSO4 and/or CCB (aOR 18.7; 95%

**Table 1** Socio-demographic and obstetrics characteristics of 651 pregnant women

| Variable | Number | Percentage |
|---|---|---|
| **Age** | | |
| ˂ 35 years | 519 | 79.7 |
| ≥ 35 years | 132 | 20.3 |
| **Marital status** | | |
| Single | 36 | 5.5 |
| Married | 596 | 91.6 |
| Cohabiting | 16 | 2.5 |
| Widow | 1 | 0.2 |
| Divorced | 2 | 0.3 |
| **Residence** | | |
| Rural | 56 | 8.6 |
| Urban | 595 | 91.4 |
| **Referral status** | | |
| Referral | 77 | 11.8 |
| Self-referred | 574 | 88.2 |
| **Occupation** | | |
| Housewife | 107 | 16.4 |
| Peasant | 51 | 7.8 |
| Employed | 176 | 27.0 |
| Business | 299 | 45.9 |
| Student | 18 | 2.8 |
| **Education level** | | |
| No education | 8 | 1.2 |
| Primary | 130 | 29.0 |
| Secondary | 287 | 44.1 |
| College/University | 226 | 34.7 |
| **Multiple pregnancy** | | |
| Yes | 34 | 5.2 |
| No | 617 | 94.8 |
| **Gestational age** | | |
| ≤ 28 weeks | 86 | 13.2 |
| ≥ 28 weeks | 565 | 86.8 |
| **Interpregnancy interval** | | |
| ˂ 3 years | 324 | 49.8 |
| ≥3 years and Primegravida | 327 | 50.4 |

CI 6.1–57.0]; p-value ˂0.001) remained as independent predictors of maternal hypocalcemia among pregnant women (Table 2).

## Discussion

Hypocalcemia has been linked to several adverse maternal and neonatal outcomes, including PE-E [7, 9]. This study highlights the importance of addressing multiple pregnancies, lack of calcium supplementation, low antenatal care visits, previous history of PE-E and residing in rural areas as key predictors of maternal hypocalcemia. These findings emphasize the need for routine calcium supplementation, especially in high-risk population and those with limited healthcare access, as well as increased importance on nutritional education during antenatal visits. Addressing these factors could help reduce the burden of maternal hypocalcemia and its associated complications improving maternal and fetal health outcomes.

### Prevalence of hypocalcemia among pregnant women at BMC

The prevalence of hypocalcemia among pregnant women in this study was 23.2%, which is low compared to the studies done in India and China, both reported the prevalence of hypocalcemia to be 66.4% and 39.0% respectively [1, 2]. However, it was low compared to the studies done in Algeria and Cameroon which reported a prevalence of 70.6% and 59% respectively and it was also slightly low compared to studies conducted in Nigeria which reported a prevalence of 29.20% and 25.6% [3–6]. The low prevalence of maternal hypocalcemia in our study is likely due to geographical location with better access to calcium-rich foods, which is consistent with findings from studies in Nigeria with high calcium rich foods availability [4, 5]. Also, the high prevalence in studies from India and China can be attributed to cultural factors and dietary preferences with limited dairy consumption or reliance on staple foods with low calcium contents, explaining the variations between our study and those conducted in these countries [14]. Lastly, genetic predisposition influencing calcium absorption such as vitamin D receptor polymorphisms and lactose intolerance have been documented contributing to these differences in prevalence across populations [15, 16].

### Factors associated with maternal hypocalcemia among pregnant women at BMC

Our study found multiple pregnancy was significantly associated with maternal hypocalcemia compared to singleton pregnancy, this could be explained by physiological changes of pregnancy, whereby total serum calcium levels normally fall throughout pregnancy due to the increased demand of the fetus. The maternal demand for calcium (Ca) is elevated by as much as 300–350 mg/day to provide the calcium required for single fetal bone mineralization, for more than one fetus, the maternal demand for calcium is even highly elevated [8].

Our findings highlight the critical role of calcium supplementation in preventing maternal hypocalcemia. The lack of calcium supplementation during antenatal visits had a significant association with hypocalcemia compared to those who were supplemented, this directly contributed to maternal hypocalcemia, as dietary alone may not be sufficient, especially in populations at higher risk of nutritional deficiency [14]. This suggests that the provision of calcium supplements during antenatal care is important in maintaining adequate calcium levels during pregnancy. Similar findings have been reported, highlighting the significance of calcium supplementation in preventing hypocalcemia [14, 17, 18].

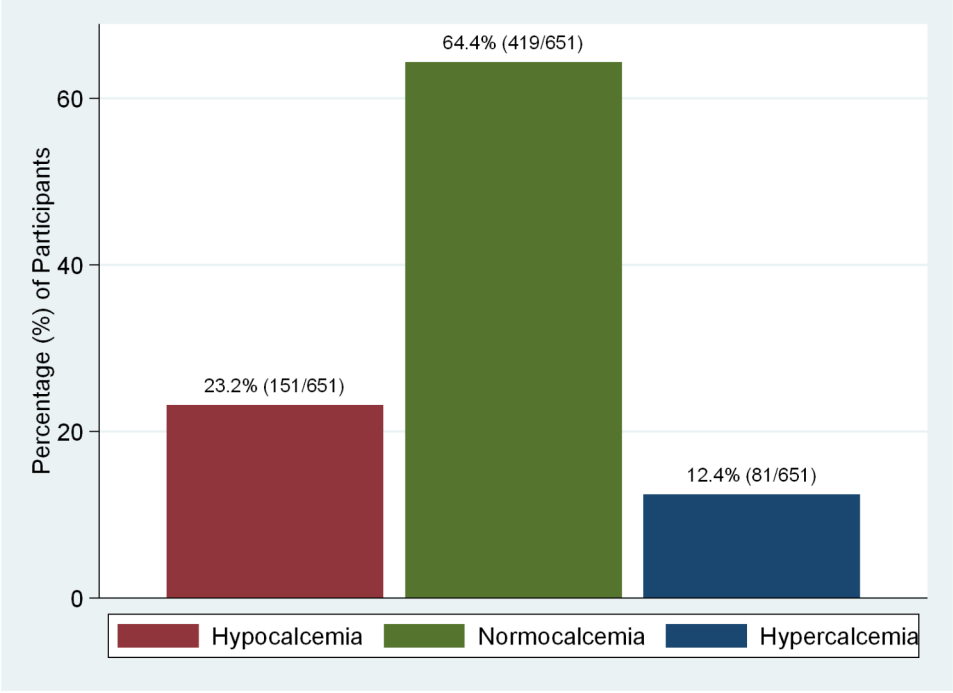


**Fig. 1** Calcium levels among pregnant women

The number of ANC visits of less than 4 also emerged as an independent factor significantly associated with maternal hypocalcemia compared to those who had ANC visits more than 4. This finding aligns with a study conducted in Cameroon which also observed a relationship between fewer ANC visits and an increased risk of hypocalcemia [6]. This could be attributed to the health education provided during ANC visits which would have changed the dietary behavior. Thus, both studies emphasize the importance of frequent ANC visits not only for monitoring maternal health but also providing critical dietary advice that can reduce the risk of nutritional deficiencies as WHO recommendations [19].

Additionally, previous history of PE-E was found to be significantly associated with maternal hypocalcemia compared to those without previous history of PE-E. Possible explanations for this being; Firstly, In pregnant women who have previously experienced PE-E, there may be a lingering dysfunction in calcium regulation, making it more difficult for them to maintain normal calcium levels during subsequent pregnancies, this could result from persistent endothelial dysfunction, a hallmark of PE-E, which may impair the body's ability to regulate calcium properly [20]. As noted in previous studies, including a study conducted in Pakistan [21]. Secondly, PE-E is associated with chronic inflammation and immune system dysfunction, these physiological changes may persist after the resolution of PE-E and could influence body's ability to maintain optimal calcium levels [22]. Inflammatory markers have been shown to alter calcium absorption and deposition in bone, leading to higher risk of hypocalcemia in subsequent pregnancies [23]. Furthermore, women with previous history of PE-E may also face challenges with lifestyle factors that contribute to calcium deficiency, such as poor dietary calcium intake, concern about the size and number of calcium supplements, and socio-economic factors that reduce their ability to purchase calcium supplements or seek proper health, these findings align with a study conducted in Dar Es Salaam, Tanzania [24].

Residing in rural areas emerged as a significant predictor of maternal hypocalcemia. Beyond limited healthcare access including lack of well-resourced healthcare infrastructures to offer the full range of services that would be available in urban centers, rural residence is often associated with lower socioeconomic status which hinders the access to calcium rich foods or a well-balanced diet making them rely on staple foods with low calcium contents [25]. Other contributing factors includes, low levels of educational and awareness about the importance of prenatal care, including calcium supplementation during pregnancy [25]. Also, cultural beliefs and traditional practices influencing dietary habits and health seeking behaviors in some rural areas has been shown to have negative impact on maternal nutritional status [26].

Third-trimester gestation age was not found to be associated with maternal hypocalcemia. This was contrary to findings from other studies [5, 27]. In the third trimester, maternal serum calcium levels tend to decrease due to the increased demand from the fetus, it has been found

**Table 2** Predictors of maternal hypocalcemia among pregnant women

| Variable | Hypocalcemia | | Univariate | | Multivariate | |
|---|---|---|---|---|---|---|
| | Yes | No | | | | |
| | n (%) | n (%) | OR[95% CI] | p-value | AOR[95%CI] | p-value |
| ***Age (year)*** | | | | | | |
| < 35 | 114 (75.5%) | 405 (81.0%) | 1.0 | | | |
| > 35 | 37 (24.5%) | 95 (19.0%) | 1.4[0.9–2.1] | 0.142 | 1.4[0.8–2.3] | 0.235 |
| ***Education level*** | | | | | | |
| Primary | 45 (29.8%) | 93 (18.6%) | 1.0 | | | |
| Secondary | 58 (38.4%) | 222 (45.8%) | 0.5[0.3–0.8] | 0.006 | 0.8[0.5–1.4] | 0.467 |
| University | 48 (31.8%) | 178 (35.6) | 0.6[0.3-1.0] | 0.016 | 1.0[0.5–1.7] | 0.871 |
| ***Residence*** | | | | | | |
| Urban | 125 (82.8%) | 470 (94%) | 1.0 | | | |
| Rural | 26 (17.2%) | 30 (6.0%) | 3.3[1.9–5.7] | <0.001 | 2.8[1.5–5.4] | 0.002 |
| ***Gravidity*** | | | | | | |
| Primegravida | 35 (23.2%) | 142 (28.4%) | 1.0 | | | |
| Multigravida | 116 (76.8%) | 358 (71.6%) | 1.3[0.8–1.9] | - | 0.9[0.5–1.8] | - |
| ***Multiple pregnancy*** | | | | | | |
| No | 128 (84.8%) | 489 (97.8%) | 1.0 | | | |
| Yes | 23 (15.2%) | 11 (2.2%) | 8.0[3.8–16.8] | <0.001 | 11.8[5.1–27.5] | <0.001 |
| ***Interpregnancy interval*** | | | | | | |
| ≥ 3 years and Primegravida | 65 (43.1%) | 262 (52.4%) | 1.0 | | | |
| < 3 years | 86 (57.0%) | 238 (47.6%) | 1.4[1.0–2.0] | 0.068 | 1.4[0.8-2.0] | 0.229 |
| ***Gestational age*** | | | | | | |
| < 28 weeks | 16 (10.6%) | 70 (14.0%) | 1.0 | | | |
| ≥ 28 weeks | 135 (89.4%) | 430 (86.0%) | 1.4[0.8–2.4] | 0.281 | - | - |
| ***Previous history of PE-E*** | | | | | | |
| No | 128 (84.8%) | 467 (93.4%) | 1.0 | | | |
| Yes | 23 (15.2%) | 33 (6.6%) | 2.5[1.4–4.5] | 0.001 | 2.1[1.1–4.1] | 0.028 |
| ***History of calcium supplementation*** | | | | | | |
| Yes | 2 (1.3%) | 67 (13.4%) | 1.0 | | | |
| No | 149 (98.7%) | 433 (86.6%) | 11.8[2.9–49.3] | 0.001 | 11.8[2.4–57.8] | 0.002 |
| ***Duration of calcium supplementation*** | | | | | | |
| ≥ 4 months | 1 (0.7%) | 31 (6.2%) | 1.0 | | | |
| < 4 months | 150 (99.3%) | 469 (93.8%) | 9.9[1.3–73.2] | 0.025 | 1.7[0.2–15.4] | 0.632 |
| ***Number of ANC*** | | | | | | |
| ≥ 4 visits | 91 (60.3%) | 395 (79.0%) | 1.0 | | | |
| < 4 visits | 60 (39.7%) | 105 (21.0%) | 2.5[1.7–3.7] | <0.001 | 1.8[1.1–2.9] | 0.013 |
| ***MgSO4 + CCB*** | | | | | | |
| Yes | 5 (1.0%) | 26 (17.2%) | 1.0 | | | |
| No | 495 (99.0%) | 125 (82.8%) | 27.0[9.3–78.6] | <0.001 | 18.7[6.1–57.0] | <0.001 |

women who consumed an average of 1171 mg of calcium per day while pregnant, absorbed 57% during the second trimester and 72% during the third. In addition, a rise in maternal estrogen levels which reaches its peak in the third trimester blocks bone resorption and raises urine calcium excretion, leading to maternal hypocalcemia [28]. Moreover, there is a decrease in plasma protein in the third trimester, particularly albumin, which is necessary for calcium binding [3]. The difference observed in our study, could be attributed to participants with differing levels of socioeconomic conditions, and baseline nutritional status, where nutritional deficiency is widespread making the risk of hypocalcemia not to follow the same pattern [25]. Furthermore, there may be inconsistencies in the availability or adherence to calcium supplementation contributed by financial constraints, lack of access and knowledge of its importance making maternal hypocalcemia not directly related to gestational age of pregnancy [24]. Another key factor is the regional dietary practices and overall nutrition, staple food being widely in different regions, it may be low in calcium-rich foods, particularly in rural areas where access to dairy products or calcium fortified foods is limited, thus the timing of calcium deficiency may not be strongly linked to gestational age [25]. Additionally, poor maternal nutrition, including insufficient intake of other key nutrients like

vitamin D, can also impair calcium absorption, potentially masking the expected relationship between gestational age and maternal hypocalcemia [5, 27].

Our study was done at a tertiary-level hospital that caters to various regions of the zone as well as many low-health facilities level. Therefore, the data obtained may not reflect the general population. It was difficult to evaluate dietary calcium levels and eating habits. Tests for thyroid and parathyroid diseases were not performed thus it was difficult to evaluate newly diagnosed patients with thyroid or parathyroid disease. Most participants were not on calcium supplementation alone, rather than in combination form with a low amount of calcium (50 mg) which is low compared to the 1.5–2.0 g recommended by WHO [10].

In conclusion, we found that one out of five pregnant women had maternal hypocalcemia. The predictors of maternal hypocalcemia were having multiple pregnancies, previous history of PE-E, lack of calcium supplementation during antenatal visits, having less than 4 antenatal visits, and residing in rural areas. We recommend routine screening for maternal hypocalcemia during antenatal clinic visits, routine calcium supplementation during antenatal visits to any pregnant woman considering the physiological changes of pregnancy, whereby total serum calcium levels normally fall throughout the pregnancy due to the increased demand of the fetus, and also, we recommend nutritional education regarding calcium-rich food to be emphasized during ANC visits.

#### Abbreviations

| | |
|---|---|
| ANC | Antenatal Care |
| AOR | Adjusted Odds Ratio |
| BMC | Bugando Medical Centre |
| CCB | Calcium Channel Blocker |
| CI | Confidence Interval |
| CUHAS | Catholic University of Health and Allied Science |
| GA | Gestation Age |
| IQR | Interquartile Range |
| LMICs | Low- and Middle-Income Countries |
| LNMP | Last Normal Menstrual Period |
| MgSO4 | Magnesium Sulphate |
| OBGY | Obstetrics and Gynecology |
| OR | Odds Ratio |
| PE-E | Pre-eclampsia-Eclampsia |
| WHO | World Health Organization |

## Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s12884-025-07536-w.

Supplementary Material 1

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#### Author contributions

GHM, RFK and BRK conceived the study. GHM, PAS, RFK, and DKM designed this study. GHM collected data and performed laboratory procedures. GHM and BRK analyzed and interpreted data. GHM and BRK wrote the initial draft of this manuscript and all authors critically edited and approved the final manuscript.

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#### Data availability

The data used to support the findings of this study are available from the corresponding author upon request.

## Declarations

#### Ethics approval and consent to participate

The Joint BMC/CUHAS Ethics review committee granted approval for this study with certificate number CREC/562/2022. Additionally, the BMC administration gave the approval to perform this study. To confirm their desire to take part in the study, participants were required to sign a permission form. A fingerprint was required of those who couldn't read or write. An informational document outlining the purpose and methods of the research was given to each participant. Those who choose not to participate were still entitled to all usual hospital standards of care. Patients and attending doctors received all results, and confidentiality was upheld. Nobody who participated in the research experienced any additional financial hardship. Those who were found with hypocalcemia were kept on calcium supplements and emphasized to take calcium-rich food. The informed consent was obtained from all participants in accordance with the Declaration of Helsinki.

#### Consent for publication

Not applicable.

#### Competing interests

The authors declare no competing interests.

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#### References

1. Guo X, Xu L, Huang J, Zhao M. Case-control study on serum calcium and magnesium levels in women presenting with preeclampsia. Chronic Dis Prev Rev. 2017;1:1–6.
2. Kumar A, Agarwal K, Devi SG, Gupta RK, Batra S. Hypocalcemia in pregnant women. Biol Trace Elem Res. 2010;136(1):26–32.
3. Ajong AB, Kenfack B, Ali IM, Yakum MN, Telefo PB. Prevalence and correlates of low serum calcium in late pregnancy. PLoS ONE. 2019;14(11):1–16.
4. Bako B, El-Nafaty AU, Mshelia DS, Gali RM, Isa B, Dungus MM. Prevalence and risk factors of hypocalcemia among pregnant and non-pregnant women in Maiduguri, Nigeria. Niger J Clin Pract. 2021;24(1):75–80.
5. Eli S, Enyindah CE, Orluwene CG, Ikimalo J, Abam DS. Prevalence of hypocalcemia and maternal complications among antenatal clinic attendees at the university of Port Harcourt teaching hospital. NigerJmed. 2017;26(3):208–19.
6. Benali AI, Demmouche A. Calcium deficiency among pregnant women and their newborns in Sidi Bel abbes region, Algeria. J Nutr Food Sci. 2014;04(06):4–7.
7. Villa-Etchegoyen C, Lombarte M, Matamoros N, Belizán JM, Cormick G. Mechanisms involved in the relationship between low calcium intake and high blood pressure. Nutrients. 2019;11(5):1–16.
8. Kovacs CS. Maternal mineral and bone metabolism during pregnancy, lactation, and post-weaning recovery. Physiol Rev. 2016;96(2):449–547.

9. Aouache R, Biquard L, Vaiman D, Miralles F. Oxidative stress in preeclampsia and placental diseases. Int J Mol Sci. 2018;19(5).
10. WHO, Guideline. Calcium supplementation in pregnant women. World Health Organ. 2013;70(04):1–35.
11. Ministry of Health. Community Development, Gender, Elderly and Children (MoHCDGEC) Tanzania ANC Guidelines. 2018.
12. Kish L, Corrigenda. Optima and proxima in linear sample designs. J R Stat Soc Ser A. 1979;142(3):404.
13. MINISTRY OF HEALTH THE UNITED REPUBLIC OF TANZANIA NATIONAL MEDICAL STANDARD OPERATING PROCEDURES FOR REGIONAL HOSPITAL LABORATORY. 2024.
14. Bourassa MW, Abrams SA, Belizán JM, Boy E, Cormick G, Quijano CD, et al. Interventions to improve calcium intake through foods in populations with low intake. Annals of the New York Academy of Sciences. Volume 1511. John Wiley and Sons Inc; 2022. pp. 40–58.
15. da Silva Lopes K, Abe SK. Polymorphisms contributing to calcium status: A systematic review. Vol. 13, Nutrients. MDPI AG; 2021.
16. Hodges JK, Cao S, Cladis DP, Weaver CM. Lactose intolerance and bone health: the challenge of ensuring adequate calcium intake. Volume 11. Nutrients. MDPI AG; 2019.
17. Sun X, Li H, He X, Li M, Yan P, Xun Y, et al. The association between calcium supplement and preeclampsia and gestational hypertension: a systematic review and meta-analysis of randomized trials. Hypertens Pregnancy. 2019;38(2):129–39.
18. Imdad A, Jabeen A, Bhutta ZA. Role of calcium supplementation during pregnancy in reducing the risk of developing gestational hypertensive disorders. BMC Public Health. 2011;3(11):1–13.
19. Alkema L, Chou D, Hogan D, Zhang S, Moller AB, Gemmill A, et al. Global, regional, and National levels and trends in maternal mortality between 1990 and 2015, with scenario-based projections to 2030: A systematic analysis by the Un maternal mortality Estimation Inter-Agency group. Lancet. 2016;387(10017):462–74.
20. Boeldt DS, Bird IM. Vascular adaptation in pregnancy and endothelial dysfunction in preeclampsia. Journal of Endocrinology. Volume 232. BioScientifica Ltd.; 2017. pp. R27–44.
21. Saeed S, Jamal A, Rafiq F, Rafiq F, Jamal A. Frequency of hypocalcemia in women with preeclampsia at a tertiary care hospital. Pakistan J Med Health Sci. 2017;11(2):773–6.
22. Harmon AC, Cornelius DC, Amaral LM, Faulkner JL, Cunningham MW, Wallace K, et al. The role of inflammation in the pathology of preeclampsia. Clinical Science. Volume 130. Portland Press Ltd; 2016. pp. 409–19.
23. Straub RH, Cutolo M, Pacifici R. Evolutionary medicine and bone loss in chronic inflammatory diseases-A theory of inflammation-related osteopenia. Seminars in Arthritis and Rheumatism. Volume 45. W.B. Saunders; 2015. pp. 220–8.
24. Metta EO, Muhihi A, Paulo HA, Sudfeld CR, Kaale A, Perumal N et al. Experiences, acceptability and barriers to calcium supplementation during pregnancy in Dar Es Salaam, Tanzania. Matern Child Nutr. 2024.
25. Langa N, Bhatta T. The rural-urban divide in Tanzania: residential context and socioeconomic inequalities in maternal health care utilization. PLoS ONE. 2020;15(11 November).
26. Felisian S, Mushy SE, Tarimo EAM, Kibusi SM. Sociocultural practices and beliefs during pregnancy, childbirth, and postpartum among Indigenous pastoralist women of reproductive age in Manyara, Tanzania: a descriptive qualitative study. BMC Womens Health. 2023;23(1).
27. Ositadinma OL, Ezike OV, Azubuike ONJ, Betrand ON, Athanasius OO. Evaluation of serum calcium level in pregnant normotensive and Pre-eclamptic/Eclamptic women in Nnewi, Nigeria. Savant Journals. 2015;1(4):60–4.
28. Ritchie LD, Fung EB, Halloran BP, Turnlund JR, Van Loan MD, Cann CE, et al. A longitudinal study of calcium homeostasis during human pregnancy and lactation and after resumption of menses. Am J Clin Nutr. 1998;67(4):693–701.


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