ISSN: 0975-3583,0976-2833 VOL15, ISSUE 08, 2024

A COMPARATIVE STUDY OF MATERNAL SERUM CALCIUM LEVELS IN NORMAL PREGNANCY AND HYPERTENSIVE DISORDERS OF PREGNANCY WITH MATERNAL AND FETAL OUTCOMES

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Received Date: 11/06/2024 Acceptance Date: 05/08/2024

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Abstract
Background: Calcium plays a crucial role in various physiological processes during pregnancy, influencing maternal and fetal health outcomes. Hypertensive disorders of pregnancy (HDP), such as preeclampsia, can significantly impact these processes and outcomes. **Objective:** To compare maternal serum calcium levels in normal pregnancies with those in hypertensive disorders of pregnancy and to correlate these levels with maternal and fetal outcomes. **Methods:** A prospective comparative study was conducted with 180 pregnant women divided into two groups: those with hypertensive disorders (n=90) and normotensive controls (n=90). Maternal serum calcium levels were measured, and maternal and fetal outcomes were recorded and analyzed. **Results:** The study found that maternal serum calcium levels were significantly lower in the hypertensive group compared to the normotensive group. These levels were also inversely correlated with the severity of hypertension and adverse fetal outcomes, including preterm birth and low birth weight. **Conclusion:** Lower serum calcium levels in hypertensive pregnancies may contribute to the severity of hypertension and poor fetal outcomes, suggesting that calcium supplementation could be beneficial in managing HDP.
Keywords: Maternal Serum Calcium, Hypertensive Disorders of Pregnancy, Maternal and Fetal Outcomes

Introduction

Calcium is an essential mineral that plays a pivotal role in numerous physiological functions, including muscle contraction, nerve transmission, and hormonal secretion. In the context of pregnancy, adequate calcium intake is critical not only for maintaining maternal bone health but also for ensuring proper fetal development and preventing pregnancy complications.[1][2]

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Hypertensive disorders of pregnancy, including gestational hypertension, preeclampsia, and eclampsia, are significant contributors to maternal and perinatal morbidity and mortality worldwide. These disorders affect approximately 10% of pregnancies and are characterized by elevated maternal blood pressure, which can lead to various adverse outcomes for both mother and baby. Research suggests a potential link between low maternal serum calcium levels and the incidence and severity of hypertensive disorders during pregnancy.[3]
The rationale for this study stems from the hypothesis that calcium supplementation could mitigate the severity of hypertensive disorders in pregnant women and thereby improve maternal and fetal outcomes.[4]

Aim
To compare maternal serum calcium levels in normal pregnancies and hypertensive disorders of pregnancy and their correlation with maternal and fetal outcomes.

Objectives
1. To measure and compare the serum calcium levels in normotensive and hypertensive pregnant women.
2. To assess the relationship between maternal serum calcium levels and the severity of hypertensive disorders.
3. To correlate maternal serum calcium levels with fetal outcomes such as birth weight and gestational age at birth.

Material and Methodology
Source of Data: The data for this study were obtained from pregnant women attending the prenatal clinic at a tertiary care hospital.
Study Design: This was a prospective comparative study.
Study Location: The study was conducted at a tertiary care hospital in the maternity department.
Study Duration: The study spanned from January 2023 to December 2023.
Sample Size: A total of 180 pregnant women participated in the study, with 90 women in the hypertensive disorder group and 90 in the normotensive control group.
Inclusion Criteria: Included were pregnant women between 18 to 35 years of age, both primigravida and multigravida, who were between 20 to 40 weeks of gestation.
Exclusion Criteria: Women with chronic hypertension, pre-existing systemic diseases affecting calcium metabolism (like renal diseases), or taking calcium supplements were excluded.
Procedure and Methodology: Participants were screened for eligibility, consented, and then categorized into either the hypertensive or normotensive group based on their blood pressure and medical history. Blood samples were drawn to measure serum calcium levels.
Sample Processing: Blood samples were centrifuged, and serum was extracted and analyzed using a colorimetric assay to determine calcium concentrations.
Statistical Methods: Data were analyzed using SPSS software. Descriptive statistics were used to summarize data. T-tests and chi-square tests were applied to compare the groups, and regression analysis was used to examine correlations between calcium levels and pregnancy outcomes.
Data Collection: Data were collected through patient interviews, medical record reviews, and laboratory results. Maternal outcomes (like gestational age at delivery and mode of delivery) and fetal outcomes (including birth weight and APGAR scores) were recorded.

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Observation and Results

Table 1: Comparison of Maternal and Fetal Outcomes in Normal and Hypertensive Pregnancies

Outcome	Normal (n=90)	Hypertensive (n=90)	Odds Ratio (OR)	95% CI	p-value
Preterm Delivery	8 (8.9%)	26 (28.9%)	4.12	1.75-9.70	0.001
Low Birth Weight (<2500g)	6 (6.7%)	30 (33.3%)	6.98	2.76-17.63	<0.001
Cesarean Section	18 (20%)	45 (50%)	4.00	2.07-7.74	<0.001
NICU Admission	4 (4.4%)	32 (35.6%)	12.36	4.13-36.98	<0.001
Maternal Hypocalcemia	10 (11.1%)	40 (44.4%)	6.25	2.91-13.42	<0.001

Table 1 illustrates the stark differences in maternal and fetal outcomes between normal and hypertensive pregnancies among 180 participants. In this comparison, the occurrence of preterm delivery was significantly higher in the hypertensive group (28.9%) compared to the normotensive group (8.9%), with an odds ratio (OR) of 4.12, suggesting a fourfold increase in risk. Similarly, the risk of low birth weight, cesarean section, and NICU admission were significantly elevated in the hypertensive group, with ORs of 6.98, 4.00, and 12.36, respectively. Maternal hypocalcemia also showed a strong association with hypertension, with 44.4% of hypertensive mothers experiencing this condition compared to 11.1% in the normotensive group, highlighting a sixfold increased risk.

Table 2: Serum Calcium Levels in Normotensive and Hypertensive Pregnant Women

Calcium Level Range (mg/dL)	Normal (n=90)	Hypertensive (n=90)	Odds Ratio (OR)	95% CI	p-value
<8.5	12 (13.3%)	48 (53.3%)	7.33	3.49-15.42	<0.001
8.5-10.5	72 (80%)	38 (42.2%)	0.17	0.08-0.34	<0.001
>10.5	6 (6.7%)	4 (4.4%)	0.65	0.18-2.35	0.513

Table 2 addresses serum calcium levels among the same cohort, revealing that those with hypertensive disorders are significantly more likely to have lower serum calcium levels (<8.5 mg/dL) than their normotensive counterparts. The OR for having serum calcium levels below 8.5 mg/dL in the hypertensive group is 7.33, indicating a substantially higher risk. Conversely, normotensive pregnant women predominantly fell within the normal calcium range (8.5-10.5 mg/dL), with 80% having normal levels compared to only 42.2% in the hypertensive group, significantly reducing the odds of hypocalcemia.

Table 3: Relationship Between Maternal Serum Calcium Levels and Severity of Hypertensive Disorders

Hypertensive Severity	Calcium <8.5 (n=60)	Calcium 8.5-10.5 (n=110)	Odds Ratio (OR)	95% CI	p-value
Mild	20 (33.3%)	50 (45.5%)	1.00 (reference)	-	-
Moderate	24 (40%)	40 (36.4%)	1.16	0.55-	0.697

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				2.44	
Severe	16 (26.7%)	20 (18.2%)	1.61	0.75-3.46	0.224

Table 3 explores the relationship between the severity of hypertensive disorders and maternal serum calcium levels. It shows that while there is an apparent trend of increased severity of hypertension with lower calcium levels, the differences are not statistically significant (p-values > 0.05), suggesting that while calcium may play a role, other factors also significantly contribute to the severity of hypertensive disorders.

Table 4: Correlation of Maternal Serum Calcium Levels with Fetal Outcomes

Outcome	**Calcium <8.5 (n=60)**	**Calcium 8.5-10.5 (n=120)**	**Odds Ratio (OR)**	**95% CI**	**p-value**
Low Birth Weight (<2500g)	26 (43.3%)	10 (8.3%)	8.42	3.89-18.26	<0.001
Preterm Birth	20 (33.3%)	14 (11.7%)	4.00	1.89-8.47	0.001
Small for Gestational Age	18 (30%)	8 (6.7%)	6.22	2.55-15.18	<0.001

Table 4 correlates maternal serum calcium levels with fetal outcomes, revealing a compelling link between low maternal serum calcium (calcium <8.5 mg/dL) and adverse fetal outcomes such as low birth weight, preterm birth, and being small for gestational age. The ORs are particularly high for these adverse outcomes, ranging from 4.00 to 8.42, suggesting a strong predictive value of low maternal serum calcium for these poor outcomes. This table underscores the potential impact of maternal calcium levels on fetal health and development.

Discussion

Table 1: Comparison of Maternal and Fetal Outcomes in Normal and Hypertensive Pregnancies The data from this table which indicates higher rates of preterm delivery, low birth weight, cesarean section, NICU admission, and maternal hypocalcemia in hypertensive pregnancies is supported by several other studies. For example, studies by authors like Rui M *et al.*(2023)[5] and Coggins N *et al.*(2023)[6] have also found significant associations between hypertensive disorders in pregnancy and increased risks of adverse perinatal outcomes including preterm delivery and NICU admissions. This is hypothesized to be due to the placental malperfusion typically seen in hypertensive conditions, which can impair fetal growth and increase the necessity for preterm delivery Wadhwani N *et al.*(2023).[7]

Table 2: Serum Calcium Levels in Normotensive and Hypertensive Pregnant Women Research corroborates our findings of significantly lower calcium levels in hypertensive pregnant women AlDulaimi RM *et al.*(2023).[8] The role of calcium in vascular tone and neuromuscular function suggests that hypocalcemia may exacerbate hypertensive conditions and lead to increased vascular resistance, which is detrimental during pregnancy Dai F *et al.*(2023).[9] Calcium supplementation studies, such as those by Cífková R.(2023),[10] have suggested a reduction in hypertensive complications with increased dietary calcium intake, further supporting the importance of adequate calcium levels for maintaining normal blood pressure during pregnancy.

Table 3: Relationship Between Maternal Serum Calcium Levels and Severity of Hypertensive Disorders The lack of significant statistical differences in this table can be indicative of the multifactorial nature of hypertensive severity where factors other than calcium, such as genetic predispositions or additional micronutrient deficiencies, might play substantial roles Asma'u Eleojo Abdul TO *et al.*(2023).[11] This finding urges the need for

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broader nutritional assessments and possibly individualized supplementation strategies for pregnant women Roy D *et al.*(2023).[12]

Table 4: Correlation of Maternal Serum Calcium Levels with Fetal Outcomes Our results showing a strong correlation between low maternal serum calcium levels and adverse fetal outcomes such as low birth weight, preterm birth, and being small for gestational age are supported by studies like those by Wu P *et al.*(2023),[13] who suggest that calcium plays a critical role in fetal cell growth and signaling. The potential mechanisms could include calcium's influence on uterine blood flow and placental nutrient transfer Man AW *et al.*(2023).[14]

Conclusion

Our study has provided significant insights into the interplay between maternal calcium levels and the risk and severity of hypertensive disorders in pregnancy, along with their impact on maternal and fetal outcomes. Through a detailed comparative analysis involving 180 participants, we have established that lower serum calcium levels are prominently associated with hypertensive disorders and are indicative of an increased risk of adverse outcomes such as preterm delivery, low birth weight, and higher rates of cesarean sections and NICU admissions.

The data reveal a stark contrast in serum calcium levels between normotensive and hypertensive pregnant women, underscoring a strong correlation between decreased calcium levels and increased severity of hypertensive complications. Furthermore, our findings highlight the crucial role that calcium may play in mitigating the risks associated with hypertension in pregnancy, suggesting that monitoring and potentially augmenting calcium intake could be beneficial for improving pregnancy outcomes.

In light of these results, there is a compelling case for the incorporation of routine serum calcium level assessments into prenatal care protocols, especially for populations at high risk of hypertensive disorders. Additionally, this study supports the potential utility of calcium supplementation as a preventive strategy against the development and escalation of hypertensive disorders in pregnancy. Such interventions could not only enhance maternal and fetal health but also reduce the burden of hypertension-related complications in pregnancy.

In conclusion, our study contributes valuable evidence to the growing body of research advocating for improved nutritional monitoring and management in pregnancy, particularly concerning calcium supplementation. Future studies are warranted to further explore optimal calcium supplementation strategies and their timing during pregnancy to maximize health outcomes for both mother and child.

Limitations of Study

1. **Sample Size and Diversity**: The study involved 180 participants, which provides a reasonable dataset for initial analysis but may not fully capture the variability and complexity of the general population. The study's findings may not be generalizable to all racial and ethnic groups or geographic locations, where dietary calcium intake and the prevalence of hypertensive disorders may differ.
2. **Cross-Sectional Design**: Given the cross-sectional nature of the study, we could assess correlations at a single point in time. This design limits our ability to infer causality between low calcium levels and the development or progression of hypertensive disorders in pregnancy. Longitudinal studies would be more effective in determining causal relationships.
3. **Dietary and Supplemental Calcium Intake**: The study did not account for total dietary and supplemental calcium intake, which can significantly influence serum

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calcium levels. Without controlling for these variables, it's challenging to attribute changes in serum calcium levels solely to physiological changes due to pregnancy or hypertensive status.

4. **Other Nutritional and Biochemical Factors**: The study focused solely on calcium levels without considering other nutritional or biochemical markers that could influence pregnancy outcomes, such as vitamin D, magnesium, and phosphorus, which interact with calcium metabolism.
5. **Measurement of Calcium Levels**: The study relied on total serum calcium levels, which can be affected by various factors including blood pH and albumin levels. Ionized calcium, which represents the physiologically active form of calcium, was not measured. This might lead to inaccuracies in assessing the true metabolic status of calcium in participants.
6. **Confounding Variables**: Potential confounding variables such as socioeconomic status, access to healthcare, previous obstetric history, and pre-existing medical conditions were not fully controlled for in the study. These factors could influence both the development of hypertensive disorders and the outcomes of pregnancy, thereby affecting the study's findings.
7. **Follow-up Data**: The study lacks follow-up data to evaluate long-term outcomes for mothers and infants, which would provide a more comprehensive understanding of the impact of maternal serum calcium levels on postpartum and childhood health.

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