MAK HILL Publications International Journal of Tropical Medicine

Research Article
doi: 10.59218/makijtm.2024.2.30.33

A Study of Correlation between Calcium Deficiency and Risk of Osteoporosis in Pregnant Women

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ABSTRACT

During pregnancy, a woman's nutritional requirements significantly differ from those in non-pregnant states. The nutrients necessary for fetal growth and development throughout the nine months of pregnancy are primarily derived from the mother's body and its reservoirs of vitamins and minerals. The objective of this study was to assess calcium deficiency and its correlation with various biochemical parameters throughout the three stages of pregnancy in Indian women. Blood samples were collected from 78 pregnant women diagnosed by specialists, aged between 17 to 50 years, from an Indian General Hospital. Additionally, 45 healthy women of similar ages were included as a control group. The study measured levels of calcium, vitamin D, parathyroid hormone (PTH), alkaline phosphates (ALP), phosphorous and albumin. The findings revealed elevated levels of vitamin D, PTH, ALP and albumin in pregnant women compared to the control group, while calcium levels were lower in pregnant women. Specifically, PTH and albumin were lower during the first trimester, whereas calcium and phosphorus were lower during the third trimester. ALP levels were lower in the second trimester and vitamin D significantly decreased in the third trimester. The study also observed a negative correlation between calcium and PTH levels, while calcium exhibited a weak positive correlation with vitamin D, albumin and phosphorus. The relationship between calcium and ALP was also weakly positive. Based on these results, it can be concluded that low calcium levels are associated with pregnancy and may indicate an increased risk of osteoporosis in women.

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Key Words
Calcium, osteoporosis, pregnancy, vitamin D, parathyroid hormone

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Received: 11 January 2024
Accepted: 20 February 2024
Published: 27 February 2024

Citation: Shashank Tyagi, Gaurav Akhand, Deepika Anuragi and Sonendra Kumar Sharma, 2024. A Study of Correlation Between Calcium Deficiency and Risk of Osteoporosis in Pregnant Women. Int. J. Trop. Med., 19 : 30-33, doi: 10.59218/makijtm.2024.2.30.33

INTRODUCTION

During pregnancy, a woman's nutritional requirements undergo significant changes compared to non-pregnant conditions. The nutrients necessary for fetal development during the nine-month gestation period are primarily sourced from the mother's body, including her vitamin and mineral reserves, alongside her dietary intake. In this context, we explore the alterations in a pregnant woman's calcium needs and highlight key sources for fulfilling this crucial requirement. Calcium plays a pivotal role in maintaining bone health throughout life. While dietary intake remains the primary source of calcium, supplements containing this mineral may be considered to address any dietary deficiencies. However, before opting for calcium supplementation, it is essential to ascertain one's specific calcium requirements and carefully weigh the advantages and disadvantages of different supplement options. Approximately 2.2 x 10^5 units of calcium ions comprise the body mass, with 99% stored in bones and the remaining 1% distributed in blood and extracellular fluid. Calcium ions play a significant role in multiple bodily functions, including cardiovascular function, nervous system activities and bone formation. The regulation of calcium metabolism involves hormones such as parathyroid hormone, which influences calcium ion levels in the blood by stimulating osteoclast activity, leading to bone resorption and inhibiting osteoblast function[1-5].

Key Hormones Involved in Calcium Regulation Include:

Parathyroid Hormone (PTH): PTH acts to elevate blood calcium levels by enhancing osteoclastic activity, resulting in bone breakdown and suppression of osteoblast function[6,7].

Calcitonin: Secreted by C-cells in the thyroid gland, calcitonin reduces plasma calcium concentration by inhibiting osteoclasts, promoting calcium deposition in bones and decreasing osteoblast and osteoclast activity, collectively reducing overall bone turnover[8,9].

Vitamin D: Vitamin D is critical for calcium absorption, facilitating the absorption process and preventing disturbances in vitamin D metabolism that can lead to reduced calcium absorption in conditions such as renal failure, along with increased thyroid hormone secretion[10-12]. Liver enzymes are essential proteins that catalyze biochemical reactions crucial for life within cells. These enzymes, including alkaline phosphates (ALP), alanine aminotransferase (ALT) and aspartame aminotransferase (AST), play key roles in biochemical pathways. Altered concentrations of these enzymes in serum reflect changes in liver function, which can indicate various health or disease conditions. Assessing liver enzyme activity is instrumental in diagnosing liver function abnormalities[7,14,13,15,16].

MATERIALS AND METHODS

Seventy Eight pregnant women, aged between 17 and 50 years, participated in visits to an Indian General Hospital. They did not exhibit clinical signs of calcium and vitamin D deficiency. Additionally, 45 healthy women of similar age were selected. 5ml of blood was drawn from each participant and serum was obtained via centrifugation at 3000 rpm for 10 minutes. The serum was then transferred into sterile tubes and frozen at -20°C until biochemical analyses were conducted. The concentration of calcium was assessed using Colorimetric Methods, utilizing pre-made solutions. For total Protein Determination a method based on the reaction of proteins with copper ions to form a blue-violet complex was employed. The Bromocresol Green Method (BCG) was utilized to estimate serum albumin concentration. The activity of AST was determined by the reaction involving oxaloacetate, L-glutamate and L-aspartate, resulting in oxoglutarate production. Serum samples were incubated and mixed with specific reagents and the absorbance at 505 nm was measured to determine AST activity. Similar to AST, ALT activity was measured using specific reagents and spectrophotometric analysis at 505 nm after incubation. The concentration of 25-hydroxy vitamin D was measured using a micro plate with calibration standards and sample solutions, followed by spectrophotometric analysis at 450nm. Data analysis was performed using ANOVA (analysis of variance) in the Epi Info statistical program. Group means were compared with significance set at $p \leq 0.05$[27-30].

RESULTS AND DISCUSSIONS

The results in (Table 1) show that pregnant women had lower calcium levels but significantly higher vitamin D, PTH and ALP levels compared to the healthy control group. Phosphorus levels were slightly elevated in pregnant women but not significantly different from the control group. (Table 2) summarizes the

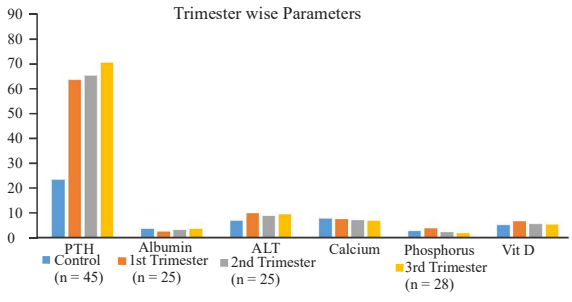

Fig. 1: Visual comparison of trimester wise biochemical parameters

Table 1: Biochemical parameters studied among pregnant and controls

Parameters	Pregnant (n = 78)	Control (n = 45)	p-value
PTH	72.534±14.021	25.401±9.793	<0.05
Albumin	3.273±0.579	3.691±0.543	<0.05
ALT	10.028±2.463	7.402±1.752	<0.05
Calcium	7.659±0.602	8.312±0.311	<0.05
Phosphorus	2.708±0.352	2.823±0.251	0.81
Vit D	6.176±0.36	5.472±0.35	<0.05

Table 2: Biochemical parameters as per trimester of pregnancy

Parameters	Control (n = 45)	1st Trimester (n = 25)	2nd Trimester (n = 25)	3rd trimester (n = 28)	p-value
PTH	25.401±9.793	69.352±14.081	71.289±14.017	76.961±14.022	<0.05
Albumin	3.691±0.543	2.693±0.390	3.390±0.647	3.790±0.541	<0.05
ALT	7.402±1.752	10.683±1.228	9.502±1.239	10.179±1.191	<0.05
Calcium	8.312±0.311	8.010±0.523	7.711±0.609	7.369±0.642	<0.05
Phosphorus	2.823±0.251	3.992±0.199	2.386±0.189	1.804±0.175	<0.05
Vit D	5.472±0.35	7.178±0.303	6.010±0.202	5.812±0.295	<0.05

biochemical indicators studied across the three stages of pregnancy. Specifically, PTH and albumin levels were lower during the first trimester, while calcium and phosphorus levels were lower during the third trimester. ALP levels were lower in the second trimester and vitamin D significantly decreased in the third trimester. The study also identified a negative correlation between calcium and PTH levels, along with a weak positive correlation between calcium and vitamin D, albumin and phosphorus. The relationship between calcium and ALP was also noted to be weakly positive. The reduced calcium levels during pregnancy result in increased calcium transfer to the fetus for skeletal development, alongside higher blood volume, dilution, increased bone calcium transfer and urinary excretion, stimulating PTH to boost calcium absorption and release from bones to address the deficiency. This raises cellular calcium levels[17,18]. Decreased dietary calcium exposes pregnant women to risks like limb spasticity, preeclampsia, or osteoporosis, while calcium supplementation reduces these risks. Calcium primarily aids in bone formation, muscle function, nerve impulse transmission, maintaining muscle and bone integrity, regulating blood pressure with magnesium, affecting cellular membrane permeability and aiding iron absorption[19,20].

(Table 1')s findings differ from a study by[21], which reported reduced vitamin D levels in pregnant women. Several studies link vitamin D deficiency to adverse pregnancy outcomes like pre-eclampsia, gestational diabetes, cesarean sections, bacterial vaginosis, possibly mediated through its role in calcium regulation. Elevated albumin levels in pregnant women, compared to controls, suggest conditions like liver disease, dehydration, or kidney impairment[22,23]. Primary hyperparathyroidism in pregnancy, though symptomless, poses diagnostic challenges and can lead to maternal and fetal complications like nephrolithiasis, bone issues, pancreatitis, muscle weakness, mental changes and hypercalcemia crises, with fetal risks including growth issues, low birth weight, preterm birth and intrauterine death. Serum ALP's efficacy as a preterm birth risk marker lacks adequate evidence due to pregnancy-related increases (placental origin)[11]. Phosphorus levels drop significantly during pregnancy, influenced by heightened cholesterol aiding calcium and phosphorus absorption to meet fetal needs for skeletal development. Our study, alongside[14,24], noted declining calcium levels in the second and third trimesters due to expanded intra vascular space, increased fetal calcium transfer for skeletal formation and heightened fetal calcium demand. This explains maternal late-pregnancy dental issues due to increased fetal calcium consumption[25]. Contrasting[7], our study found vitamin D deficiency early in pregnancy, continuing through later stages, influenced by education levels, community factors and vitamin D intake. PTH levels increased throughout pregnancy, peaking in the third trimester, in agreement with[16]. ALP and albumin levels varied across trimesters, reflecting pregnancy's metabolic demands and nutrient shifts[17,26].

CONCLUSION

The observed relationship between low calcium levels during pregnancy and an increased risk of osteoporosis in women underscores the importance of monitoring and managing calcium levels during this critical period. Osteoporosis, characterized by decreased bone density and increased susceptibility to fractures, is a significant concern for women, particularly during and after pregnancy due to the demands placed on calcium stores by the developing fetus. Healthcare providers should monitor calcium levels and provide appropriate guidance and interventions to pregnant women to mitigate the risk of osteoporosis. This may include dietary recommendations rich in calcium, vitamin D supplementation and regular assessments of bone health post-pregnancy to address any potential deficiencies or imbalances that could contribute to osteoporosis development.

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