Original Article

Evaluation of Calcium, Phosphorus and Vitamin D Level in Different Stages of Pregnancy in East Indian Population

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ABSTRACT

Background: Vitamin D, serum calcium (Ca) and inorganic phosphorus deficiency during pregnancy is a significant public health problem in many parts of the world. It is associated with an increased risk of pre-eclampsia, gestational diabetes, and preterm births. Approximately, 99% of the Ca and magnesium in the human body is located in the skeleton. Ca is a essential nutrient and mineral consumed in food and supplements. The mineral is stored bones where it is used to promote strength and support changes and growth throughout life. There is also free Ca in blood used by cells during the normal cellular function. The objective of this study was to assess the role of Ca, phosphorous and vitamin D level in pregnant women at different age groups compare to nonpregnant women in East Indian population. **Materials and Methods:** This cross-sectional study was conducted on 180 normal women between 22 and 45 years of age in their first 24-28 weeks of pregnancy and 50 normal nonpregnant women. After 3 months of follow-up, serum levels of vitamin D and Ca and inorganic phosphorous were measured. Written informed consent was obtained from the subjects. **Results:** The mean age of women in the study group was 25.34 ± 5.40 years; while that in the control group was 25.80 ± 5.90 years. The age of study and control groups was matched. The result shows that serum Ca and inorganic phosphorous in pregnant women lower significantly ($P < 0.001$), especially in the third trimester as compared to controls. However, vitamin-D levels in pregnant women lower significantly ($P < 0.001$) at all trimester as compared to controls. **Conclusion:** Vitamin D deficiency coupled with Ca and inorganic phosphorous deficiency may found to be highly prevalent in pregnant East Indian women. The decrease in serum vitamin-D, Ca and inorganic phosphorous levels parallels increase in gestational age. This may result from mineral transfer from mother to developing fetus.

Key words: Calcium, inorganic phosphorous, pregnancy, vitamin D

INTRODUCTION

For the absorption of calcium (Ca) and inorganic phosphorous, vitamin D is essential to maintain a healthy mineralized skeleton. In fetus, vitamin D deficiency is recognized as the most untreated nutritional deficiency currently in the world. Adverse consequences in the mother include increased the risk of preeclampsia, gestational diabetes, and increased rate of cesarean section. Vitamin D deficiency is recognized as the most untreated nutritional deficiency currently in both developed and developing countries including India.[1-3] Although India is a tropical country with abundant sunshine, still vitamin D deficiency is very common in India in all age groups and both sexes across the country.[4] Because Ca demands increase in the third trimester of pregnancy, vitamin D status becomes crucial for maternal health, fetal skeletal growth, and

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optimal maternal and fetal outcomes. Vitamin D deficiency is common in pregnant women (5-50%) and breastfed infants (10-56%), despite the widespread use of prenatal vitamins, because these are inadequate to maintain normal vitamin D levels (≥32 ng/mL). Circulating concentrations of vitamin D levels gradually increase during the 1st and 2nd trimesters, owing to an increase in vitamin D-binding protein concentrations in the maternal circulation. However, the free levels of vitamin D levels, which are responsible for enhancing intestinal Ca absorption, are only increased during the 3rd trimester.[5] In pregnancy, the very high circulatory concentrations of estrogen and progesterone alter the concentration of many substances in the maternal blood.[6] Some authors have noted that there is an increased demand for Ca and inorganic phosphorous for fetal development during pregnancy.[7]

The objective of this study was to assess the serum concentration of vitamin D, Ca and inorganic phosphorous levels in pregnant and nonpregnant women.

Normal value range

- Negative pregnancy adult: 8.7-10.2 mg/dL to 2.18-2.55 μmol/L
- Pregnancy trimester one: 8.8-10.6 mg/dL to 2.2-2.65 μmol/L
- Pregnancy trimester two: 8.2-9 mg/dL to 2.05-2.25 μmol/L
- Pregnancy trimester three: 8.2-9.7 mg/dL to 2.05-2.43 μmol/L.

MATERIALS AND METHODS

This study was conducted at the Obstetrics and Gynecology and Biochemistry Department of the PMCH and IGIMS Patna different stages of pregnancy (first, second, and third trimester) in comparison with nonpregnant women. 180 pregnant women of three different groups were included in the study, and 50 non-pregnant with an age ranging from 20 to 40 years. Among 180 pregnant women, 60 in number were included in each trimester forming three Groups I, II, and III depending on the type of trimester first, second, or third. Category IV included nonpregnant women. The serum Vitamin D concentration was measured in all these 230 women.

The following exclusion criteria were used in the study: Chronic liver disease, pregnancy toxemia, women taking vitamin D supplements, and undergoing treatment with antitubercular or antiepileptic drug. All the subjects completed a questionnaire that had information about the subject's age, educational level, socioeconomic status, lifestyle, exposure to sunlight and use of any supplements related to Ca and vitamin D and approximate dietary vitamin D intake. Institutional Ethical Committee clearance was obtained. Necessary permission for data collection was obtained from IGIMS. Written informed consent was obtained from the subjects. Data collection comprised of standardized questionnaires, anthropometry and detailed information on medical history and medication use. Blood samples from subjects were obtained and tested for serum Ca, serum inorganic phosphorous by fully autoanalyzer (Olympus 400) and vitamin-D by chemiluminescence immunoassay (Access 2 Beckman Coulter).

Statistical analysis

Data analysis was performed using SPSS software (Windows version 11). Data were expressed as mean ± standard deviation. Groups were compared by one-way analysis of variance (ANOVA) and the significance of mean difference between groups was done by Tukey's HSD (honestly significant difference) *post hoc* test. A two-tailed ($\alpha = 2$) $P < 0.05$ was considered statistically significant.

RESULTS

The mean age of women in the study group was 25.34 ± 5.40 years; while that in the control group was 25.80 ± 5.90 years. The mean age of two groups was similar ($P > 0.05$). Comparing the mean vitamin-D, Ca and inorganic phosphorus levels of four groups, ANOVA showed significantly different vitamin-D ($F = 23.17$, $P < 0.001$), Ca ($F = 16.63$, $P < 0.001$) and inorganic phosphorus ($F = 22.81$, $P < 0.001$) levels among the groups [Table 1]. Further, Tukey test showed that the mean vitamin-D levels lowered significantly ($P < 0.001$) in all study groups (Groups I, II, and III) as compared to control group (Group IV) [Table 2 and Figure 1]. In contrast, both Ca and inorganic phosphorus were found significantly ($P < 0.01$ or $P < 0.001$) different and lower in both Groups II and III as compared to Group IV [Table 2 and Figure 1].

Table 1: Serum vitamin-D, serum Ca and serum inorganic phosphorous levels (mean±SD) in pregnant women and controls

Parameter	Group I (1st trimester) (*n*=60)	Group II (2nd trimester) (*n*=60)	Group III (3rd trimester) (*n*=60)	Group IV (Control) (*n*=50)	*F* value	*P* value
Vitamin-D	22.80±8.2	20.01±5.80	18.00±4.01	30.00±12.30	23.17	<0.001
Ca	9.70±0.97	9.30±0.71	8.90±0.77	9.90±0.79	16.63	<0.001
Inorganic phosphorous	4.10±0.98	3.77±0.71	3.10±0.61	4.30±0.99	22.81	<0.001

Ca: Calcium, SD: Standard deviation

Table 2: Comparison (*P* value) of mean difference in serum vitamin-D, serum Ca and serum inorganic phosphorous levels between groups by Tukey test

Comparison	Vitamin-D	Serum Ca	Serum inorganic phosphorous
Group I versus Group II	>0.05	<0.05	>0.05
Group I versus Group III	<0.01	<0.001	<0.001
Group I versus Group IV	<0.001	>0.05	>0.05
Group II versus Group III	>0.05	<0.05	<0.001
Group II versus Group IV	<0.001	<0.01	<0.01
Group III versus Group IV	<0.001	<0.001	<0.001

Ca: Calcium

DISCUSSION

In our study, we found that two-thirds of the participants (66.6%) had vitamin D deficiency with levels lower than 20 ng/ml, serum Ca, and inorganic phosphorous level were significantly and continuously reduced during the second and third trimesters compared with the first trimester and the nonpregnant group. During pregnancy physiological, biochemical and pathological changes affect the serum vitamin-D, Ca and inorganic phosphorous concentrations.[6] In this study, there was a significant decrease in serum Ca and inorganic phosphate levels in pregnant women, when compared with the nonpregnant women. This may be as a result of their utilization for fetal growth.[7-9] Significant decreases in serum Ca and inorganic phosphorous levels with increase in gestational age were observed in this study. The decrease in serum Ca and inorganic phosphorous levels was highly significant in the third trimester when compared to the first and second trimester, respectively. Socioeconomic status may be correlated with Ca intake. The vitamin D content of the diet must be at least 400 IU/day, and the places where sunshine exposure is not adequate, 1000 IU/day should be given during the past 3 months of pregnancy or 100,000 IU in one dose at the beginning of the last trimester.[10] Low -income women of reproductive age were more likely to have less than the recommended dietary allowance for Ca.

Serum Ca levels are tightly controlled within a narrow range, usually 8.5-10.5 mg/dL (2.1-2.6 mmol/L). However, the serum Ca level is a poor reflection of overall total body Ca, as serum levels are only 0.1-0.2% of extracellular Ca, which in turn is only 1% of total body Ca. The remainder of total body Ca is stored in bone. Ionized Ca, generally 40% of total serum Ca level is physiologically active, while the nonionized Ca is bound to albumin or anions such as citrate, bicarbonate, and phosphorus. In the presence of hypoalbuminemia, there is a relative increase in the ionized Ca relative to the total Ca; thus total serum Ca may underestimate the physiologically active (ionized) serum Ca. A commonly utilized formula for estimating the ionized Ca from total Ca is to add 0.8 mg/dl for every 1 mg decrease in serum albumin below 4 mg/dl.[10,11]

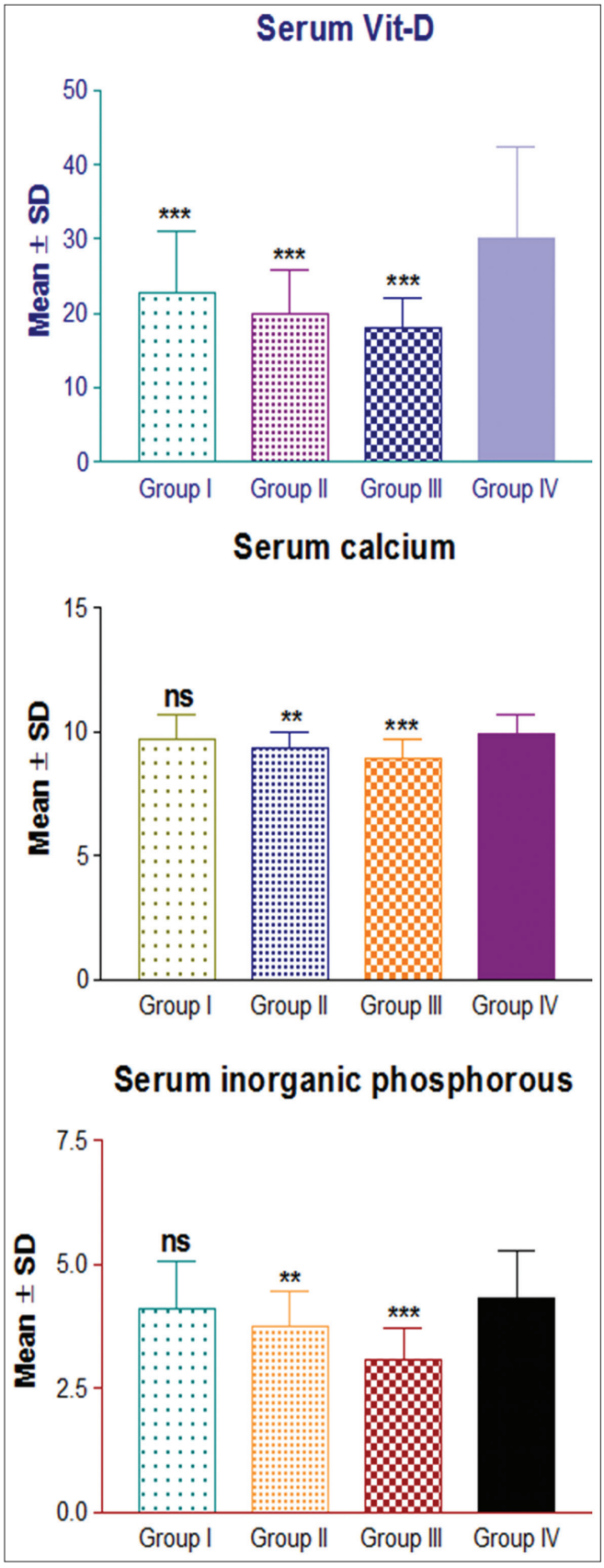

Figure 1: Mean serum vitamin-D, calcium, and inorganic phosphorous levels of four groups. $^{ns}P > 0.05$ or $^{**}P < 0.01$ or $^{***}P < 0.001$ - as compared to Group IV

The effects of dietary Ca on blood pressure regulation appear to be paradoxical, as increasing intracellular Ca increases vascular smooth muscle tone, peripheral vascular resistance, and blood pressure, while increasing dietary Ca exerts the opposite effect.

In this study, serum measured total Ca level was significantly and continuously reduced during the second and third trimesters compared with the first trimester and the nonpregnant group. To find the etiological point behind that, other factors that may affect serum measured total Ca level were excluded; these included factors affecting body Ca and vitamin D status, since all have the same dietary habit (including vitamin D containing diet), same sun exposure as the study done in the same season and locality, no drug history of vitamin D or Ca administration.[12-14]

CONCLUSION

Vitamin D deficiency coupled with Ca consumption in pregnancy should be encouraged, especially during the second and third trimester of pregnancy. The Ca supplement is recommended for women who live in places of low socioeconomic status as well as for women who prefer to skip milk and milk products due to personal preference.

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