

Original article

Serum bone markers in pregnant women at Parirenyatwa Group of Hospitals and Chitungwiza Central Hospital

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Abstract

Background: Pregnancy induces a number of physiological changes in the body including changes in bone profile. As the gestational period progresses and the foetus grows, its demand for mineral micronutrients increases inducing changes in the maternal body. Serum bone profile varies according to trimester as gestational period progresses. The study on which this article is based sought to determine changes in bone profile with trimester in pregnant women attending antenatal clinic at Parirenyatwa Group of Hospitals (PGH) and Chitungwiza Central Hospital, Zimbabwe. **Method:** An analytical cross sectional study was conducted on pregnant women attending antenatal clinics at Parirenyatwa Group of Hospitals and Chitungwiza Central Hospital. A questionnaire was administered and blood samples were collected for analysis of albumin, corrected calcium, phosphate and alkaline phosphatase. **Results:** A total of 171 pregnant women were recruited into the study. The albumin level showed a significant fall from trimester 1 to 2 ($P<0.05$) and an insignificant rise from trimester 2 to 3 ($P>0.05$). **Conclusion:** This study confirms the previously reported constant serum inorganic phosphate level throughout the gestational period and an increase in alkaline phosphatase with gestational age. Corrected calcium level had a statistically significant increase from the second to the third trimester ($P<0.05$). This study provided exploratory data on serum bone markers. Further research on more specific bone markers such as DEXA and bone specific alkaline phosphatase is required. A continual check of at risk women is needed to be able to advice on dietary supplementation to prevent premature osteoporosis.

Keywords: serum calcium; serum inorganic phosphate; serum alkaline phosphate; pregnancy

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Introduction

The ageing population has resulted in an increased burden of osteoporotic fractures, making it necessary to identify novel prevention strategies. There is increased recognition that the factors during pregnancy may influence maternal bone mineral accrual and osteoporosis risk. In pregnancy there are progressive anatomical, physiological and biochemical changes¹. Hormonal secretion is responsible for maternal adaptation which occurs due to the increased demand of the growing foetus². An increase in the demand for calcium and inorganic phosphate for foetal development occurs during pregnancy³. Furthermore, an insufficient calcium supply during pregnancy causes maternal bone loss and high blood pressure. Thus optimal calcium intake

during pregnancy may have a beneficial effect on the blood pressure of the offspring and protect women from hypertension⁴ and osteoporosis. In developing countries, poverty has been indicated to contribute to poor calcium intake⁵.

It has been hypothesized that the levels of serum phosphate decrease during pregnancy due to low intake, hypoalbuminemia and increased demand for foetal growth. Increased risk of maternal bone fracture has been associated with lower bone calcium and phosphate².

Alkaline phosphatase is found in many tissues of the body with high levels being in the liver, bone, placenta, intestine and kidney. Alkaline phosphatase is a bone formation marker which is elevated in serum in pregnancy. The rise in alkaline phosphatase has

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been reported to commence at the fourth month of gestation. The elevation of alkaline phosphatase is a reflection of placental alkaline phosphatase entering the maternal blood ⁶.

Since there is no reported study on serum calcium, phosphate and alkaline phosphate in pregnancy in our population. We sought to find the variation of serum calcium, phosphate and alkaline phosphate according to trimester. An analytical cross-sectional study was carried out on pregnant women attending antenatal clinics at Parirenyatwa Group of Hospitals and Chitungwiza Central Hospital, Zimbabwe.

Materials and methods

Ethical approval

The research was ethically approved by the Joint Parirenyatwa Hospital and College of Health Sciences Research Ethics Committee (JREC): JREC/339/12.

Study design

It was an analytical cross-sectional study in which pregnant women were recruited from January 2013 to 28 March 2013. The study participants were recruited at ANC at Parirenyatwa Group of Hospitals and Chitungwiza Central Hospital, Zimbabwe.

Study procedure

All pregnant women attending the antenatal clinics at Parirenyatwa Group of Hospitals and Chitungwiza Central Hospital during the study period were given information on the study. Pregnant women who consented to participate in the study were recruited. A questionnaire was administered to obtain demographic information. Blood samples collected from the pregnant women for routine antenatal clinic investigations were used for biochemical analysis.

Biochemical analysis

The samples were thawed only once for analysis. The Mindray BS-120 chemistry analyser was calibrated and controls (normal and abnormal) were analysed before analysis of the samples. The samples were analysed for albumin, calcium, inorganic phosphate and alkaline phosphatase.

Statistical Analysis

Means and standard deviation were used to describe the bone profile when the distribution was Gaussian

and median (interquartile range) was used to describe non-Gaussian bone profile. One-way ANOVA was used to test for differences among means for more than two groups and the Tukey post-hoc test was used for multiple comparisons of means. Stata v11 was used for all analyses.

Results

A total of 171 consenting pregnant women were recruited for the study from the antenatal clinics of the Parirenyatwa Group of Hospitals and Chitungwiza Central Hospital. The 171 pregnant women were aged from 15 to 45 years. The age distribution of the pregnant women was normally distributed. Disease and clinical conditions found in the participants were 4.1% (7) back pain, 5.8% (10) hypertension, 0.6% (1) anaemia, 0.6% (1) diabetes mellitus and 1.2% (2) bone disorders. Eighty-eight percent (150) did not have any disorders.

There was a statistically significant decrease in the serum albumin level from the first to the second trimester ($P < 0.05$) and a statistically insignificant increase from the second to the third trimester ($P > 0.05$) as can be seen in Table 1 and Figure 1.

There was a statistically insignificant decrease in corrected calcium plasma level from the first to the second trimester ($P > 0.05$) whereas from the second to the third trimester, there was a statistically significant increase ($P < 0.05$). Between the first and third trimesters, mean levels were non significantly different from each other ($P > 0.05$) as shown in Table 1 and Figure 2.

Inorganic phosphate level remained constant throughout the whole gestational period showing no statistically significant changes between trimesters ($P > 0.05$). See Table 1 and Figure 3 in this regard.

There was a statistically insignificant increase in the alkaline phosphatase plasma level from the first to the second trimester ($P > 0.05$) whilst the increase from the second to the third trimester was statistically significant ($P < 0.05$) as shown in Table 1 and Figure 4.

Discussion

Serum albumin was analysed to enable the calculation

Table 1: Mean corrected calcium, albumin, phosphate and alkaline phosphatase variation according to trimesters

ANALYTE	1 st TRIMESTER (n ₁ = 30) [μ ₁ ± sd ₁]	2 nd TRIMESTER (n ₂ = 57) [μ ₂ ± sd ₂]	3 rd TRIMESTER (n ₃ = 84) [μ ₃ ± sd ₃]
Albumin (g/L)	40.15 ± 4.45	35.84 ± 4.84	36.79 ± 2.17
Corrected calcium (mmol/L)	2.43 ± 0.19	2.36 ± 0.20	2.45 ± 0.10
Phosphate (mmol/L)	1.16 ± 0.17	1.14 ± 0.19	1.18 ± 0.17
Alkaline phosphatase (U/L)	62.6 ± 23.1	75.0 ± 33.9	137 ± 77.1

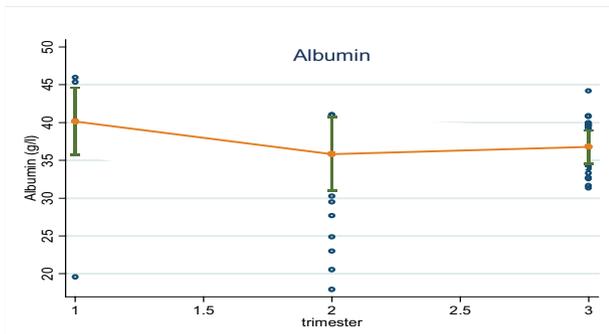


Figure 1: Variation of albumin with gestational period

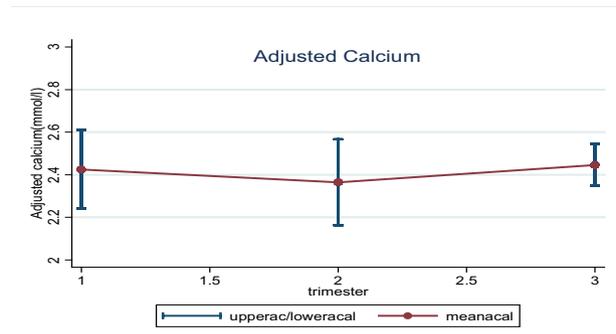


Figure 2: Variation of corrected calcium with gestational period

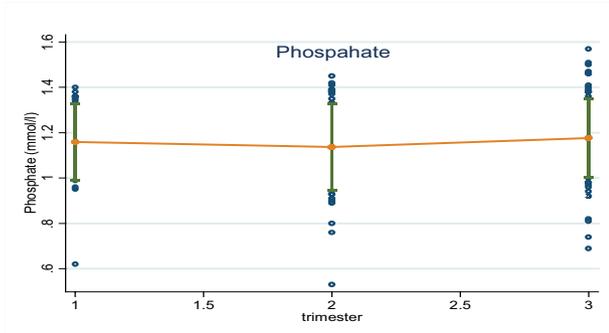


Figure 3: Variation of phosphate with gestational period

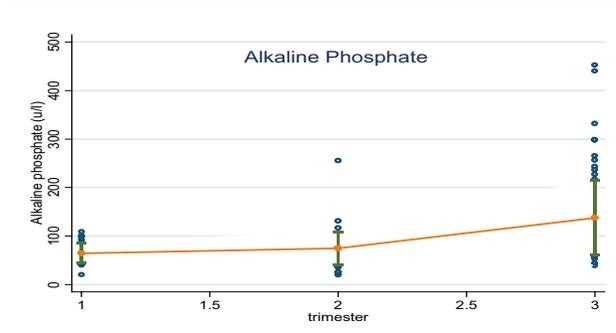


Figure 4: Variation of alkaline phosphatase with gestational period

of corrected calcium. The serum albumin level had a statistically significant decrease from the first to the second trimester, and a statistically insignificant increase from the second to the third trimester. This is in agreement with previous reports that serum albumin decreases during pregnancy.

The corrected calcium level showed a statistically insignificant decrease from the first to the second trimester, and a statistically significant increase from the second to the third trimester. Between the first and third trimester mean levels, the difference was non significant. A study in Nigeria reported a decrease in serum calcium with an increase in gestational age. In contrast to our study, the Nigerian researchers reported a significant decrease in serum calcium in the third trimester when compared to the first and second trimester³. However, it is important to note that the mean serum calcium was found to be within the reference range of 2.05 – 2.55mmol/L for all trimesters which is in agreement with previous reports considering that 88% of the pregnant women studied did not have any other condition⁷. Ionized calcium is reported to be unchanged between early and late pregnancy. In pregnancy calcium is transferred across the placenta for skeletal mineralization in the foetus⁸. Increased intestinal absorption of calcium from the gut is caused by higher generation of calcitriol which would assist in maintaining maternal calcium levels⁹. An increase in the demand for calcium and

inorganic phosphate for foetal development occurs during pregnancy³. The World Health Organization recommends calcium supplementation as part of antenatal care for prevention of preeclampsia in pregnant women particularly among those at higher risk of developing hypertension¹⁰.

The maternal serum inorganic phosphate level remained constant throughout the gestational period without any significant changes between trimesters. This result was also in contrast to that of a study conducted in Nigeria which reported a decrease in inorganic phosphate with trimester³. However in Dhaka Senegal researchers also observed serum inorganic phosphate which was not different in the different trimesters². Inorganic phosphate in this study remained within the reference range of 0.6 – 1.7mmol/L across all trimesters.

Alkaline phosphatase increased progressively across the gestational period with a statistically significant rise from the second to the third trimester. The increase in alkaline phosphatase can be attributed to an increase in anabolic bone metabolism¹¹. In normal pregnancy the placenta secretes placental alkaline phosphatase at a rate which strongly correlates with the nutritional demand of the growing foetus. The placental alkaline phosphatase activity would normally increase as the gestational period advances, accounting for the observed increase in alkaline phosphatase as the gestational age increases¹².

This increase in alkaline phosphatase in pregnancy has been reported to reach peak at term and usually disappears within a few weeks after delivery¹³.

Limitations of the study

A limitation of the study is that the dietary intake and supplementation of calcium and phosphate in the study group was unknown. Due to limited availability more bone specific markers such as bone-specific alkaline phosphatase could not be analysed.

This study confirms the previously reported constant serum inorganic phosphate level throughout the gestational period and an increase in alkaline phosphatase with gestational age. Corrected calcium level had a statistically significant increase from the second to the third trimester.

Recommendations

Serum levels of calcium and phosphate may remain within normal limits despite a negative mineral balance. It is recommended that further research be conducted to determine the bone mineral density with DEXA to determine bone health.

Conclusion

This study provided exploratory data on serum

bone markers which requires further study with more specific bone markers such as DEXA and bone specific alkaline phosphatase. It is suggested that a dietary survey and information on calcium supplementation among pregnant women be collected to obtain information on average dietary intake among pregnant women. A continual check of at risk women is needed to be able to advise on dietary supplementation to prevent premature osteoporosis.

Competing interests

The Authors declare that there no competing interests.

Authors' contribution

Pasipanodya Ian Machingura was responsible for the study design and manuscript preparation. Kudakwashe Muringai carried out the data and sample collection and laboratory analysis. Vasco Chikwasha carried out the study design and statistical analysis.

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