



Age-Related Changes in Serum Calcium and Phosphorus Levels in Osteopenic and Osteoporotic Urban Women

KEYWORDS

Serum calcium, phosphorus, osteoporosis, urban

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ABSTRACT

The calcium and phosphorus play a crucial role in the bone health status of an individual. The quantitative ultra sound (QUS) bone densitometry measured at calcaneus bone is used to evaluate the bone strength based on WHO criteria of BMD T-score standard deviation against normal adult mean. Accordingly the women are divided into normal, osteopenic and osteoporotic women. The age-related changes are evaluated by four different age groups viz., 35-44, 45-54, 55-64 and 65-74 years. The results clearly indicated by reduction in serum calcium and phosphorus with progressive age and as the bone health regressed from normal to osteopenia and to osteoporosis. Intervention strategies in dietary modifications by including calcium rich foods might reduce the extent of bone loss and consequences of osteoporotic risk levels in aged and elderly women.

Introduction

The key to bone health lies in the body's calcium balance. Calcium plays a vital role in intracellular communications and other body processes which require regulation of the calcium in serum within narrow limits. The skeleton serves as a bank from which the blood can borrow and return calcium as needed. If the 'saving account' is not sufficient, then it will develop the fragile bones of osteoporosis. Maintaining serum calcium level through sufficient dietary intake could prevent or at least would slow down the consequence of bone loss associated with ageing process.^[1]

Calcium requirements for skeleton maintenance fluctuate throughout a women's life. During the teen years, calcium requirements are high because of the demands of a rapidly growing skeleton. Low calcium intake during that time may impede reaching peak bone mass, which can increase the risk of osteoporosis later in life. During woman's 20s, less calcium is required as bone turnover stabilizes (i.e., bone formation and resorption rates become balanced) and peak adult bone mass is achieved. Calcium requirements remain stable until menopause. When woman reaches menopause, the bone resorption rate increases, bone mass declines and associated with the fall in ovarian estrogen production. Calcium needs rise at that time because of a decrease in the efficiency of utilization of dietary calcium, which is also associated with the fall in ovarian estrogen production.^[2]

While calcium is the most prevalent element in bone, bone diseases (such as osteoporosis) are due to more than just a lack of calcium. Several other nutrients and minerals, including phosphorus are also critical for maintaining healthy bones. Phosphorus is an essential nutrient for human and animal life. It is fundamental to growth, maintenance, and repair of all body tissues, and is necessary, along with calcium and magnesium for proper growth and formation of bones in infants and children. Sufficient phosphorus intake is important throughout life to ensure the proper balance of essential minerals in order to promote re-mineralization of bones and teeth to keep them in a healthy state.^[3]

Since these two are concerned with calcification of bone, they are often determined together. In addition to the part which it plays in the building of bones and teeth, the calcium present in the blood and other extracellular fluid is important for maintaining the correct conditions for normal nerve irritability and muscle contraction and plays a role in blood coagulation.

Phosphorus is more widely distributed than calcium. Besides being present in bones and teeth, unlike calcium it is found in the cells and so is present in the soft tissues and in many important substances like nucleic acids, coenzymes etc and essential for acid-base regulation. Based on the need of the dual elements, calcium and phosphorus in the maintenance of appropriate bone health and bodily functions throughout human life, the current research is aimed at the estimation of serum calcium and phosphorus levels among urban women in relation to bone metabolic conditions, osteopenia and osteoporosis.

Methodology

The age-related changes are evaluated among urban women through assessment of alterations in serum calcium and phosphorus levels in relation to bone metabolic conditions of osteopenia and osteoporosis among four different age groups viz., younger (35-44 years), middle aged (45-54 years), aged (55-64 years) and elderly (65-74 years) women. The whole urban women study group comprised of 260 members with sub-sample sizes of 60 in younger, 80 in middle aged, 80 in aged and 40 in elderly aged women respectively.

The osteoporotic condition is analyzed based on BMD T-score obtained from QUS bone densitometry. WHO classification of BMD T-score is followed to categorize the women into normal (BMD T-Score: >-1.0), Osteopenia (BMD T-Score:-1.0 to -2.5) and osteoporosis (<-2.5).^[4] The serum calcium and phosphorus levels are estimated in the select women of four different age groups as per the standard procedures.^[5]

Results and discussion

The mean serum calcium contents in relation to osteopenia and osteoporosis of four different age groups along with calculated t-values for the mean differences of serum calcium between normal Vs osteopenia, normal Vs osteoporosis and osteopenia Vs osteoporosis are denoted in table-1.

The data from the table-1 indicated that the serum calcium levels analyzed in the urban women were within normal reference range of 9.0 to 11.0 mg/dl. However, in comparison to normal women of the four age groups, osteoporotic women had significantly low values (P < 0.01). The reduction in serum calcium content is also noticed in osteopenic women indicating that 'osteopenia' though an early symptom of osteoporosis based on BMD also associated with low levels. The declining levels towards osteopenia from normal seemed to be associated significant in middle (p<0.05) and

aged women ($p < 0.01$) only. There was no significant difference in the serum calcium levels between osteopenic and osteoporotic women, but a trend of reduction in the values are noticed from osteopenia to osteoporosis. The most important finding to be noted that as the age progressed, the serum calcium levels decreased from younger (35-44 years) to elderly (65-74 years) including both conditions of osteopenia and osteoporosis and of course including normal status representing the inevitable changes in calcium metabolism with ageing process.

Similar to mean serum calcium levels, the mean phosphorus levels in relation to osteopenic and osteoporotic women of the select age groups along with calculated t-values are tabulated in Table-2.

The mean serum phosphorus levels are also maintained with normal standard range of 2.5 to 4.5 mg/dl. The trend of decrease in mean phosphorus contents of serum is observed at significant level either at one or five percent level as the bone mineral density reduced from normal to osteopenia and later shifting towards osteoporosis among all age groups. Though the serum phosphorus levels are reduced from osteopenia to osteoporosis, the declining levels are not altered significantly. Similar to serum calcium, phosphorus content in serum was also generally lowered with the advancing age and with the age-related bone loss.

The changes in mean serum calcium and phosphorus levels with the progressive age are denoted in table 3. The results clearly demonstrated the reduction in the mean values of both biochemical parameters analyzed indicating more of bone resorption due to lowering of bone formation markers of serum calcium and phosphorus resulting in imbalance in bone remodeling process which may affect the restoration of bone mass in the later years. If this condition is not considered in the initial stages may accelerates withdraw of calcium from the bones and thus the bones become more fragile and porous leading to the threatening condition of osteoporosis.

Finally it can be inferred that the serum homeostasis of calcium and phosphorus levels are maintained within narrow range of normal limits though age-related decreasing trend is noticed mainly due to strong associated regulatory hormonal mechanism. The levels of the decline in the serum calcium and phosphorus as the age progress probably due to decreased capacity of calcium absorption with advancing age.

The inadequate supply of calcium over a lifetime contributes to the development of osteoporosis. Even the changes in the women's reproductive life also alter the calcium and phosphorus contents in the serum. During the physiological conditions of pregnancy and lactation, the women required more of calcium to meet the extra nutritional demands. Unfortunately Indian women were not provided with optimal calcium and protein and hence the bone needed to spare the calcium stores for maintenance of calcium homeostasis resulting in deprivation of bone health and strength.

The important stage to be considered in women's life is the onset of menopause which brings imbalances in the endocrinal functions, primarily estrogen deficiency. The estrogen deprivation slower down the bone formation process and escalates the bone loss and makes it more susceptible to the risk of osteoporosis. The inadequate protein, calcium and other micronutrients prevailing in Indian conditions are the added risk conditions to enhance bone loss and the state of calcium deficiency. Increase in the calcium intakes even at the current age may be helpful to prevent or reduce further bone loss and minimize risk of future fractures instead of worsening the situation.

Conclusion

The major finding to be note down that serum calcium and

phosphorus levels are lowered with the progressive age and with the onset of osteopenia and osteoporosis. The condition challenges the scientists, nutritionists and policy makers to improve the nutritional and health status of women to minimize the age-related risk in lowering bone mineral density and to strengthen the bone health. Educating the community on etiological factors and suitable preventive measures may be the best means of prevention and/ or reduction of osteoporosis risk.

Table 1: Mean serum calcium contents in osteopenic and osteoporotic urban women of different age groups – calculated T test values for the disease condition wise mean differences in serum calcium

| Age group (Years) | WHO criteria of osteoporosis & Mean serum calcium \pm SD(mg/dl) | | | Calculated t-values | | |
|-------------------|---|------------------|-----------------|----------------------|------------------------|----------------------------|
| | Normal | Osteopenia | Osteoporosis | Normal Vs Osteopenia | Normal Vs Osteoporosis | Osteopenia Vs Osteoporosis |
| 35-44 (n = 60) | 10.32 \pm 0.19 | 10.28 \pm 0.21 | 9.94 \pm 0.36 | 0.82 ^{NS} | 3.23** | 2.20* |
| 45-54 (n = 80) | 10.23 \pm 0.19 | 10.09 \pm 0.30 | 9.79 \pm 0.25 | 2.17* | 6.37** | 2.57* |
| 55-64 (n = 80) | 10.13 \pm 0.27 | 9.74 \pm 0.25 | 9.64 \pm 0.32 | 5.85** | 5.61** | 1.09 ^{NS} |
| 65-74 (n = 40) | 9.91 \pm 0.09 | 9.59 \pm 0.28 | 9.46 \pm 0.30 | 1.56 ^{NS} | 2.07 ^{NS} | 1.40 ^{NS} |

Table 2: Mean serum phosphorus contents in osteopenic and osteoporotic urban women of different age groups – calculated T test values for the disease condition wise mean differences in serum phosphorus

| Age group (Years) | WHO criteria of osteoporosis & Mean serum phosphorus \pm SD (mg/dl) | | | Calculated t-values | | |
|-------------------|---|-----------------|-----------------|----------------------|------------------------|----------------------------|
| | Normal | Osteopenia | Osteoporosis | Normal Vs Osteopenia | Normal Vs Osteoporosis | Osteopenia Vs Osteoporosis |
| 35-44 (n = 60) | 4.26 \pm 0.17 | 4.06 \pm 0.19 | 3.83 \pm 0.39 | 3.69** | 3.95** | 1.54 ^{NS} |
| 45-54 (n = 80) | 4.07 \pm 0.19 | 3.89 \pm 0.22 | 3.78 \pm 0.30 | 3.04** | 3.96** | 1.07 ^{NS} |
| 55-64 (n = 80) | 3.89 \pm 0.23 | 3.75 \pm 0.20 | 3.69 \pm 0.18 | 2.36* | 2.78** | 0.91 ^{NS} |
| 65-74 (n = 40) | 3.65 \pm 0.09 | 3.57 \pm 0.20 | 3.41 \pm 0.25 | 0.56 ^{NS} | 1.31 ^{NS} | 2.16* |

Table 3: Age-related changes in mean serum calcium and phosphorus levels of urban women

| Age group (Years) | Mean serum calcium \pm SD(mg/dl) | Mean serum phosphorus \pm SD(mg/dl) |
|-------------------|------------------------------------|---------------------------------------|
| 35-44 (n = 60) | 10.30 \pm 0.21 | 4.19 \pm 0.22 |
| 45-54 (n = 80) | 10.15 \pm 0.26 | 4.00 \pm 0.24 |
| 55-64 (n = 80) | 9.94 \pm 0.34 | 3.82 \pm 0.23 |
| 65-74 (n = 40) | 9.54 \pm 0.30 | 3.50 \pm 0.23 |

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