GAU Research Journal **46** (2) : 101-105 (April 2021)

Serum Calcium and Phosphorus Levels In Relation to Age and Bone Health

R.BHARATHI

Department of Home Science
Sri Padamavati Mahila Visvavidyalayam , Tirupati

Received: 27th November, 2020 Accepted: 21st May, 2021

ABSTRACT

Globally the health standards are being increased in the modern age and lead to increase in substantial number of elderly people with the increased life expectancy and correspondingly age-related problems especially bone health. In this regard, the study was conducted to assess bone health through Quantitative Ultrasound (QUS) bone densitometry and analyze serum calcium and phosphorus levels in South Indian rural women. The investigation was also aimed at arriving age-related changes for which women of 35 to 74 years were sub-grouped into young, middle age, aged and elderly. The study results demonstrated definite decline in bone mass with advancing age with overall prevalence of 34 percent osteopenia and 29 percent osteoporosis and none of elderly women had normal bone mass. On the other hand the serum calcium and phosphorus levels are lowered with the progressive age and also as the bone density regressed from normal to osteopenia and osteoporosis.

KEYWORDS: Bone Health, Serum Calcium, Serum Phosphorus, Rural Women, India

INTRODUCTION

The role of calcium and phosphorus is very crucial in the skeletal system as the bone typically made up of hydroxyapatite [$Ca_{10}(PO_4)_6(OH)_2$]. Calcium occupies the major abundant portion about 99 percent including bone and teeth. The remaining one percent is found in the serum within tight limits by the effective fundamental biological and metabolic processes. Calcium metabolism is integrated with certain other nutrients especially pss and accelerates the prognosis of osteoporosis in elderly. Vitamin D play a crucial role in regulating blood calcium levels as the active form of calcitriol and is responsible for dimerization of Vitamin D receptor by triggering the appropriate metabolic functioning of intestines, kidneys and bones. Vitamin D can be accessed well from the diet or obtained from the 7-dehydrocholesterol which is present under the skin and gets activated in the presence of sunlight. However, the interesting fact that to the maximum extent serum levels are maintained within normal range. The bone health management should be focused on effective measures those lower the risk of bone loss and to minimizing the high risk conditions of either declined serum calcium (hypocalcaemia) or elevated levels (hypercalcemia) where the two extremities are the indications of severe bone losses in the body (Bhattarai *et al*., 2020).

Osteoporosis is a major health problem threatening the public bone health worldwide. Asian women especially are affected and in India the exact picture on the prevalence of the disease is not well established but on an average one in four women above the age of 50 years believed to be suffered from the bone deteriorating problem. Calcium and Vitamin D supplementation is well recognized as the first line intervention approach in the management of osteoporosis. This reflects the importance of calcium in the bone metabolism and in fact the bone tissue is majorly made of calcium and phosphorus (Khadilkar and Kajale, 2013). Based on this background the current research was aimed at assessing the bone health among rural women of South India and to find out the changes in serum calcium and phosphorus levels in relation to bone health evaluation as normal, osteopenia and osteoporosis.

MATERIALS AND METHODS

The study was conducted in the rural areas of Chittoor district located nearby to Tirupati town among women in the age range of 35 to 74 years. The sample was further subdivided into four different age groups viz., 35 to 44 years (young), 45 to 54 years (middle age), 55 to 64 years (aged) and 65 to 74 year (elderly) to study age-related changes in biochemical markers of serum calcium and phosphorus in relation to bone health in terms of

Assistant Professor
Department of Home Science
Sri Padamavati Mahila Visvavidyalayam , Tirupati

Bone Mineral Density (BMD). The sample comprised of 60 young, 80 each of middle age and aged and 40 elderly women with a total size of 260 rural women.

Bone health was evaluated through Quantitative Ultrasound (QUS) bone densitometry measured at calcaneus bone. World Health Organization (WHO) classification of BMD T-score was considered for assessment of osteopenia (BMD T-Score: -1.0 to -2.5) and osteoporosis (BMD T-Score: ≤ -2.5) (Hans *et al*., 1996). The evaluation was carried out at the local orthopedic hospitals during BMD campaigns and intimation was conveyed to the target group after receiving confirmation from the hospital authorities and mobilized to attend the BMD analysis. Meanwhile the serum was also collected from the subjects to estimate the biochemical markers of serum calcium and serum phosphorus using standard protocols through automated analyzer.

RESULTS AND DISCUSSIONS

The data gathered from the selected rural women was interpreted and illustrated in terms of bone health status and biochemical markers of serum calcium and phosphorus. The bone health was evaluated based on WHO criteria of BMD T-scores standard deviations and accordingly the women were categorized into normal, osteopenia and osteoporosis. The results thus obtained were discussed further under different subheads.

Bone Health Status

The bone health status was analyzed through frequency distribution by considering the number of women affected by osteopenia and osteoporosis in each age group. Based on the frequency distribution and the corresponding sample size of the respective age group, the percent values were calculated. Even the overall low and poor bone density conditions were estimated by considering both osteopenic and osteoporotic women to predict the percent of women deviated from the normal bone mass of each age group. The data was also evaluated for the total sample size to express the total prevalence of osteopenia and osteoporosis in the selected rural women. The distribution of women belonging to four different age groups was expressed as frequency distribution and the corresponding percent values and presented in table1.

Table 1 Distribution of osteopenia and osteoporosis among rural women of different age groups

Group	Frequency (%)			
Age (Years)	Normal	Osteopenia	Osteoporosis	Osteopenia+ Osteoporosis
Young 35-44 (n = 60)	37 (62)	17 (28)	6 (10)	23 (38)
Middle Age 45-54 (n = 80)	37 (46)	30 (38)	13 (16)	43 (54)
Aged 55-64 (n = 80)	23 (29)	32 (40)	25 (31)	57 (71)
Elderly 65-74 (n = 40)	Nil	10 (25)	30 (75)	40 (100)
Total (n=260)	97 (37)	89 (34)	74 (29)	163 (63)

Note: Values within parentheses indicate percent values

The percent distribution from the table 1 denoted that the normal bone density condition seemed to be lowered from young (63 percent) to aged rural women (29 percent) and none of the elderly women had normal bone density. The osteopenic condition found to be increased with the advancing age from the prevalence of 25 percent to 40 percent in the different age groups. Later the percent prevalence of osteopenia was reduced to 25 percent in elderly rural women as three fourth of them were affected by severe bone loss condition of osteoporosis (75 percent). On the other hand the prevalence of osteoporosis had increased from 10 percent to 75 percent with the progressive age.

The bone densities are relatively lower in both the conditions of osteopenia and osteoporosis which

need to be considered by initiating preventive measures at normal bone status, curative measures at osteopenia and further effective integrated intervention approaches to minimize the risk of osteoporosis. When considered both conditions, slightly above one third of the young rural women (38 percent), half of the middle age (54 percent) and slightly lower than three fourth (71 percent) of aged women and absolutely all the elderly experienced either from osteopenia or osteoporosis. The overall prevalence of osteopenia was 34 percent and osteoporosis about 29 percent and all together 63 percent of the selected rural women in the age range of 35 to 74 years suffered from either low (osteopenia) or poor (osteoporosis) bone mineral density.

Binu *et al*., 2019 denoted similar trend of results with the rise in the incidence of postmenopausal osteoporosis with advancing age. The prevalence of osteoporosis was noted as 22 percent at the site of femoral neck and 39 percent at the site of lumbar spine when evaluated through dual energy X-ray absorptiometry. Similarly in another study also indicated the high prevalence of 32.47 percent osteoporosis between ages of 20 and 76 years among female population of rural central India measured at heel by ultrasound (Nikose *et al*, 2015).

Serum calcium levels in relation to bone health

The present study was focused on analyzing the changes of serum calcium levels in association with the bone health status as compared against normal, osteopenic and osteoporotic women of each age group. The levels of differences in the changes of bone densities were interpreted statistically by finding out the relationship between the serum calcium values through calculated t- values viz., normal vs osteopenia, normal vs osteoporosis and osteopenia vs osteoporosis. The mean serum calcium values thus estimated in relation to bone health were depicted in table 2.

Table 2 Mean serum calcium levels in relation to bone health among rural women of different age groups

Group	Mean serum calcium(mg/dl)			Calculated t-values		
Age (Years)	Normal Mean & ± S.D	Osteopenia Mean & ± S.D	Osteoporosis Mean & ± S.D	Normal Vs Osteopenia	Normal Vs Osteoporosis	Osteopenia Vs Osteoporosis
Young 35-44 (n=60)	10.11 ± (0.29)	9.88 ± (0.35)	9.64 ± (0.27)	2.60*	3.73**	1.51 NS
Middle Age 45-54 (n = 80)	9.68 ± (0.31)	9.47 ± (0.28)	9.36 ± (0.17)	2.88**	3.47**	1.27 NS
Aged 55-64 (n = 80)	9.38 ± (0.25)	9.31 ± (0.16)	9.22 ± (0.17)	1.30NS	2.74**	2.11*
Elderly 65-74 (n = 40)	Nil	9.25 ± (0.09)	9.18 ± (0.11)	Nil	Nil	1.71 NS

Reference values: 9 to 11 mg/dl

*= Significant at 5 percent level **= Significant at 1 percent level NS = Not Significant

The data from the table 2 represented that the mean serum calcium levels found to be lowered from young to elderly irrespective of bone health status. The most important point to be highlighted that the serum calcium values seemed to be within normal range of 9 to 11 mg/dl. The homeostasis mechanism involved is that in spite of progressive age-related accelerated calcium loss, the serum calcium levels are maintained by drawing calcium from the bones into the blood during declined conditions (Fazlini *et al* (2013). Because skeleton acts as bank for the calcium where the blood can easily borrow calcium from the bone marrow whenever needed. The situation well explained the basic requirement of adequate dietary calcium intakes, otherwise much of the bone calcium reserves will be drawn leading to appearance of osteopenia and further to osteoporosis resulting in more porous and fragile bones.

The results on serum calcium revealed a significant decrease from normal to osteopenia in young and middle age women but the reduction was not at significant level in aged probably due to the reason of associated lowered serum levels even in normal bone density individuals. The comparative levels

between normal and osteoporotic women found to be highly significant at one percent levels in young, middle and aged rural women indicating significant calcium loss as the bone density regressed from normal to osteoporotic bone within the narrow normal limits of serum calcium. None of the elderly rural women had normal bone density for comparison as they experienced the bone health problem of either osteopenia or osteoporosis. The serum calcium levels observed to be reduced from osteopenic to osteoporotic women but the differences were not significant except in aged women probably due to relatively higher losses at slightly higher pace from the age of 55 years. The non-significant differences in elderly women might be due to existing lower range of serum calcium values among osteopenic women which continued to be maintained in those narrow limits.

One of the recent study carried out by Himabindu, 2019 also indicated the existence of low bone densities in post-menopausal women with the incidence of 1.6 percent normal, 21.6 percent of osteopenia and 76.66 percent of osteoporosis. Similar to the present study, there was positive correlation between serum calcium levels and bone mineral density.

Serum phosphorus levels in relation to bone health

Similar to that of serum calcium values, the mean serum phosphorus levels were also expressed in terms of bone health condition of normal, osteopenia and osteoporosis of each age group. The differences were shown statistically through calculated t-values and tabulated in table 3.

Table 3 : Mean serum phosphorus levels in relation to bone health among rural women of different age groups

Group	Mean serum phosphorus(mg/dl)			Calculated t-values		
Age (Years)	Normal Mean & ± S.D	Osteopenia Mean & ± S.D	Osteoporosis Mean & ± S.D	Normal Vs Osteopenia	Normal Vs Osteoporosis	Osteopenia Vs Osteoporosis
Young 35-44 (n=60)	3.96 ± (0.29)	3.77 ± (0.44)	3.58 ± (0.53)	1.87 NS	2.63**	0.88 NS
Middle Age 45-54 (n = 80)	3.76 ± (0.44)	3.62 ± (0.37)	3.51 ± (0.30)	1.38 NS	1.96 NS	1.01 NS
Aged 55-64 (n = 80)	3.57 ± (0.38)	3.50 ± (0.34)	3.39 ± (0.30)	0.73 NS	1.88NS	1.30NS
Elderly 65-74 (n = 40)	Nil	3.42 ± (0.41)	3.29 ± (0.20)	Nil	Nil	1.39 NS

Reference values: 2.5 to 4.5 mg/dl
*= Significant at 5 percent level **= Significant at 1 percent level NS = Not Significant

The findings from the table 3 also implicated that similar to that of serum calcium levels, a decline in serum phosphorus levels were noticed to be lowered from younger to elderly rural women within tightly regulated normal reference values of 2.5 to 4.5 mg/dl. The major mechanism behind this direct association was mainly attributed that the two essential minerals work in cohort intricately in metabolic and regulation processes concerned to bone remodeling process and metabolism. The other probable factor was the non-evidence of phosphorus deficiency as the optimal supply of phosphorus commonly obtained from the usual diets.

The interesting point to be stressed that the mean serum phosphorus levels varied within the age group from normal to osteopenia and still worsen with the proceeding worsening condition of osteoporosis within normal values. But the differences were not significantly different except between normal and osteoporotic young women indicating slighter variations of phosphorus only and are little affected with the lowered bone density conditions of both osteopenia and osteoporosis. The condition indicated greater alterations with the serum calcium levels rather than serum phosphorus. However, the trend of results strongly evidenced that both serum calcium and phosphorus were lowered with the advancing age and with the shift from normal to osteopenia and further to osteoporosis in spite of

effective regulatory mechanisms involved to maintain within the normal standard reference ranges.

The current research findings also coincided with the cross-sectional study conducted by Shakoor *et al*., 2014 with the reduction in both serum calcium and phosphorus with the advancing age as well as while the bone health regressed from normal to low bone density condition of osteopenia and in turn a shift towards poor bone density condition of osteoporosis. They carried out research in thirty postmenopausal women to identify the prevalence of osteoporosis and studied for the relationship with body mass index, body fat, muscle mass and the levels of calcium and phosphorus in the serum. The results indicated by significant decline in body weight, muscle mass and serum calcium and phosphorus with increasing age and observed no significant association with body mass index and height.

CONCLUSION

The study was emphasised on evaluating bone health status in South Indian rural women and evaluated the relationship with serum calcium and phosphorus levels. The findings clearly demonstrated gradual decline in bone mineral density and simultaneously both the biochemical markers analysed with the advancing age. However, the serum calcium and phosphorus levels were tightly regulated within the normal reference ranges. This particular scenario strongly indicated the diet need of maintaining the calcium intakes to prevent the bone calcium loss for maintaining serum calcium levels and restore bone mass effectively.

REFERENCES

Beto, J A. 2018. The Role of Calcium in Human Aging. *Clinical Nutrition Research*, 4(1): 1–8.

Bhattarai, H.K., Shrestha, S., Rokka, K and Shakya. 2020. Vitamin D, Calcium, Parathyroid Hormone, and Sex Steroids in Bone Health and Effects of Aging. *Hindawi Journal of Osteoporosis*: 1-10.

Binu, A.J., Cherian, K.E., Kapoor, N., Jebasingh, F.K., Asha, H.S. and Paul, T.V. 2019. Bone health after fifth decade in rural ambulatory South Indian postmenopausal women. *Indian Journal of Community Medicine*, 44:205-8.

Fazlini, M.F., Suriah,A.R., Zaitun,Y., Kandiah,M.2013. Calcium supplementation amongst postmenopausal women: Effect on serum calcium, phosphorus and magnesium level. *International Food Research Journal*, 20(1):477-480

Hans, D., Dargent-Molina, P., Schoott, A.M.1996. Ultrasonographic heel measurements to predict hip fracture in elderly women: the EPIDOS prospective study. *Lancet*, 348:511–514.

Himabindu, P.H. 2019. Study on the Prevalence of Osteoporosis and the Association between the Serum Calcium Levels and the Bone Mineral Density Levels in Postmenopausal Women. International Journal of Contemporary Medical Research, 6(9): 11-13.

Khadilkar, A.V. and Kajale, N.A. 2013. Bone health status in Indian women. *Indian Journal of Medical Research*, 137(1): 7–9.

Nikose, S., Singh, P., Khan, S., Arora, M., Taywade, S., Gushed, M. and Gadge,S. 2015. Prevalence of Osteoporosis in Female Population in Rural Central India [By Calcaneal Ultrasound]. *Journal of Women's Health Care*, 4: 262.

Shakoor, S., Shakoor, S., Abbas, N., Mirza, M.A. 2014. Prevalence of osteoporosis in relation to serum calcium and phosphorus in aging women. *Journal of Global Innovations in Agricultural and Social Sciences*, 2(2):70-75.