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RESEARCH ARTICLE

SERUM CALCIUM, PHOSPHOROUS, MAGNESIUM, SODIUM, POTASSIUM, ALKALINE PHOSPHATASES AND VITAMIN D LEVELS IN OSTEOPOROTIC AND NON OSTEOPOROTIC POST- MENOPAUSAL WOMEN

***Papa Kusuma, B., Lakshmi Kalpana, V. and Sudhakar, G.**

Department of Human Genetics, Andhra University, Visakhapatnam, India

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ABSTRACT

Back ground: Because of the incidence and the health –related problems of post- menopausal osteoporosis it has become a social problems requiring appropriate management strategies. The present study is an attempt to estimate the levels of calcium, phosphorous, magnesium, sodium, potassium, alkaline phosphatases and vitamin D of post-menopausal osteoporotic women. The present study was carried out to find out the association of minerals with post-menopausal osteoporotic women.

Methods: 100 post- menopausal osteoporotic women and 90 non osteoporotic women of age and sex matched healthy controls were obtained from King George Hospital, Visakhapatnam during the period January 2015 to April 2015. The levels of calcium, phosphorous, magnesium, sodium, potassium, alkaline phosphatases and vitamin D were estimated by using kits (Calmagite Method) (For invitro diagnostic use). The data was analyzed by online free calculator(quantpsy.org.) Med calculator (www.open epi.com).

Results: The odds ratio shows only small risk for 75-85 years age group of post- menopausal osteoporotic and non osteoporotic women. The odds ratio p-value shows statistically insignificant result with the age of post-menopausal osteoporotic women. For calcium and alkaline phosphotases statistically significant mean p-values were obtained.

Conclusion: The study confirms findings of earlier studies carries out in India and other countries. The present study reveals that serum calcium levels are significantly reduced in post-menopausal osteoporotic women than non osteoporotic women, whereas serum ALP levels are significantly increased.

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INTRODUCTION

Osteoporosis is defined as a systemic skeletal disease characterized by low bone mass and microarchitectural deterioration of bone tissue, with a consequent increase in bone fragility and susceptibility to fractures (Consensus development conference, 1993). For the purposes of clinical diagnosis, a working party of the world health organization has refined osteoporosis according to bone mass, at least for women. Osteoporosis is an increasing public health problem worldwide (Lau *et al*., 2001; Wasnich, 1997). It has been estimated that, in 1990, 1.7 million people globally suffered from osteoporotic hip fractures. The number might increase to 6.3 million by 2050 (Johnnell, 1997).

****Corresponding author: Papa Kusuma, B.***
Department of Human Genetics, Andhra University, Visakhapatnam, India.

Osteoporosis is more common in post- menopausal women and not only gives rise to morbidity but also markedly diminishes the quality of life in this population. There is lack of information regarding the risk factors of osteoporosis in developing countries (Keramat *et al*., 2008).

Many of the nutrients and food components we consume as part of a westernized diet can potentially have a positive or negative impact on bone health. They may influence bone by various mechanisms, including alterations of bone structure, the rate of bone metabolisms, the endocrine and/or paracrine system, and homeostasis of calcium and possibly of other bone active mineral elements (Cashman, 2004). These dietary factor range from inorganic minerals (e.g., calcium, magnesium, phosphorous, sodium, potassium, and various trace elements) and vitamins (vitamins A, D, E, K, C, and certain B vitamins),

to micronutrients, such as protein and fatty acid. Since 1959, many investigators have repeatedly observed that increased dietary salt ingestion by healthy adults results in increased urinary calcium loss, which potentially increases the risk of developing osteoporosis (Massey and whiting, 1996) and kidney stones (Massey and whiting, 1995). The role of nutritional factors in the etiology of osteoporosis is controversial. However adequate nutrition does influence all aspects of bone health throughout human life cycle. Calcium is particularly important in elderly women because low dietary intake have been associated with reduce bone mineral density (BMD) (Dawson- Hudegs *et al*., 1990; Prince *et al*., 1995; Reid *et al*., 1995). Postmenopausal women need to obtain sufficient amount of calcium to maintain bone health and suppress parathyroid hormone (PTH) (Mc Kane *et al*., 1996).

Phosphorous and magnesium are among minerals that have been proposed as having an important role in bone metabolism. Phosphorous, as phosphates combine with calcium ions to form hydroxyapatite, the major inorganic molecule in teeth and bones. Magnesium (Mg) is an essential intracellular cation, a cofactor of much basic cellular processes, particularly those involving energy metabolisms (Heaney, 2001). Individuals with low calcium to phosphorous serum (Ca:P serum) ratio would benefit from increasing their calcium intake from foods or supplements. Although there is both theoretical and some clinical evidence of an association, relatively few studies have examined the effect of either potassium or magnesium intake on bone. Low potassium intake has been shown to increase rates of calcium excretion (Lemann *et al.,* 1993). Serum alkaline phosphatases (ALP) is most commonly used biomarkers of bone formation. ALP is a ubiquitous enzyme that plays an important role in osteoid formation and bone mineralization. The serum ALP pool consists of several dimeric isoform that originate from various tissues, such as the liver, bone, intestine, spleen, kidney and placenta (Delmas *et al.,* 2000).

Among the osteoporosis management factors, vitamin D plays an important role (Lips and Van Schoor, 2011; Dawson-Hughes *et al.,* 2010). Vitamin D is absorbed from food or synthesized in skin that is exposed to sunlight. The liver convert it to 25-hydroxyvitamin D [25(OH) D], which in turn is converted by the kidney to active form calcitriol 1,25 $(OH)_2D$. Vitamin D increases serum calcium by promoting intestinal calcium absorption and plays a role in bone formation and resorption (Lips, 2006).

MATERIALS AND METHODS

100 post- menopausal osteoporotic women and 90 non osteoporotic women of age and sex matched healthy controls were obtained from King George Hospital, Visakhapatnam during the period January 2015 to April 2015. SOP module of Beckman coulter AU 480 analyser for quantitative estimation of calcium in heparanised plasma and serum.

Normal levels of calcium: 8.5-10.5 mg/dl

SOP module of Beckman coulter AU 480 analyser for quantitative estimation of inorganic phosphorous in plasma and serum.

Normal levels of phosphorous: 2.5-4.8 mg/dl

Calmagite method (For invitro diagnostic use only) used for estimation of magnesium in serum.

Narmal levels of magnesium: 1.3-2.5 mg/dl

ISE module of Beckman coulter AU analyser for the quantitative (indirect) determination of sodium(Na^+) and potassium(K^+) in plasma and serum.

Normal levels of sodium: 135-155mmol/L
Normal levels of potassium: 3.5-5.5mmol/L

SOP module of Beckman coulter AU 480 analyser for quantative estimation of alkaline phosphatase in plasma and serum.

Normal levels of alkaline phosphotases: 15-112 U/L

Electrochemilumimescence method (on roche cobas E411) is used for quantitative determination of vitamin D in plasma and serum.

Normal levels of vitamin D: 30.0 -100.0ng/ml

RESULTS

The net loss of bone that occurs with aging is a universal phenomenon, but rates of loss are modified by genetics, endocrine, and environmental factors. The process of bone remodeling helps to explain how bone loss occurs with menopause and aging.

Table-1 shows distribution of post-menopausal osteoporotic and non-osteoporotic women according to age. It is revealed from the Table-1, the highest number of post- menopausal osteoporotic (26) and non osteoporotic (22) women were found in 55-65 age group. The lowest number of post-menopausal osteoporotic (1) and non osteoporotic (6) women were found in 85-95 and 75-85 age groups respectively. The odds ratio shows only small risk for 75-85 age group post-menopausal osteoporotic and non osteoporotic women. The odds ratio p-value shows statistically insignificant results with the age of post-menopausal osteoporotic women.

The role of nutritional factors in the etiology of osteoporosis is controversial. However adequate nutrition does influence all aspects of bone health throughout human life cycle. Many of the nutrients and food components we consume as part of a Westernized diet can potentially have a positive or negative impact on bone health. These dietary factors range from inorganic minerals (e.g., calcium, magnesium, phosphorus, sodium, potassium, and various trace elements) and vitamins (vitamins A, D, E, K, C, and certain B vitamins), to macronutrients, such as protein and fatty acids.

Table-2 reveals distribution of mean values of post-menopausal osteoporotic and non-osteoporotic women for calcium, phosphorus, magnesium, sodium, potassium, alkaline phosphatases and vitamin D.

Table 1. Distribution of post- menopausal osteoporotic and non-osteoporotic women according to age

S.No	Age group	Osteoporotic	Non-osteoporotic	Total	Odds ratio	95% class interval	P-value
1	25-35	15	19	34	1	-	-
2	35-45	17	15	32	0.697	0.26 to 1.837	0.465
3	45-55	23	17	40	0.584	0.232 to 1.468	0.253
4	55-65	26	22	48	0.668	0.276 to 1.616	0.371
5	65-75	14	11	25	0.620	0.219 to 1.755	0.368
6	75-85	4	6	10	1.184	0.282 to 4.973	0.817
7	85-95	1	-	1	0.265	0.010 to 6.967	0.426

Table 2. Distribution of mean values of post-menopausal osteoporotic and non-osteoporotic women for calcium, phosphorus, magnesium, sodium, potassium, alkaline phosphatases and vitamin D

S.No	Variable	Group	N	Mean	Standard deviation	P value
1	Calcium	Osteoporotic	100	6.360	1.656	0.000**
		Non osteoporotic	90	8.953	0.785	
2	Phosphorus	Osteoporotic	100	5.824	1.204	0.049*
		Non osteoporotic	73	3.967	0.966	
3	Magnesium	Osteoporotic	95	2.345	0.882	0.001**
		Non osteoporotic	74	1.808	0.612	
4	Sodium	Osteoporotic	98	145.064	8.222	0.354NS
		Non osteoporotic	71	141.85	7.402	
5	Potassium	Osteoporotic	98	2.529	0.777	0.184NS
		Non osteoporotic	83	4.120	0.894	
6	Alkaline Phosphotase	Osteoporotic	39	125.64	34.929	0.005**
		Non osteoporotic	88	108.92	52.696	
7	Vitamin-D	Osteoporotic	45	21.206	18.375	0.033*
		Non osteoporotic	34	32.376	25.893	

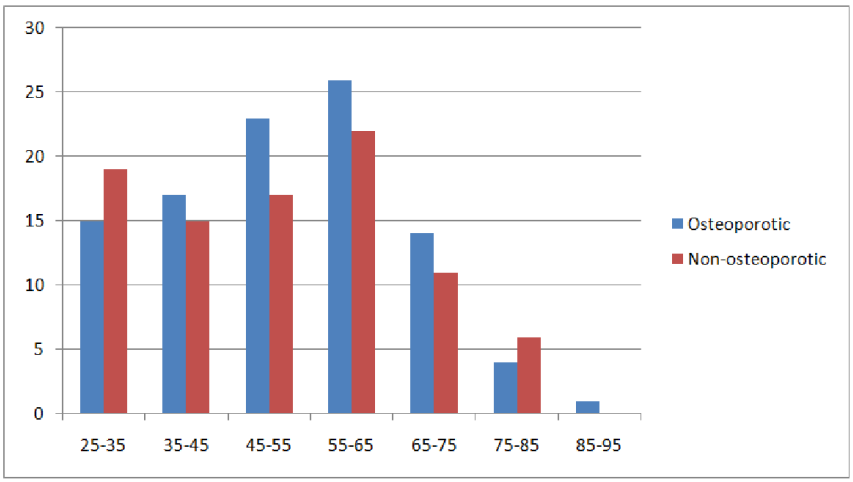

Figure 1. Distribution of post-menopausal osteoporotic and non-osteoporotic women according to age

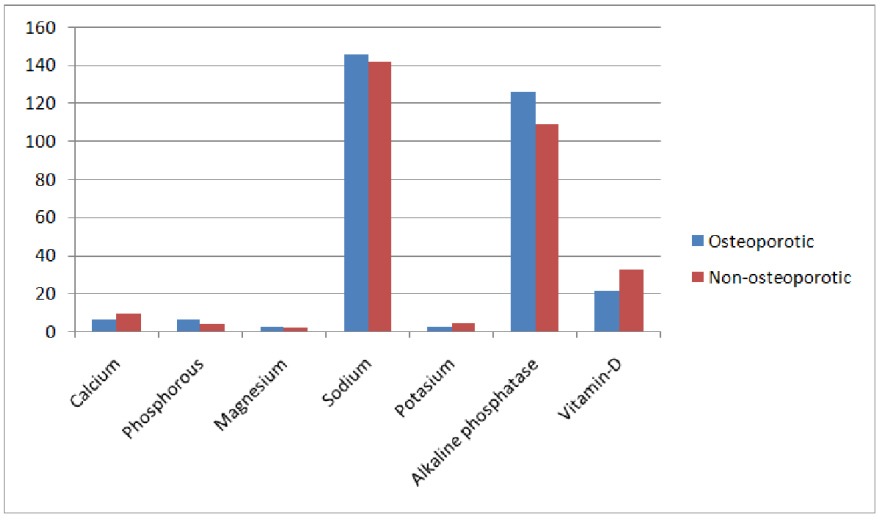

Figure 2. Distribution of mean values of post-menopausal osteoporotic and non-osteoporotic women for calcium, phosphorus, magnesium, sodium, potassium, alkaline Phosphatases and vitamin D

The highest mean value of post-menopausal osteoporotic (145.064) and non osteoporotic (141.85) women were observed for sodium, where as the lowest mean value was found for magnesium in post-menopausal osteoporotic (2.345) and non osteoporotic(1.808) women. The mean value of calcium is lower for post-menopausal osteoporotic (6.360) than non osteoporotic (8.953) women. The mean value of alkaline phosphatases is higher for post-menopausal osteoporotic (125.64) than the non osteoporotic (108.92) women. The table-2 also shows significant mean p-values for calcium and alkaline phosphatases.

DISCUSSION

Menopause is known to be associated with numerous physiological and biochemical changes affecting bone mineral metabolism. The results of various case control studies of (Ashuma *et al*., 2005; Suresh and Naidu, 2006; Masse *et al.,* 2005) have shown that changes in the serum calcium levels in post-menopausal osteoporotic women are not statistically significant, however, in the present study, we found that the mean values of serum calcium levels were significantly reduced in the post-menopausal osteoporotic women 6.360 (SD 1.656) when compared to the non osteoporotic women 8.953 (SD 0.789) (P=0.000) (Table 2).

Ashuma *et al.,* 2005 reported that aging and menopause lead to a decline in oestrogen production, which has been implicated in the increased calcium levels of post-menopausal osteoporotic women. Conversely, the mean values of serum alkaline phosphatases (ALP) levels were significantly increased in the post-menopausal osteoporotic women 125.64 (SD 34.929) compared to the non osteoporotic women 108.92 (SD 52.696) (P = 0.005) (Table 2).

It has also been shown that oestrogen deficiency, as occurs during menopause, induces the synthesis of cytokines by osteoblasts, monocytes, and T cells and thereby stimulates bone resorption by increasing osteoclastic activity. This action results in modification of the reabsorption, excretion, and resorption of calcium, which leads to increased circulating levels of this ion (Esbrit ,2001; Riggs *et al*.,1998; Kurland *et al*., 2000). Thus, we have reported a negative correlation between serum calcium and ALP levels in post-menopausal osteoporotic women (Table 2).

The studies of (Dutta *et al*., 2013; Sengupta , 2013; Sengupa and Sahoo, 2013; Senguptan *et al*., 2013; Sengupta and Banerjee, 2014; Sengupta, 2012) have reported no significant correlation between serum calcium levels and ALP when assessing various years since menopause. However, contrary to these findings in the study of Sengupta, 2013 higher levels of calcium and ALP have been demonstrated in non oateoporotic women compared with post- menopausal osteoporotic women.

Conclusion

The present study reveals that serum calcium levels are significantly reduced in post-menopausal osteoporotic women, whereas serum ALP levels are significantly increased. In addition, a significant negative correlation was observed between serum calcium and ALP levels in the experimental group. Calcium supplementation amongst post-menopausal osteoporotic women benefits them by increasing the subject daily intake of calcium. Sufficient intake of calcium maintains serum calcium level, and suppresses PTH secretion. Furthermore, the study reveals that osteoporosis is a multi-factorial disease and various factors including sex, lifestyle and dietary inadequacy might play an important role in development of this disease.

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