

## Research Article

# Comparison of bone mineral density and serum minerals in pre and post-menopausal women

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## ABSTRACT

**Background:** Osteoporosis is a disease that weakens bones, increasing the risk of sudden and unexpected fractures. Literally meaning “porous bone”, it results in an increased loss of bone mass and strength. The disease often progresses without any symptoms or pain. Though the exact cause is not known it can be prevented. After age 35, bone breakdown outpaces bone build-up, resulting in a gradual loss of bone mass. Once this loss of bone reaches a certain point, a person has osteoporosis. After menopause, bone resorption (breakdown) outpaces the building of new bone. Osteoporosis is a silent disease, reflected only in a low bone density, till a fracture occurs. One of the most rapidly emerging health problems in the postmenopausal women is osteoporosis. It is now realized that, osteoporotic fractures are a major cause of morbidity and mortality in India in the elderly women population. Aim: To study the correlation between serum minerals and Bone Mineral Density (BMD) in pre and postmenopausal women.

**Methods:** This study was designed to find out the serum mineral levels and its correlation with bone mineral density in pre and post-menopausal women. The present study was a cross-sectional study. 40 women from each group i.e. premenopausal and postmenopausal women were selected for the study with no medical, surgical or gynaecological abnormalities. The Bone Mineral Density (BMD) was measured by Bone Densitometer and classified as normal, osteopenia and osteoporosis according to T-score. Serum minerals were measured in autoanalyser. The data was analyzed using Microsoft excel 2007. For the comparison of values between the groups, students ‘t’ test was used, for the correlation, Pearson’s correlation coefficient was used.

**Results:** Around 80% of the post-menopausal women are osteoporotic. BMD scores were significantly low in postmenopausal women according to T-score along with significantly decreased Serum mineral levels when compared to premenopausal women. There was significant positive correlation between T-score and serum calcium and magnesium levels in postmenopausal women.

**Conclusions:** Our study suggests that peri and postmenopausal women should take magnesium rich foods also like whole grains, legumes, fruits and vegetables (especially dark-green, leafy vegetables) every day which will help to provide recommended intakes of magnesium and maintain normal storage levels of this mineral. If these foods are not available or serum levels are too low supplementation can be given in the form of tablets.

**Keywords:** Postmenopausal women, Osteoporosis, Serum calcium, Serum magnesium, Bone mineral density

## INTRODUCTION

Menopause is defined as the permanent cessation of menses resulting from reduced ovarian hormone secretion

that occurs naturally or is induced by surgery, chemotherapy or radiation.<sup>1</sup> Due to menopause ovarian follicles loss its function, which results in decreased production of estradiol and other hormones. Decreased

levels of estrogen leads to increased osteoclast formation and enhanced bone resorption, which intern leads to loss of bone density and destruction of local architecture resulting in osteoporosis.<sup>2</sup>

Osteoporosis is commonly seen in postmenopausal women, resulting in fragile and weak bones highly susceptible to fractures of hips, spine and wrist. One in three women over age of 50 years will develop the disease during their lifetime. Loss of 20% bone mass in 5 to 7 years following menopause is seen. Osteoporosis is a silent disease, because bone loss occurs without symptoms.

Calcium has definite role in bone metabolism is particularly important in elderly women because low dietary intake have been associated with reduced bone mineral density.<sup>3,4</sup> Postmenopausal women need to obtain sufficient amounts of calcium to maintain bone health and suppress parathyroid hormone (PTH).<sup>5</sup>

Phosphorus and magnesium are among minerals that have been proposed as having an important role in bone metabolisms. Phosphorus, as phosphates combine with calcium ions to form hydroxyapatite, the major inorganic molecule in teeth and bones. Individuals with low calcium to phosphorus serum (Ca:P serum) ratio would benefit from increasing their calcium intake from foods or supplements.<sup>6</sup>

Magnesium (Mg) is an essential intracellular cation, a cofactor of many basic cellular processes, particularly those involving energy metabolisms.<sup>7</sup> Epidemiologic studies have demonstrated a positive correlation between dietary Mg intake and bone density and an increased rate of bone loss with low dietary intake suggesting that dietary Mg deficiency may be a risk factor for osteoporosis.

BMD: (Bone Mineral Density) detects osteoporosis before fracture occurs, predicts fracture chances in future, detects rate of bone loss, and monitors effect of treatment. A low bone density value in a very elderly woman is likely due to progressive bone loss over many years since menopause. In this process bone mass is reduced, and bone quality or architecture also deteriorates, adding further to skeletal fragility.<sup>8</sup>

Osteoporotic fractures can be prevented by improving calcium and magnesium nutrition, vitamin D intake, regular exercise; hormonal replacement therapy is very essential and should be started in time, calcitonin to prevent further fractures. In many studies calcium and magnesium supplementation increased the BMD and prevented osteoporotic fractures in postmenopausal women.

With this background the above study was conducted to evaluate the BMD and serum minerals (calcium, magnesium and phosphorus) in post-menopausal women

to compare them with the pre-menopausal women and also to study the correlation between bone mineral density and serum minerals in both the groups.

## METHODS

The present study is a case control study that was conducted in the department of Biochemistry and Radiology, Aarupadai Veedu Medical College and Hospital, Puducherry, India.

For our study, subjects were selected among the female patients attending the OPD of medicine and OG department and also the staff of A.V. Medical College & hospital between the age group of 25- 65 years.

Study subjects were divided into 2 groups. Group 1 were apparently normal postmenopausal women (within age group of 45-65 years). Group 2 were apparently normal premenopausal women (between the age group of 25-50 years). In this study, group 1 was considered as the main study group and they will be compared with group 2.

A detailed medical, obstetrical, menstrual, and drug history was recorded in a proforma designated for the study. Information on past fracture history, family history of fracture and osteoporosis, socioeconomic status, occupation, educational level, and weight-bearing exercises was collected and recorded.

Women with parathyroid disease, metabolic bone disease; malignancy, long term steroid medication, renal diseases, diabetes mellitus, hormone replacement therapy (HRT) and calcium were excluded from the study. The study was conducted from September 2014 to April 2015.

Both the groups were subjected to estimation of biochemical parameters. Blood samples were collected in Clot activator tubes for estimations of calcium and phosphorus after an overnight fast.

Calcium and phosphorus were estimated by using commercially available kits in Chem well auto-mated analyzer. Specific tests for serum Magnesium was done by collecting the blood in heparinized green capped plastic tube. Magnesium was estimated by a kit purchased from Reckon Diagnostics, India that uses Calmagite dye method.<sup>9</sup> The reference serum or plasma magnesium level by this method is 1.6-3 mg/dl. The principle of this method is that magnesium forms a purple coloured complex when treated with Calmagite dye in alkaline solution, chelating agent and detergent present in the reagent will help out interference occurring from Calcium and Proteins. The intensity of the purple colour is proportional to magnesium concentration.

Bone mineral density was determined at the lumbar spine (L2-L4) anteroposteriorly by using densitometry in radiology department. Results were expressed by T-score.

The criteria of the World Health Organization are:

- Normal is a T-score of -1.0 or higher
- Osteopenia is defined as between -1.0 and -2.5
- Osteoporosis is defined as -2.5 or lower.

**Statistical analysis**

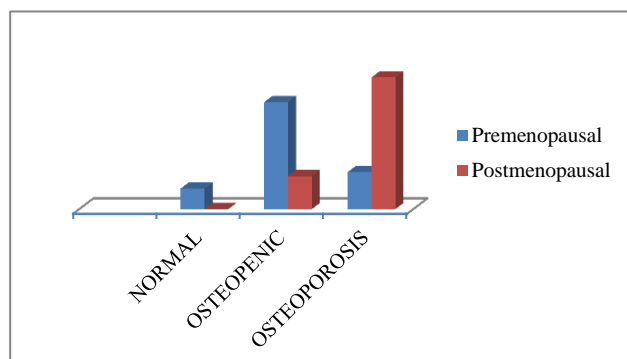
The data was analysed using Microsoft excel 2007. For the comparison of values between the groups, students ‘t’ test was used, represented by p value. Statistical significance was considered at p value <0.05. For the correlation, Pearson’s correlation coefficient was used. Column charts are used to compare values across categories. Scatter chart was used to compare pairs of values.

**RESULTS**

The age distributions of premenopausal women were between 25-45 years and postmenopausal women were between 50 to 65years. Out of 40 premenopausal women 5 were normal, 26 were osteopenic and 9 were osteoporotic. Out of 40 postmenopausal women no body was normal, 8 were osteopenic and 32 were osteoporotic (Table 1, Figure 1). It shows almost 80% of postmenopausal women are osteoporotic.

**Table 1: Distribution of pre & postmenopausal women according to T score.**

T score	Status	Premenopausal	Postmenopausal
>-1	Normal	5	0
-1 to -2.5	Osteopenic	26	8
<-2.5	Osteoporosis	9	32



**Figure 1: Comparison of pre & postmenopausal women in three groups.**

There is a significant difference in T score of both the groups (p<0.001). Minerals like calcium and magnesium are significantly lower in case of postmenopausal women (p<0.001) (Table 2).

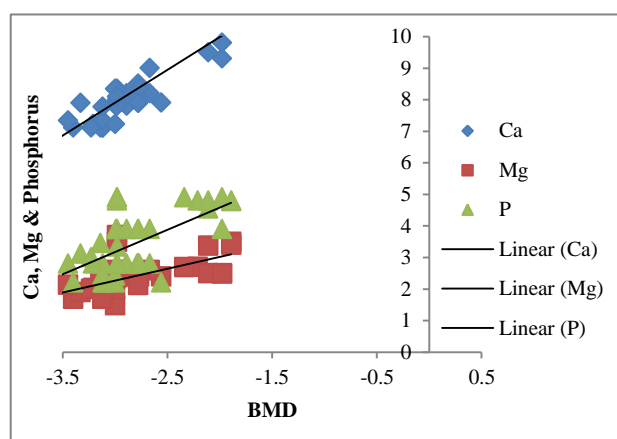
**Table 2: Comparison of different parameters in pre and postmenopausal women.**

Parameter	Premenopausal	Postmenopausal	p value
	Mean	Mean	
BMD	-1.91	-2.81	<0.001
Ca	9.49	8.28	<0.0001
Mg	2.80	2.4	<0.0001
P	3.45	3.43	>0.05

There was a significant positive correlation between the T score and Ca (r=0.86), Mg (r=0.61) and phosphorus (r=0.64) in post-menopausal women (Table 3, Figure 2).

**Table 3: Correlation of different minerals and BMD in postmenopausal women.**

Correlation of different minerals and BMD in postmenopausal women				
BMD				
BMD	1			
t				
p				
sig				Calcium
Calcium	0.868767	1		
t	10.81426			
p	<0.001			
sig	***			Mg
Mg	0.61785	0.553742	1	
t	4.843826	4.099365		
p	<0.001	<0.001		
sig	***	***		P
P	0.645672	0.689042	0.591367	1
t	5.212298	5.860928	4.520607	
p	<0.001	<0.001	<0.001	
sig	***	***	***	



**Figure 2: Correlation between serum Ca, Mg & P with BMD in postmenopausal women.**

There was a significant positive correlation between the T score and Ca (r=0.64), Mg (r=0.74) and phosphorus (r=0.55) in premenopausal women also (Table 4).

**Table 4: Correlation of different minerals and BMD in premenopausal women.**

Correlation of different minerals and BMD in premenopausal women.				
BMD				
BMD	1			
t				
p				
sig	Calcium			
Calcium	0.643109	1		
t	5.176969			
p	<0.001			
sig	***	Mg		
Mg	0.741873	0.493722	1	
t	6.820186 3.499812			
p	<0.001 <0.01			
sig	***	***	P	
P	0.547159	0.698611	0.493189	1
t	4.029625 6.018884 3.494821			
p	<0.001 <0.001 <0.001			
sig	***	***	***	

## DISCUSSION

The prevalence of osteoporosis increases with age and by World Health Organization (WHO) definition, up to 70% of women over the age 80 years have osteoporosis. Indians get sufficient sunlight throughout the year and vitamin D synthesis is also adequate. However recent modernization of India resulting in working indoor, and reduced physical activity have resulted in limited sun exposure and increased risk of osteoporosis.

This silently progressing metabolic bone disease is widely prevalent in India and osteoporotic fractures are a common cause of morbidity and mortality in adult Indian women. So it is of utmost importance that we take immediate steps to create awareness and treatment of this disease.

Osteoporosis is a condition that can be prevented and treated if diagnosed early and accurately. Unfortunately, it is often undiagnosed until a fracture occurs.

In our study an age-dependent decline in BMD was seen in women in both the groups and almost 80% of postmenopausal age group were found to have low BMD of osteoporotic range. This finding is similar to Seema et al.<sup>10</sup>

An inadequate intake of either calcium, vitamin D, or both will influence calcium-regulating hormones. A deficiency of either calcium or vitamin D will result in reduced calcium absorption and a lower concentration of circulating ionized calcium. When this occurs, parathyroid hormone (PTH) secretion is stimulated and there is a resulting increase in PTH levels. The

cumulative effect of higher PTH levels, secondary to poor calcium and vitamin D nutrition (secondary hyperparathyroidism), is an increase in bone remodelling leading to significant loss of bone and an increased fracture risk.

In this study serum Ca level is significantly lower ( $p < 0.001$ ) in postmenopausal women when compared to premenopausal women. Calcium level also had a positive correlation with T score in both the groups which explains role of calcium in osteoporosis.

Considerable epidemiologic data have been accumulated seeking to evaluate the relation between calcium intake and bone density. In postmenopausal women, reviews of over 20 studies have concluded that calcium supplementation can decrease bone loss by  $\approx 1\%$  per year.<sup>11</sup> Therefore, calcium supplementation has been shown to be effective in retarding bone loss in postmenopausal women. The beneficial effect of calcium intake on bone mass in postmenopausal women may be modified by factors including age, number of years since menopause, baseline calcium intake before supplementation, and possibly physical activity level. In addition, the effect of calcium may be greater at the sites with more cortical bone,<sup>12-13</sup> in elderly and late postmenopausal women, and in women with low baseline calcium intakes. In large enough doses calcium can reduce the higher PTH levels and lower the rate of bone remodeling.<sup>14</sup> Calcium supplementation appears to improve the efficacy of antiresorptive therapy, such as with Hormone Replacement Therapy (HRT), on bone mass.<sup>15</sup>

Phosphorus and magnesium are among minerals that have been proposed as having an important role in bone metabolisms. Phosphorus, as phosphates combine with calcium ions to form hydroxyapatite, the major inorganic molecule in teeth and bones.

Individuals with low calcium to phosphorus serum (Ca:P serum) ratio would benefit from increasing their calcium intake from foods or supplements.

In our study there was no significant difference of phosphorus level in pre and post-menopausal group ( $p > 0.05$ ) but there is a significant positive correlation between the T score and phosphorus level in both the groups. Many studies have shown that after giving calcium supplementation the level of phosphorus increases in post-menopausal women.<sup>6</sup>

Magnesium is the fourth most abundant mineral in the body. Approximately 50 per cent of it is present in our bones. Magnesium helps prevent osteopenia and osteoporosis in the following ways:<sup>7,16,17</sup>

- Magnesium helps control hundreds of enzymatic reactions in cells that influence bone density.

- Magnesium is required for the formation of proteins that help form bone.
- Magnesium serves as a calcium regulator. Magnesium is important in calcium metabolism because it is required for secretion of parathyroid hormone (PTH). PTH increases the production of the active form of vitamin D, and plays a role in the absorption of calcium and phosphorus (another important bone mineral).
- Magnesium deficiency alters calcium metabolism and the hormones that regulate calcium, so individuals with chronically low blood levels of calcium may actually be deficient in magnesium.<sup>17</sup>

In our study also serum Mg level is significantly lower ( $p < 0.001$ ) in postmenopausal women when compared to premenopausal women. Mg level also had a positive correlation with T score in both the groups which explains role of Magnesium in osteoporosis.

Researchers at Yale University School of Medicine, United States found that adolescent girls who were given magnesium supplements had significant increases in body mineral content in the hip bones and spine.<sup>18</sup>

Many studies have already proved that Mg supplementation is beneficial in osteoporotic women.<sup>19,20</sup>

## CONCLUSION

High calcium foods include dark leafy greens, cheese, low fat milk and yogurt, okra, broccoli, green beans, almonds, and fish canned with their bones. Peri and postmenopausal women should take these foods daily which maintains serum calcium level, and suppresses PTH secretion.

Our study suggests that peri and postmenopausal women should take magnesium rich foods also like whole grains, legumes, fruits and vegetables (especially dark-green, leafy vegetables) every day which will help to provide recommended intakes of magnesium and maintain normal storage levels of this mineral. If these foods are not available or serum levels are too low supplementation can be given in the form of tablets.

If women have been diagnosed with osteopenia and osteoporosis or are at risk to develop it, she should increase her intake of Magnesium. Magnesium is a balancing mineral for calcium and it is recommended that one should take both in the ratio of at least 1:1.

BMD & serum minerals (Calcium and magnesium) together can be taken as a useful marker to assess and treat osteoporosis and also to prevent complications in post-menopausal women.

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