A Study of Relationship of Bone Mineral Density with Age, Body Mass Index, Obesity and Serum Magnesium Level

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ABSTRACT

BACKGROUND

Menopause is defined as the permanent cessation of menstruation following loss of ovarian activity. One of the most important problems associated with menopause is osteoporosis. This study was conducted to evaluate the relationship between bone mineral density, body mass index, age, serum calcium, and serum magnesium in 120 women.

METHODS

Present study was an observational study done from Feb 2017 to July 2017 in Pt. J.N.M. Medical College to evaluate the relationship of bone mineral density with age, body mass index (BMI), obesity and serum magnesium in 120 postmenopausal women. A detailed medical, obstetrical, menstrual, and drug history was recorded in a proforma designed for the study. Past fracture history, family history of fracture and osteoporosis, socioeconomic status, occupation, educational level and weight-bearing exercises were collected and recorded.

RESULTS

Average age of women with normal bone health was 30.5 ± 0.58 years, while the age of osteopenic and osteoporotic women was 43.11 ± 6.79 years and 54.64 ± 11.92 years respectively. Most of the osteopenic women belonged to the age group of 40 – 49 years. Osteoporotic patients (78.57 %) had a high (> 0.85) waist-hip ratio, while women with normal bone mineral density had a normal waist-hip ratio. Most of the women with normal bone mineral density (100 %), osteopenia (85.29 %) and osteoporosis (57.14 %) had normal serum magnesium levels.

CONCLUSIONS

We found that the bone mineral density reduced with advancing age, decreasing BMI and obesity, while we found no correlation of serum magnesium level with bone mineral density (BMD).

KEY WORDS

Bone Mineral Density, Body Mass Index, Perimenopause, Magnesium, Calcium

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BACKGROUND

Menopause is defined as the permanent cessation of menstruation following loss of ovarian activity.¹ One of the most important problems associated with menopause is osteoporosis. Osteoporosis is the most common metabolic bone disease and it affects up to 40 % of postmenopausal women.² Peak bone mass is achieved in 3rd decade of life. Approximately, 50 % of bone loss occurs in 5 to 7 years of menopause,³ as due to menopause there is lack of oestrogen which leads to increase in osteoclastic activity of bone. A more recent definition from the National Institutes of Health (NIH) consensus development panel on osteoporosis defines osteoporosis as a skeletal disorder characterised by compromised bone strength predisposing a person to an increased risk of fracture.² Osteoporosis is caused by imbalance between bone formation and bone resorption. Bone mineral density is a quantitative measure of bone mass and represents the total mineral in a selected volume of bone in hip or in spine.⁴ Bone mineral density is considered to be the standard measure for diagnosis of osteoporosis and the assessment of fracture risk. Majority of fragility fractures occur in patients with bone mineral density in the osteopenic range. Study group meeting of World Health Organization (WHO) assessed fracture risk and applied it to screen postmenopausal osteoporosis, and recorded that more than 75 million people in US, Europe and Japan were suffering from osteoporosis in 2006. Osteoporosis is a multifactorial disease. Several studies have shown that in addition to risk factors such as aging, lack of physical activity, smoking, premature menopause, family history, poor diet and low intake of calcium and vitamin D, other factors including body weight and body mass index (BMI) are also important in the risk assessment tools, which contribute to osteoporosis and osteoporotic fracture risk.⁴ Low BMI and low weight are also associated with occurrence of osteoporosis. In several studies on different species, dietary magnesium (Mg) restriction promotes osteoporosis. Bones of Mg deficient animals are brittle and fragile.⁵ Micro fracture and trabeculae can be detected and mechanical properties are severely impaired. So, Mg deficient diet could be a factor which can lead to osteoporosis. Present observational study was conducted in obstetrics and gynaecology department of Pt. J.N.M. Medical College to see the correlation of bone mineral density with age, body mass index (BMI), obesity and serum magnesium.

Objectives

Find relationship between bone mineral density with body mass index, age and serum calcium and serum magnesium in 120 women.

METHODS

The present study was an observational study, which was conducted in the Department of Obstetrics and Gynaecology, Pt. J.N.M. Medical College and Hospital Raipur, India. The study was conducted among 120 postmenopausal women.

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.

BMI: Weight and height were measured through standard methods and BMI was calculated by dividing weight (kilogram) by height square (square meter).

Classified by Asian pacific classification-

Underweight - < 18.5 Kg / m²

Normal - 18.5 - 22.9 Kg / m²

Overweight - 23 - 24.9 Kg / m²

Class 1 obese - > 25 Kg / m²

Waist / hip ratio-waist circumference was taken by positioning the tape just above iliac crest parallel to the floor (in centimetre). Hip circumference was measured by widest part of hip (in centimetre). The ratio was calculated. Then classified as (WHO classification⁶)

< 0.80 - low risk

0.81 - 0.85 - moderate risk

> 0.85 - high risk

The bone mineral density was measured by bone densitometer and classified as normal, osteopenia and osteoporosis according to T-score. Based on WHO classification⁴, individuals with T-score values higher than - 1 were classified as normal -

- Those with T-score between - 1 and - 2.5 as osteopenic
- Those with T-score less than - 2.5 as osteoporotic.

Serum mineral was measured in auto-analyser. Blood samples were collected in tubes for estimations of calcium and magnesium after an overnight fast. Calcium and magnesium were estimated by using commercially available kits in ChemWell automated analyser. All post-menopausal women were included in the study.

Exclusion Criteria

Post-menopausal women with secondary causes of decreased BMD or any other chronic illnesses such as hyperthyroidism, diabetes mellitus, renal or liver disease, rheumatoid arthritis or a history of treatment with levothyroxine, furosemide, heparin, phenytoin, phenobarbital, vitamin K, ranitidine, corticosteroids, alcohol consumption, those having history of fractures, bone deformity and surgical operations were not included in the study.

Statistical Analysis

Data was entered to Microsoft Access Databank, and analysed using Statistical Package for the Social Sciences (SPSS) 13.0 for Windows (SPSS, Chicago, IL) based on a Pair-wise approach. P-values lower than 0.01 were considered statistically significant. Categorical variables were expressed as percentages and compared using chi-square. Differences among means were investigated by analysis of variance (ANOVA) with post-hoc test.

RESULTS

Table 1 shows that the average age of women with normal bone health was 30.5 ± 0.58 years, while the age of osteopenic

and osteoporotic women was 43.11 ± 6.79 years and 54.64 ± 11.92 years respectively. This showed that there was statistically significant (P -value < 0.0001) correlation of age with bone mineral density. Table 1 also shows that average BMI of osteoporotic group was 16.32 ± 2.08 while BMI of women with normal bone health was 20.98 ± 2.47 which showed statistically significant (P -value < 0.0001) correlation of low BMI with low BMD.

Average age of women with normal bone health was 30.5 ± 0.58 years, while the age of osteopenic and osteoporotic women was 43.11 ± 6.79 years and 54.64 ± 11.92 years respectively. There was statistically significant (P -value < 0.0001) correlation of increasing age with bone mineral density. There was no statistical difference in value of calcium level (mg / dl) in blood of normal, osteopenic and osteoporotic group of women.

	Normal Bone Health (N = 4)	Osteopenia Group (N = 102)	Osteoporosis Group (N = 14)	F Value	P-Value
Age (year)	$30.5 \pm .58$	43.11 ± 6.79	54.64 ± 11.92	21.55	$< .0001$
BMI (kg / m ²)	20.98 ± 2.47	23.42 ± 10.93	16.32 ± 2.08	20.45	$< .0001$
Ca (mg / dl)	$9.9 \pm .23$	9.60 ± 1.35	$10.04 \pm .13$	.82	.44
Mg (mg / dl)	$2.1 \pm .11$	$2.05 \pm .21$	$2.25 \pm .11$	6.15	$< .05$

Table 1. Baseline Characteristics in Women with Osteoporosis and Osteopenia

Values are calculated through Analysis of variance with post hoc test

Variable	Normal (N = 4)	Osteopenia (N = 102)	Osteoporotic (N = 14)
Age			
30 - 39 (N = 35)	4 (100 %) (3.33 %)	31 (30.39 %) (88.57 %)	0
40 - 49 (N = 55)	0	51 (50 %) (92.72 %)	4 (28.57 %) (7.27 %)
50 - 59 (N = 24)	0	19 (18.62 %) (79.16 %)	5 (35.71 %) (20.83 %)
> 60 (N = 6)	0	1 (0.98 %) (16.66 %)	5 (35.71 %) (83.33 %)

Table 2. Correlation of Age with Bone Mineral Density

$\chi^2 = 46.682$ degree of freedom = 6, P -value $< .05$

Table 2 shows that all the patients with normal bone mineral density belonged to the age group of 30 - 39 years. Most of the osteopenic women belonged to the age group of 40 - 49 years and all the osteoporotic women's age was more than 40 years.

Variable	Normal (N = 4)	Osteopenia (N = 102)	Osteoporotic (N = 14)
Waist / hip ratio			
< .80 (low risk) (N = 53)	2 (50 %) (3.77 %)	49 (48.03 %) (92.45 %)	2 (14.28 %) (3.77 %)
.81 - .85 (moderate risk) (N = 32)	2 (50 %) (6.25 %)	29 (28.43 %) (90.62 %)	1 (7.14 %) (3.12 %)
> .85 (high risk) (N = 35)		24 (23.52 %) (68.57 %)	11 (78.57 %) (31.42 %)

Table 3. Correlation of Waist Hip Ratio with BMD

$\chi^2 = 20.13$ degree of freedom = 4, P -value = $< .05$

Table 3 shows that 78.57 % of osteoporotic women had waist hip ratio of $> .85$, while women with normal bone health had waist hip ratio $< .85$, which showed statistically significant correlation of high waist hip ratio with low bone mineral density.

Table 4 shows that 85.71 % of the osteoporotic women were underweight (BMI < 18.5), while women with normal bone mineral density had a normal BMI. 48.03 % of the osteopenic women had normal BMI, 10.78 % were

underweight, 35.29 % were overweight and 5.88 % were class I obese.

BMI	Normal (N = 4)	Osteopenia (N = 102)	Osteoporosis (N = 14)	Total (120)
Underweight (< 18.525 kg / m ²)	0	11 (10.78 %) (47.82 %)	12 (85.71 %) (52.17 %)	23 (19.67 %)
Normal (18.5 - 22.925 kg / m ²)	4 (100 %) (7.27 %)	49 (48.03 %) (89.09 %)	2 (14.28 %) (3.63 %)	55 (45.83 %)
Overweight (23 - 24.925 kg / m ²)	0	36 (35.29 %) (100 %)	0	36 (30 %)
Class I obese (> 25 kg / m ²)	0	6 (5.88 %)	0	6 (5 %)

Table 4. Correlation of BMI with BMD

$\chi^2 = 49.975$, degree of freedom = 6, χ^2 / degree of freedom = 8.33, P ($\chi^2 > 49.975$) = < 0.05

Serum Magnesium Level	Normal (N = 4)	Osteopenia (N = 102)	Osteoporotic (N = 14)
< 1.7 (N = 1)	0	1 (0.98 %) (100 %)	0
1.7 - 2.2 (N = 99)	4 (100 %) (4.04 %)	87 (85.29 %) (87.87 %)	8 (57.14 %) (8.08 %)
> 2.2 (N = 20)	0	14 (13.72 %) (70 %)	6 (42.85 %) (30 %)

Table 5. Correlation of Serum Magnesium Level with BMD

$\chi^2 = 8.471$, degree of freedom = 4, $P = 0.07$

Table 5 shows that most of the women with normal bone mineral density (100 %), osteopenia (85.29 %) and osteoporosis (57.14 %) had normal serum magnesium level.

DISCUSSION

Osteoporosis is a public health problem worldwide and is a common disease in the older population, especially in postmenopausal women. In this study, prevalence of osteopenia (85 %) and osteoporosis (11.67 %) was very high, may be due to most women belonging to lower socioeconomic status with nutritional deficiency and lack of awareness. A number of studies have been conducted in countries of the Middle East; the prevalence of osteoporosis was estimated to be ranging from 13 - 31 % in women. Several studies have shown that in addition to risk factors such as aging, lack of physical activity, smoking, premature menopause, family history, poor diet and low intake of calcium and vitamin D, other factors like BMI and weight are also important risk assessment tools, which contribute to osteoporosis and osteoporotic fracture risk.⁴ Calcium and vitamin D has definite role in bone formation while other nutrient like magnesium might have some role in bone metabolism. Mg and Ca are closely related due to the presence of approximately 50 - 60 % of total Mg in the bones along with calcium phosphate. Mg is an important ion due to its catalytic activity in the various metabolic process. So, evaluation of Mg might be helpful in bone homeostasis, especially in post-menopausal women with osteopenia and osteoporosis.

Some studies showed that BMD reduce with advancing age as shown in this study.^{7,8,9} In our study we found about 70 % of osteoporotic women were over the age of 50 year. 83.33 % of osteoporotic women belonged to the age group of more than 60 year, while small number of women who had normal BMD belonged to < 40 year of age group. (P -value < 0.05). With advancing age, bone resorption is faster than the new bone

formation, calcium absorption decreased with age. 88.57 % women with age group of 30 - 39 year are osteopenic. It may be due to high incidence of osteopenia in this area or due to lack of nutrition. None of the women were with normal BMD after 40 years of age. In females after menopause, prevalence of osteoporosis increases due to lack of oestrogen which increases osteoclastic activity and also decreases receptor of vitamin D in osteoblast which lead to osteoporosis.⁵ In these studies 100 % women with normal BMD belonged to premenopausal age group, while 92.85 % women with osteoporosis belonged to postmenopausal age group. Although 92.30 % women of premenopausal age group were osteopenic, it may be due to high prevalence of osteopenia, while in postmenopausal women, 76.36 % women were osteopenic and 23.63 % women were osteoporotic. In this study, 85.71 % osteoporotic women were underweight, while 100 % women with normal BMI belonged to normal BMD. 89.09 % women with normal BMI fell in osteopenic group (P-value < 0.05), as prevalence of osteopenia was high in this study. In this study, low BMI correlated with low BMD, which was consistent with other study.^{7,10,9} In other¹¹ they found no correlation with BMI with BMD. Another study showed that overweight men were associated with low BMD,¹² while other study reported that higher weight was associated with higher BMD.^{10,13} To reduce the risk of osteoporosis people were advised to maintain normal weight. Obesity is thought to be advantageous to maintain healthy bone but some studies showed that greater accumulation of body fat was associated with increased risk of low BMD, similar result was found in this study also. 78.57 % osteoporotic women belonged to high risk group for waist hip ratio of 0.47. Excessive body fat principally abdominal fat produces inflammatory cytokines which stimulate bone resorption and reduce bone strength. In osteoporotic and osteopenic group, we didn't find any correlation of BMD with decreased serum Mg level while other studies showed lower serum concentration of Mg in osteopenic and osteoporotic group.¹³ Another study of elderly Chinese women, Wang et al. observed a higher concentration of Mg in women with osteoporosis and osteopenia compared to normal women and inverse relation between serum Mg and serum Ca was observed.¹⁴

CONCLUSIONS

BMD has direct relationship with BMI and age. Maintenance of normal weight, exercise and lifestyle modification can prevent bone loss.

Data sharing statement provided by the authors is available with the full text of this article at jemds.com.

Financial or other competing interests: None.

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