

doi: <http://dx.doi.org/10.18203/2319-2003.ijbcp20150874>**Research Article****Screening of bone mineral density by densitometer and correlation with serum calcium and vitamin D levels to detect early osteoporotic changes in postmenopausal women in slum areas of Raipur and Kalupur of Ahmedabad****Adarshjit Singh^{1*}, Harpreet Singh², Safal Patel³**

¹Department of Pharmacology, AMC MET Medical College, Ahmedabad, Gujarat, India,
²Department of Radiology,
³Intern, Surat Municipal Institute of Medical Education and Research, Gujarat, India

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***Correspondence to:**
 Adarshjit Singh,
 Email: adarshjit@yahoo.com

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ABSTRACT

Background: Osteoporosis is a rising health difficulty, which is renowned in both developed and developing countries. It is linked with considerable morbidity and socio-economic burden worldwide. Various factors are responsible for osteoporosis such as race, family history, body weight, estrogen deficiency (menopause), low calcium intake, and many others. The present study was aimed to early prediction and evaluates the prevalence of osteoporosis in postmenopausal women of slum area of Ahmedabad (Raipur and Kalupur).

Methods: The prospective, single-center study included 230 postmenopausal women. Baseline demographic characteristics were recorded using standard pre-designed case record form. Eligible patients according to inclusion and exclusion criteria were underwent for dual-energy X-ray absorptiometry (DEXA) scan to measure bone mass density at the lumbar spine, femoral neck, and hip bone. Laboratory investigations such as serum calcium and serum vitamin D were performed according to standard procedure. Prediction for early detection of osteopenia and osteoporosis was evaluated based on T-score (DEXA scan).

Results: The overall prevalence of osteopenia and osteoporosis were found 28.69% and 44.34%, respectively. Prevalence of osteoporosis was found higher (50.72%) in study population belongs to age between 51 and 60 years, whereas the prevalence of osteopenia was higher (38.53%) in age group (41-50). In further, normal body mass index was associated with the higher prevalence of osteopenia and osteoporosis. The calcium deficiency, vitamin D deficiency, family history of osteoporosis were found major risk factor associated with osteopenia and osteoporosis ($p < 0.05$). T-score was much lower at femoral neck site (-3.29 ± 0.47) and lumbar spine site (-3.15 ± 0.50) when compared with hip bone (-2.40 ± 0.68).

Conclusions: The present study found moderately higher prevalence of osteopenia and osteoporosis among the postmenopausal women from slum area of Ahmedabad. Results revealed that the early measurement of bone mineral density will not only help for early detection, but it will also help for the prevention of osteoporosis.

Keywords: Bone mass density, Dual-energy X-ray absorptiometry scan, Osteoporosis, Postmenopausal women

INTRODUCTION

Osteoporosis is skeletal disease characterized by decreased bone strength and increasing the risk of fractures.¹ Osteoporosis is silent disorder similar to hypertension and dyslipidaemia.¹ Various factors are responsible for osteoporosis such as race, family history, body weight, estrogen deficiency (menopause), low calcium intake, and others.² Amongst these all risk factors, the estrogen deficiency is the most common factor associated

with postmenopausal osteoporosis.² This estrogen deficiency is mediated by higher level of cytokines such as interleukin 1 (IL 1), IL 6 and tumor necrosis factor α .³ Previously, many studies reported bone loss in Indian postmenopausal women is due to estrogen deficiency.⁴ In South India, approximately 30% women had post-menopause as a risk factor for developing osteoporosis.⁵ International osteoporosis foundation reported that 1.7 million people globally suffered from osteoporosis hip fractures. The number might increase

to 6.3 million by 2050. In India, accurate prevalence data of postmenopausal osteoporosis are not available. However, physicians routinely seen the patients suffering from bone fractures and other complications due to the postmenopausal osteoporosis. World Bank reported that India will be second highest in the world after China in terms of postmenopausal osteoporosis cases.⁴ Vitamin D deficiency is very common in India at all the age groups and both sexes across the country. Vitamin D deficiency and low calcium intake are important risk factors for osteoporosis. Vitamin D deficiency causes low bone mass, muscle weakness which is increasing the risk of fracture.⁶ Harinarayan have studied level of 25(OH)-D and bone mass density (BMD) in women of reproductive (WR) age group and postmenopausal women (PMW) in South India.⁷ Study reported that Vitamin D deficiency was found in 76% in WR, 70% in PMW, insufficiency in 16.5% in WR, and 23% in PMW.⁷

Measurement of bone mineral density is the most important test to diagnose osteoporosis. The standard test for assessing BMD is the dual-energy X-ray absorptiometry (DEXA) densitometer. It is a specialized X-ray device that accurately measures BMD at the spine, femur, and other skeletal sites. DEXA scans are convenient to patients with low exposure to radiation and 10 mins for the whole test.⁸ Rapid bone loss occurs in the early postmenopausal years.⁸ Hence, postmenopausal osteoporosis can be prevented and treated very well if diagnosed early and accurately. Hence, epidemiological surveys are useful tools to predict and evaluate the prevalence of postmenopausal osteoporosis and related risk factors in communities. Therefore, this study was aimed to evaluate the prevalence and related risk factors for postmenopausal osteoporosis by measuring bone mineral density (DEXA scan).

METHODS

Patient population

About 230 postmenopausal women of slum area of Ahmedabad (Raipur and Kalupur), Gujarat were enrolled from June-2012 to December-2013. Inclusion and exclusion criteria are mentioned in Table 1.

Ethics Committee (EC) approval

EC approval was obtained prior to start any study related analysis. All activities were performed in accordance with the ethical standards laid down in the 1964 Declaration of Helsinki and its later amendments as well as in accordance with Indian guidelines, schedule Y, good clinical practices and other applicable regulatory guidelines.

Study design and study procedures

This was a prospective, single-center, investigator-initiated study. All patients gave their written consent before enrolling into the study. Identity of the patients was kept confidential.

Table 1: Inclusion and exclusion criteria.

Inclusion criteria	Exclusion criteria
Willing to give written informed consent and to follow study procedures	History of any malignancy/ radiotherapy
Between >18 years of age	History of iatrogenic menopause
Patients with postmenopausal women	History of any vertebral deformities at L1-L4 interfering with the measurement of BMD with DEXA
	In the opinion of the investigator, patient is unable to cooperate with any study procedures and clinically unfit

DEXA: Dual energy X-ray absorptiometry, BMD: Bone mass density

Baseline parameters such as age, weight, body mass index (BMI), serum calcium, serum vitamin D, exercise, type of lifestyle, diet, smoking, family history of osteoporosis, and thyroid disorder history were recorded in standard pre-designed case record form. Eligible patients according to inclusion and exclusion criteria were underwent for DEXA scan to measure BMD at the lumbar spine, femoral neck, and hip bone. DEXA Scans were performed at Green Cross Health Checkup Center at Paldi, Ahmedabad. Laboratory investigations such as serum calcium and serum vitamin D were performed according to standard procedure at Green Cross Pathology Laboratory, Paldi, Ahmedabad. Age and BMI wise correlation with BMD was performed. Further, risk factors such as deficiency of calcium, low level of vitamin D, family history of osteoporosis, and thyroid disease history were correlated with bone mineral density. Additional necessary investigations were done as per investigator discretion.

Data analysis

Statistical analysis was performed by applying Chi-square test. Statistical analysis was performed using Graph Pad prism version 5.0. Chi-square analysis was performed to test for differences in proportions of categorical variables between two or more groups and $p < 0.05$ was considered as a test of significance.

RESULTS

Baseline characteristics

The demographic characteristics of study participants are summarized in Table 2. Present study included 230 postmenopausal women. Majority of the study population (47.39%) belong to age group of 41-50 years. Further, higher percentages of study population were suffering from

Table 2: Demographic characteristics of study participants (n=230).

Parameters	n (%)
Age (years)	
31-40	18 (7.83)
41-50	109 (47.39)
51-60	69 (30)
61-70	20 (8.7)
>70	14 (6.09)
BMI (kg/m ²)	
Underweight (<18.5)	0 (0.0)
Normal (18.5-24.9)	94 (40.86)
Overweight (25.0-29.9)	75 (32.60)
Obese (≥30)	61 (26.52)
Vitamin D level (ng/ml)	
Normal	35 (15.21)
Deficient (<20 ng/ml)	195 (84.78)
Calcium level (mg/dL)	
Normal (8.5-9.7 mg/dL))	38 (16.52)
Deficiency (<8.5 mg/dL)	192 (83.47)
Exercise (at least 30 mins/day)	
Yes	173 (75.21)
No	57 (24.78)
Diet	
Vegetarian	145 (63.04)
Non-vegetarian	34 (14.78)
Mixed diet	51 (22.17)
Family history of osteoporosis	
Yes	137 (59.56)
No	93 (40.43)
Smoking habit	
Yes	12 (5.12)
No	218 (94.78)
Thyroid disorder	
Yes	62 (26.95)
No	168 (73.04)

BMI: Body mass index

deficiency of calcium (83.47%) and vitamin D (84.78%). However, 40.86% women showed normal BMI. Most of the postmenopausal women (59.56%) had family history of osteoporosis. However, only 26.95% percentage women had positive thyroid disease history.

Evaluation of prevalence

Age-specific

Age specific prevalence of osteopenia and osteoporosis at different sites (femoral and/or spine and/or hip) in postmenopausal women is shown in Table 3. Overall

prevalence of osteopenia and osteoporosis among postmenopausal women were found 28.69% and 44.34%, respectively. Prevalence of osteoporosis was found higher (50.72%) in study population belongs to age between 51 and 60 years whereas the prevalence of osteopenia was higher (38.53%) in age group (41-50). Further, 46.78% and 42.85% women had osteoporosis in 41-50 and 61-70 years age group whereas approximately similar prevalence was found in age group 51-60 years and more than 70 years in osteopenia group (21.73% and 21.42%, respectively).

BMI-specific

The correlation of BMI with osteopenia and osteoporosis in postmenopausal women is shown in Figure 1. Prevalence of osteopenia and osteoporosis was noted higher with normal BMI (43.61% and 48.935) and then followed by overweight (37.33% and 40%) and obese (34.42% and 37.70%) postmenopausal women. The reverse trend was observed in postmenopausal women with normal T-score.

Correlation of BMD with serum calcium level and serum vitamin D level

The association of BMD with serum calcium and serum vitamin D among postmenopausal women was shown in Table 4. Around 59 (89.40%) women shows serum calcium levels <8.5 mg/dl with $-1 < \text{BMD} < -2.5$ whereas 91 (89.21%) women had serum calcium levels <8.5 mg/dl with $\text{BMD} \geq -2.5$. Similar trend was also observed in women with serum vitamin D levels <20 ng/ml. The association of serum calcium and serum vitamin D with BMD was statistically significant ($p < 0.001$).

Correlation of BMD with family history of osteoporosis and history of thyroid disease

As shown in Table 5, positive family history of osteoporosis was observed significantly higher in postmenopausal women with osteopenia and osteoporosis compared to normal postmenopausal women. In osteopenic and osteoporotic women, lower percentage of thyroid disease history was found when compared with women with absence of thyroid disease history. However, both values were found statistically significant.

Mean T-score

As shown in Figure 2, T-score was much lower at femoral neck site (-3.29 ± 0.47) and lumbar spine site (-3.15 ± 0.50) when compared with hip bone (-2.40 ± 0.68).

DISCUSSION

Osteoporosis is a bone disease distinguished by reduced bone mineral density and worsening of bone structure

Table 3: Age specific prevalence of osteopenia and osteoporosis (femoral and/or spine and/or hip) in postmenopausal women (n=230).

Age	Total population	Normal (T-score ≥ -1 or higher)	Osteopenia (T-score -1 to -2.5)	Osteoporosis (T-score ≤ -2.5 or less)	p-value
31-40	18 (7.83)	13 (72.22)	3 (16.66)	2 (11.11)	0.0001
41-50	109 (47.39)	16 (14.68)	42 (38.53)	51 (46.78)	
51-60	69 (30)	19 (27.54)	15 (21.73)	35 (50.72)	
61-70	20 (8.7)	9 (45)	3 (15)	8 (40)	
>70	14 (6.09)	5 (35.71)	3 (21.42)	6 (42.85)	
Total	230 (100)	62 (26.95)	66 (28.69)	102 (44.34)	

BMD: Bone mass density

Table 4: Correlation of BMD with serum calcium level and serum vitamin D level.

Parameters	Yes/no	Normal (T-score ≥ -1 or higher) (n=62)	Osteopenia (T-score -1 to -2.5) (n=66)	Osteoporosis (T-score ≤ -2.5 or less) (n=102)	p-value
Ca ²⁺ deficiency	Yes	42 (67.75)	59 (89.40)	91 (89.21)	0.0004
	No	20 (32.25)	7 (10.60)	11 (10.78)	
Vitamin D deficiency	Yes	47 (75.80)	53 (80.30)	95 (93.13)	0.005
	No	15 (24.19)	13 (19.69)	7 (6.86)	

BMD: Bone mass density

Table 5: Correlation of BMD with family history of osteoporosis and history of thyroid disease.

Parameters	Yes/no	Normal (T-score ≥ -1 or higher) (n=62)	Osteopenia (T-score -1 to -2.5) (n=66)	Osteoporosis (T-score ≤ -2.5 or less) (n=102)	p-value
Family history of osteoporosis	Yes	29 (46.77)	39 (59.09)	69 (67.64)	0.03
	No	33 (53.22)	27 (40.9)	33 (32.35)	
Thyroid disorder	Yes	8 (12.9)	21 (31.81)	33 (32.35)	0.01
	No	54 (87.1)	45 (68.18)	69 (67.64)	

BMD: Bone mass density

which results into fractures.⁹ Osteoporosis become commonest problem of postmenopausal women globally.¹⁰ It has been reported that osteoporosis increases risk of hip fractures approximately 6 times till 2050.¹⁰ The present was conducted to predict prevalence of osteoporosis and osteopenia in postmenopausal women along with association of risk factors associated with osteoporosis and osteopenia. The results of the current study state that postmenopausal women were highly prone to femoral neck and lumbar spine fracture when compared with hip bone. Previously, none of study reported prognosis of osteoporosis with respect to different sites.

In United States of America, 55% postmenopausal women had osteoporosis aged 50 and above.¹¹ Previous study reported that peak incidence of osteoporosis occurs at 70-80 years of age in the Western countries.¹² Garg et al. reported that 58.6% and 24.1% women had osteopenia and osteoporosis, respectively aged more than 50 years.¹³ In contrast, our study showed 21.73% of osteopenia and

50.72% of osteoporosis in the age group 51-60 years. Further, 38.53% of osteopenia and 46.78% osteopenia were observed in the age group of 41-50 years. These results indicate peak incidence of postmenopausal osteoporosis is earlier when compared with western data. This can be managed by early detection and timely treatment of osteoporosis. Previously many studies reported the same results as our study.^{12,13}

Previously, few studies reported positive correlation between BMD and BMI, stating that increases BMD with increasing BMI.^{14,15} However, Kataria et al., reported no correlation between BMD and BMI.¹⁶ Further, one Indian study reported negative correlation between BMD and BMI.¹⁷ Similar results were also obtained in our study, stating decreases T-score with increasing BMI. Hence, overweight may protect postmenopausal women against bone loss. This caring effect may be due to mechanical support and higher estrogen synthesis in adipose tissue. Thus, BMI has an effect on BMD and BMI can prevent bone loss by increasing the BMD.¹⁷

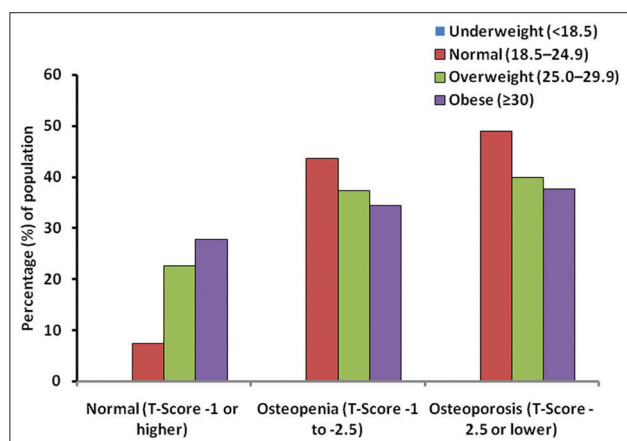


Figure 1: Correlation of T-score with body mass index (kg/m²) in postmenopausal women with osteopenia and osteoporosis. (Normal: n=62; osteopenia: n=66; osteoporosis: n=102).

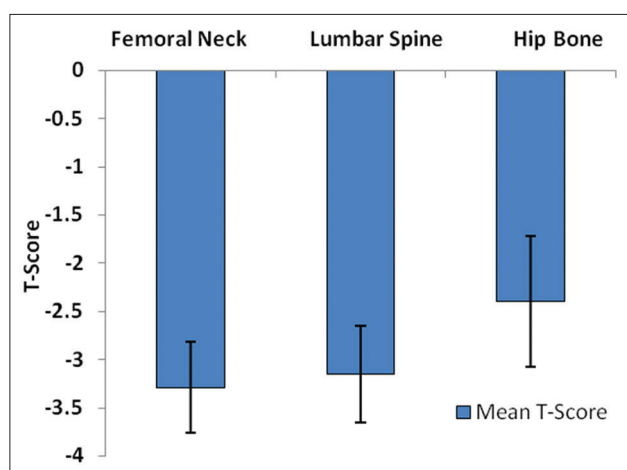


Figure 2: Mean T-score at femoral neck, lumbar spine, and hip bone.

Calcium is vital component of the bones. Loss of calcium ions is due to estrogen deficiency after menopause. This effect is mediated by indirect effects on extra skeletal calcium homeostasis as well as reduction in intestinal calcium absorption. Disturbances in the absorption of calcium ion results into hormonal imbalance and causes bone disorders such as osteopenia and osteoporosis.^{18,19} Previously conducted study in Western India stated that BMD decreases significantly with decreasing level of serum calcium.²⁰ Our study results also reported the similar results for relationship between serum calcium level and BMD. Vitamin D is fundamental vitamin to maintain calcium level in bone by increasing calcium absorption in the intestines, stimulating bone resorption by increasing number of osteoclast, and maintain level of parathyroid hormone to stabilize serum calcium levels.²¹ Previously, many studies reported strong correlation between vitamin D deficiency and lower value of BMD.²¹⁻²³ In the present study, author also obtained similar results for correlation between vitamin D level and BMD.

Family history is an important criterion to evaluate the risk of osteoporosis in women. Numerous is reported that risk of osteoporotic fracture was higher in women with parental or maternal family history of fracture. Family history of osteopenia, osteoporosis, and osteoporotic fracture has been recommended as a contrivance to empower people to accept preventive strategy to reduce the risk of osteoporosis in women with/without postmenopausal and premenopausal women. Previously, many studies were reported with higher prevalence of family history as an independent risk factor for osteoporosis among women with/without postmenopausal and premenopausal women. In our study, we also observed the family history as an independent risk factor associated with osteoporosis.²⁴ In earlier published literature, few studies reported no association between subclinical hypothyroidism or subclinical hyperthyroidism and hip fracture risk or BMD in older women.²⁵ However, one study reported positive correlation in women having subclinical hyperthyroidism and women with subclinical hypothyroidism have reduced femoral neck BMD.²⁶ In our study, negative correlation was obtained between thyroid disease history and BMD. Additional studies are required to elucidate the mechanism for this finding.

Concluding above points, the present study predicted that higher prevalence of osteoporosis and osteopenia at an earlier age group. Positive correlation was found between osteopenia/osteoporosis and risk factors such as serum calcium deficiency, vitamin D deficiency and family history of osteoporosis. However, negative association was observed in relationship between BMI and thyroid disease history with respect to osteopenia and osteoporosis.

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Conflict of interest: None declared

Ethical approval: The study was approved by the Institutional Ethics Committee

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