

## ORIGINAL RESEARCH

### UTILITY OF DEXA SCANS AS A DIAGNOSTIC TOOL DETECTING OSTEOPOROSIS RISK IN PERI AND POSTMENOPAUSAL WOMEN

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#### ABSTRACT

**Background:** Multifactorial etiology of osteoporosis is underestimated including genetic predisposition, lifestyle and dietary modification, and pharmacological treatments. It is also vital to identify and eliminate the risk factors associated with osteoporosis owing to increased incidence in Indian perimenopausal and postmenopausal females.

**Aim:** The present study aimed to assess the risk factors for osteoporosis in peri and postmenopausal females of India.

**Methods:** The present study assessed 540 females in the age of perimenopausal and postmenopause reporting to the Department of Obstetrics and Gynecology of the Institute. In all the females, serum calcium levels were assessed along with bone mineral density using DEXA (dual-energy X-ray absorptiometry) scanning in the lumbar spine and hip. The collected data were subjected to statistical assessment.

**Results:** The study results showed a significant association between lower serum calcium levels and osteoporosis with  $p < 0.0001$ . For calcium  $> 8.5\%$ , normal BMD was noted compared to the high incidence of osteopenia and osteoporosis in serum calcium  $< 8.5\%$  with  $p < 0.0001$ . Concerning medical disorders, a significant association was seen in BMD and chronic renal diseases, diabetes mellitus, and hypertension with  $p = 0.04$ ,  $< 0.001$ , and  $< 0.001$  respectively. Also, exercise, and smoking had a significant association with BMD with  $p < 0.0001$  and  $0.0002$ .

**Conclusions:** The present study concludes that the DEXA standard has high efficacy in assessing bone mineral density and is highly productive in diagnosing osteoporosis in both appendicular and axial skeletons. The prevalence of osteopenia and osteoporosis is higher in perimenopausal and postmenopausal females. However, the risk of osteopenia is higher in perimenopausal females. Overweight and obesity are preventive factors

**Keywords:** BMD, DEXA scan, osteopenia, postmenopausal, osteoporosis

## INTRODUCTION

Osteoporosis has a high prevalence globally including in India. A high prevalence of osteoporosis is seen in perimenopausal and postmenopausal females with an incidence rate of 30%. However, the incidence is further increased to 70% in females aged more than 80 years. It has been suspected that osteoporosis incidence will be doubled in coming decades with an increase in the risk of hip fractures including an increase in mortality. Whites and Asians are commonly affected by osteoporosis compared to blacks who have higher bone density and low risk.<sup>1</sup>

In the Indian context, concern has grown for osteoporosis in the healthcare sector which is increased further by inadequate calcium and vitamin D intake and with an increase in age. It has been considered that in coming years, India will become the second highest population comprising of postmenopausal women only after China with approximately 60 million females having osteoporosis. Literature data suggest that deficiency of estrogen following menopause is the main reason for bone loss in females with nearly 30% of females from South India at risk. In India, the main risk factor is a deficiency of vitamin D and low intake of calcium leading to low bone mineral density in comparison to females from developed nations.<sup>2</sup>

Risk factors associated with osteoporosis include age more than 65 years, prior fragility to fractures, family history, prolonged glucocorticoid use, malabsorption syndrome, lifestyle factors including smoking, excessive alcohol intake, and other factors. Other risk factors posing significant contribution to osteoporosis are endocrine disorders, vitamin deficiencies, gastrointestinal disturbances, and certain medications.<sup>3</sup>

Methods used for diagnosis of osteoporosis include tests that measure bone mineral density including DEXA (Dual Energy X-ray Absorptiometry) scan, SEXA (Single Energy X-ray Absorptiometry), and QUS (quantitative ultrasound) where DEXA scan is the most commonly used method for diagnosis which depicts Z-scores and T-scores where Z-scores compare BMD to age-matched peers and T-scores compare BMD to young adults. DEXA scan at the hip or spine is a preferred diagnostic method for osteoporosis and also assesses the fracture risk.<sup>4</sup>

Considering the high susceptibility of osteoporosis and osteopenia in females of peri and postmenopausal age, early screening is vital in females of this age group. Measurement of bone mineral density (BMD) is the most effective tool for diagnosis of osteoporosis where DEXA scan is the gold standard for assessing osteopenia and osteoporosis. DEXA scan has the benefit of being done in 10 minutes for completion, is patient-friendly, and involves low radiation exposure.

Increased and rapid bone loss in early menopause underestimates the vital role of early and accurate diagnosis in the effective prevention and management of osteoporosis.<sup>5</sup>

The present literature data also underrate the multifactorial nature of osteoporosis including pharmacological treatment, diet and lifestyle modification, and genetic predisposition. Effective management and preventive strategies should evaluate the multifactorial nature and must focus on the vital role of calcium and vitamin D intake, regular physical activity, and fall preventive measures. Identification and elimination of the risk factors including family history, low BMI (body mass index), and sociodemographic challenges are vital for adequate care for osteoporosis.<sup>6</sup>

The present study aimed to assess the risk factors for osteoporosis in peri and postmenopausal females of India using DEXA scan which can further help in early diagnosis and management of osteoporosis in peri and postmenopausal females.

## **MATERIALS AND METHODS**

The present prospective observational study was aimed to assess the prevalence and risk factors of osteopenia and osteoporosis in peri and postmenopausal females utilizing the DEXA scans. The study also aimed to assess the efficacy of DEXA scan in assessing osteopenia and osteoporosis and to help in the early identification of subjects at high risk for osteoporosis allowing timely initiation of treatment. The study subjects were from the Department of Obstetrics and Gynecology of the Institute. Verbal and written informed consent were taken from all the subjects before participation.

The present study assessed 540 females in the age of perimenopausal and post-menopause reporting to the Department of Obstetrics and Gynecology of the Institute. The inclusion criteria for the study were females of perimenopausal and postmenopausal age, females with or without the risk of osteoporosis attending the Gynaecology OPD, and females who were willing to participate in the study. The exclusion criteria for the study were subjects with recent gastrointestinal contrast or radionuclide use, history of malignancy with radiotherapy, inability to cooperate, extreme obesity or low BMI, and females who did not give consent for study participation.

After the final inclusion of the females based on strict inclusion and exclusion criteria, for all the females, detailed history was taken followed by general and systemic examinations needed for the study. For each of the study participants, an intravenous blood sample from the antecubital vein was taken under strict sterile and aseptic conditions to measure and evaluate the serum calcium levels. Bone mineral density (BMD) was evaluated in all the participants with a DEXA (dual-energy X-ray Absorptiometry) scan of the hip and lumbar spine.

Concerning the DEXA scanning procedure in the present study, two X-ray beams were used for the estimation of bone density in the spine and hip. DEXA scans involve low radiation dose exposure and is fast, and non-invasive method of assessing BMD. The areas of measurement include the Lumbar spine at L1, L2, L3, L4, and total and hip including Ward's area, neck region, trochanter,

intertrochanteric, and total hip. The DEXA scanning results were reported as T-scores and Z-scores where Z-scores compare to gender, ethnicity, weight, and age norms, and T-scores compare bone density to a young normal reference mean.

The risk of DEXA scans includes the slight chance of cancer from excessive radiation exposure; however, the benefit outweighs the risk factors. Also, no serious complications result from the DEXA scanning procedure. The contraindication for the present study includes the recent gastrointestinal contrast or radionuclide use, low BMI, or extreme obesity, which affects the accuracy of the measurement.

The data gathered were analyzed statistically using SPSS (Statistical Package for the Social Sciences) software version 24.0 (IBM Corp., Armonk, NY, USA) for assessment of descriptive measures, chi-square test, and Mann Whitney U test. The results were expressed as mean and standard deviation and frequency and percentages. The p-value of <0.05 was considered statistically significant.

## RESULTS

The present prospective observational study was aimed to assess the prevalence and risk factors of osteopenia and osteoporosis in peri and postmenopausal females utilizing the DEXA scans. The study also aimed to assess the efficacy of DEXA scan in assessing osteopenia and osteoporosis and to help in the early identification of subjects at high risk for osteoporosis allowing timely initiation of treatment. The present study assessed 540 females in the age of perimenopausal and postmenopause reporting to the Department of Obstetrics and Gynecology of the Institute. The mean age of the study subjects was  $54.22 \pm 12.77$  years. The mean BMI, weight, and height of the study subjects were  $25.36 \pm 3.66 \text{ kg/m}^2$ ,  $58.05 \pm 8.57 \text{ kg}$ , and  $151.45 \pm 4.72 \text{ cm}$  respectively. There were 51.48% (n=260), 18.52% (n=100), 18.15% (n=98), 10.37% (n=56), and 1.48% (n=8) subjects from 10-50, 51-60, 61-70, 71-80, and 81+ years respectively. In WHO grading, normal BMD, osteopenia, and osteoporosis were seen in 34.81% (n=188), 35.93% (n=194), and 29.26% (n=158) study subjects respectively (Table 1).

It was seen that for the distribution of different Bone densities in Perimenopausal and Postmenopausal study females, osteoporosis was seen in 54.01% (n=148) postmenopausal and 6.33% (n=12) perimenopausal females. Osteopenia was seen in 33.57% (n=92) postmenopausal and 53.76% (n=102) perimenopausal females. Normal bone density was seen in 12.40% (n=34) and 38.91% (n=76) perimenopausal females as shown in Table 2.

The study results showed that for the relationship of demographic characteristics to Bone mineral density in study females, a significantly higher number of subjects from 41-60 years had normal BMD compared to osteoporosis and osteopenia with  $p < 0.0001$ . In age 61-70, the highest number of subjects had osteoporosis compared to osteopenia and normal BMD with  $p < 0.0001$ . In age 71-80, the highest number of subjects had osteoporosis compared to osteopenia and normal BMD with  $p < 0.0001$ . At age 81 or higher, 8 subjects had osteoporosis 2 subjects had osteopenia, and no

subjects had normal BMD with  $p=0.04$ . Osteoporosis had a high incidence in subjects with smaller height compared to subjects with more height with  $p=0.003$ . Higher weight subjects had normal BMD and decreased weight had osteopenia and osteoporosis with  $p=0.04$ . In menopause duration, increased duration of menopause showed higher subjects with osteoporosis and osteopenia with  $p=0.03$ ,  $0.0002$ ,  $0.0001$ , and  $0.0001$  respectively with menopause duration of 1-10, 11-20, 21-30, and  $>30$  years (Table 3).

Concerning the association of habits, calcium, levels, and medical disorders to BMD, in serum calcium levels  $<8.5\text{mg/dl}$ , a higher number of subjects had osteoporosis with  $p<0.0001$ , and in serum calcium levels of  $\geq 8.5\text{mg/dl}$ , majority subjects had normal BMD compared to osteoporosis and osteopenia with  $p=0.003$ . For diet, the majority of subjects had normal BMD with a non-vegetarian diet and the majority of subjects with osteoporosis had a vegetarian diet depicting a statistically non-significant difference with  $p<0.0001$ . In medical disorders, a significant correlation was seen between osteoporosis and osteopenia with hypertension, diabetes mellitus, and CRD with  $p<0.001$ ,  $<0.001$ , and  $0.04$  respectively. Smokers and subjects not doing exercise had a higher incidence of osteoporosis and osteopenia with  $p=0.0002$  and  $<0.0001$  (Table 4).

## DISCUSSION

The present study assessed 540 females in the age of perimenopausal and post-menopause reporting to the Department of Obstetrics and Gynecology of the Institute. The mean age of the study subjects was  $54.22\pm 12.77$  years. The mean BMI, weight, and height of the study subjects were  $25.36 \pm 3.66\text{kg/m}^2$ ,  $58.05 \pm 8.57$  kg, and  $151.45 \pm 4.72\text{cm}$  respectively. There were 51.48% ( $n=260$ ), 18.52% ( $n=100$ ), 18.15% ( $n=98$ ), 10.37% ( $n=56$ ), and 1.48% ( $n=8$ ) subjects from 10-50, 51-60, 61-70, 71-80, and 81+ years respectively. In WHO grading, normal BMD, osteopenia, and osteoporosis were seen in 34.81% ( $n=188$ ), 35.93% ( $n=194$ ), and 29.26% ( $n=158$ ) study subjects respectively. These demographic characteristics were comparable to the studies of Pande KC et al<sup>7</sup> in 2006 and Rao H et al<sup>8</sup> in 2003 where authors assessed subjects with demographic data comparable to the present study.

The study results showed that for the distribution of different Bone densities in Perimenopausal and Postmenopausal study females, osteoporosis was seen in 54.01% ( $n=148$ ) postmenopausal and 6.33% ( $n=12$ ) perimenopausal females. Osteopenia was seen in 33.57% ( $n=92$ ) postmenopausal and 53.76% ( $n=102$ ) perimenopausal females. Normal bone density was seen in 12.40% ( $n=34$ ) and 38.91% ( $n=76$ ) perimenopausal females. These results were consistent with the studies of Babu AS et al<sup>9</sup> in 2009 and Paul TV et al<sup>10</sup> in 2008 where the distribution of different Bone densities in Perimenopausal and Postmenopausal study females similar to the present study was reported by the authors in their studies.

It was seen that for the relationship of demographic characteristics to Bone mineral density in study females, a significantly higher number of subjects from 41-60 years had normal BMD compared to osteoporosis and osteopenia with  $p<0.0001$ . In age 61-70, the highest number of subjects had osteoporosis compared to osteopenia and normal BMD with  $p<0.0001$ . In age 71-80, the highest

number of subjects had osteoporosis compared to osteopenia and normal BMD with  $p < 0.0001$ . At age 81 or higher, 8 subjects had osteoporosis 2 subjects had osteopenia, and no subject had normal BMD with  $p = 0.04$ . Osteoporosis had a high incidence in subjects with smaller height compared to subjects with more height with  $p = 0.003$ . Higher weight subjects had normal BMD and decreased weight had osteopenia and osteoporosis with  $p = 0.04$ . In menopause duration, increased duration of menopause showed higher subjects with osteoporosis and osteopenia with  $p = 0.03, 0.0002, 0.0001,$  and  $0.0001$  respectively with menopause duration of 1-10, 11-20, 21-30, and  $>30$  years. These findings were in agreement with the results of Vaidya R et al<sup>11</sup> in 2010 and Sharma S et al<sup>12</sup> in 2010 where authors reported increased incidence of osteoporosis with increasing age, with smaller height subjects having high osteoporosis incidence and high-weight subjects having lesser incidence of osteoporosis as seen in the results of the present study.

On assessing the association of habits, calcium, levels, and medical disorders to BMD, in serum calcium level  $< 8.5 \text{ mg/dl}$ , a higher number of subjects had osteoporosis with  $p < 0.0001$ , and in serum calcium level of  $\geq 8.5 \text{ mg/dl}$ , majority subjects had normal BMD compared to osteoporosis and osteopenia with  $p = 0.003$ . For diet, the majority of subjects had normal BMD with a non-vegetarian diet and the majority of subjects with osteoporosis had a vegetarian diet depicting a statistically non-significant difference with  $p < 0.0001$ . In medical disorders, a significant correlation was seen between osteoporosis and osteopenia with hypertension, diabetes mellitus, and CRD with  $p < 0.001, < 0.001,$  and  $0.04$  respectively. Smokers and subjects not doing exercise had a higher incidence of osteoporosis and osteopenia with  $p = 0.0002$  and  $< 0.0001$ . These results correlated with the findings of Kanis JA et al<sup>13</sup> in 2008 and Shah RS et al<sup>14</sup> in 2004 where authors reported similar habits, calcium, levels, and medical disorders to BMD in their studies as seen in the present study.

## CONCLUSIONS

Within its limitations, the present study concludes that the DEXA standard has high efficacy in assessing bone mineral density and is highly productive in the diagnosis of osteoporosis in both appendicular and axial skeletons. The prevalence of osteopenia and osteoporosis is higher in perimenopausal and postmenopausal females. However, the risk of osteopenia is higher in perimenopausal females. Overweight and obesity are preventive factors.

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## TABLES

| S. No | Data                     | Number (n)    | Percentage (%) |
|-------|--------------------------|---------------|----------------|
| 1.    | Mean age (years)         | 54.22±12.77   |                |
| 2.    | Age range (years)        |               |                |
| a)    | 10-50                    | 260           | 51.48          |
| b)    | 51-60                    | 100           | 18.52          |
| c)    | 61-70                    | 98            | 18.15          |
| d)    | 71-80                    | 56            | 10.37          |
| e)    | 81 or higher             | 8             | 1.48           |
| 3.    | Mean height (cm)         | 151.45 ± 4.72 |                |
| 4.    | Mean weight (kg)         | 58.05 ± 8.57  |                |
| 5.    | BMI (kg/m <sup>2</sup> ) | 25.36 ± 3.66  |                |
| 6.    | WHO grading              |               |                |
| a)    | Osteoporosis             | 158           | 29.26          |
| b)    | Osteopenia               | 194           | 35.93          |
| c)    | Normal                   | 188           | 34.81          |

**Table 1: Demographic and disease characteristics in the study subject**

| S. No | Grading      | Postmenopausal |       | Perimenopausal |       |
|-------|--------------|----------------|-------|----------------|-------|
|       |              | n              | %     | n              | %     |
| 1.    | Osteoporosis | 148            | 54.01 | 12             | 6.33  |
| 2.    | Osteopenia   | 92             | 33.57 | 102            | 53.76 |
| 3.    | Normal       | 34             | 12.40 | 76             | 38.91 |
| 4.    | Total        | 274            | 100   | 190            | 100   |

**Table 2: Distribution of Different Bone densities in Perimenopausal and Postmenopausal study females**

| S. No | Variables                  | Osteoporosis (n) | Osteopenia (n) | Normal (n)  | Total (n) | p-value |
|-------|----------------------------|------------------|----------------|-------------|-----------|---------|
| 1.    | Age group                  |                  |                |             |           |         |
| a)    | 41-60                      | 22               | 110            | 156         | 278       | <0.0001 |
| b)    | 61-70                      | 62               | 50             | 28          | 98        | <0.0001 |
| c)    | 71-80                      | 52               | 32             | 4           | 56        | <0.0001 |
| d)    | 81+                        | 8                | 2              | 0           | 8         | 0.04    |
| 2.    | Height (cm)                | 150.06 ± 4.23    | 151.82 ± 4.95  | 152.17±4.62 |           | 0.003   |
| 3.    | Weight kg (kg)             | 54.18± 8.04      | 56.53± 7.96    | 62.87±7.46  |           | 0.05    |
| 4.    | Menopause duration (years) |                  |                |             |           |         |
| a)    | 1-10                       | 46               | 26             | 8           | 90        | 0.03    |
| b)    | 11-20                      | 48               | 34             | 6           | 88        | 0.0002  |
| c)    | 21-30                      | 64               | 12             | 2           | 79        | 0.0001  |
| d)    | 31+                        | 18               | 0              | 0           | 18        | 0.0001  |

**Table 3: Relationship of demographic characteristics to Bone mineral density in study females**

| S. No | Variable              | Osteoporosis n (%) | Osteopenia n (%) | Normal n (%) | Total n (%) | p-value |
|-------|-----------------------|--------------------|------------------|--------------|-------------|---------|
| 1.    | Serum calcium (mg/dl) |                    |                  |              |             |         |
| a)    | <8.5                  | 46 (82.14)         | 8 (14.29)        | 2 (3.57)     | 56          | <0.0001 |
| b)    | ≥8.5                  | 112 (23.15)        | 18 (38.43)       | 186 (38.43)  | 316         | 0.003   |
| 2.    | Diet                  |                    |                  |              |             |         |
| a)    | Non-veg diet          | 54 (15)            | 148 (41.11)      | 158 (43.89)  | 360         | <0.0001 |
| b)    | Veg diet              | 46 (25.56)         | 104 (57.78)      | 30 (16.67)   | 180         |         |
| 3.    | Medical disorders     |                    |                  |              |             |         |
| a)    | Hypertension          | 128 (62.75)        | 50 (24.51)       | 26 (12.75)   | 204         | <0.001  |
| b)    | Diabetes mellitus     | 38 (69.64)         | 28 (25)          | 6 (5.36)     | 112         | <0.001  |
| c)    | Hyperthyroidism       | 6 (100)            | 0                | 0            | 6           | 0.1025  |
| d)    | Hypothyroidism        | 6 (15)             | 20 (50)          | 14 (35)      | 40          | 0.1572  |
| e)    | CLD                   | 6 (100)            | 0                | 0            | 6           | 0.1025  |
| f)    | CRD                   | 16 (88.89)         | 2 (11.11)        | 0            | 18          | 0.04    |



|           |                        |             |             |             |     |                   |
|-----------|------------------------|-------------|-------------|-------------|-----|-------------------|
| <b>g)</b> | Asthma                 | 6 (27.27)   | 8 (36.36)   | 8 (36.36)   | 22  | 0.9131            |
| <b>h)</b> | Rheumatoid arthritis   | 4 (50)      | 2 (50)      | 0           | 4   | 0.4795            |
| <b>i)</b> | Carcinoma breast       | 4 (100)     | 0           | 0           | 4   | 0.1025            |
| <b>j)</b> | No medical disorder    | 24 (8.33)   | 120 (41.67) | 144 (50)    | 288 |                   |
| <b>4.</b> | <b>Smoking status</b>  |             |             |             |     |                   |
| <b>a)</b> | Smokers                | 38 (65.52)  | 18 (31.03)  | 2 (3.45)    | 58  | <b>0.0002</b>     |
| <b>b)</b> | Non-smokers            | 120 (24.90) | 176 (36.51) | 186 (38.59) | 482 |                   |
| <b>5.</b> | <b>Exercise status</b> |             |             |             |     |                   |
| <b>a)</b> | Active                 | 104 (52.99) | 108 (39.71) | 148 (54.41) | 272 | <b>&lt;0.0001</b> |
| <b>b)</b> | Sedentary              | 54 (29.26)  | 86 (32.09)  | 40 (14.93)  | 268 |                   |

**Table 4: Correlation of habits, calcium, levels, and medical disorders to BMD**