Section: Endocrinology

Original Research Article

COMPARATIVE ANALYSIS OF OSTEOPOROSIS PREVALENCE IN PREMENOPAUSAL AND POSTMENOPAUSAL WOMEN USING DEXA SCAN

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Abstract

Background: Osteoporosis is characterized by decreased bone mass and increased fracture risk particularly among postmenopausal women. Postmenopausal women are at a significantly higher risk of developing osteoporosis due to hormonal changes leading to accelerated bone resorption. Despite the known prevalence of osteoporosis comparative data on its occurrence in premenopausal and postmenopausal women is limited. The purpose of this study was to compare the prevalence of osteoporosis in premenopausal and postmenopausal women using Dual Energy X-ray Absorptiometry (DEXA) scans. **Materials and Methods:** This comparative cross-sectional study was conducted in the department of endocrinology of Index Medical College and Research Center. The duration of study was six months. 60 women (30 premenopausal and 30 postmenopausal) were included in this study. Bone Mineral Density (BMD) was measured at the lumbar spine and femoral neck using DEXA scans. Serum Vitamin D levels were also assessed. Statistical analysis was performed using SPSS version 21.0. A p-value of <0.05 was considered statistically significant. **Result:** Postmenopausal women showed significantly lower BMD at the femoral neck (0.70 ± 0.11 g/cm²) and lumbar spine (0.83 ± 0.10 g/cm²) compared to premenopausal women (0.91 ± 0.09 g/cm² and 1.01 ± 0.08 g/cm², respectively) ($p < 0.001$). Osteoporosis was notably more common in postmenopausal women (63.33%) as compared to premenopausal women (3.33 %). Similarly, Vitamin D deficiency (< 20 ng/mL) was significantly more common in postmenopausal women (63.33%) as compared to premenopausal women (16.67%) ($p < 0.001$). **Conclusion:** The study showed a significantly higher risk of osteoporosis in postmenopausal women compared to premenopausal women. These findings highlight the necessity for early screening using DEXA scans and preventive interventions such as calcium and vitamin D supplementation and dietary modifications in postmenopausal women.

INTRODUCTION

Osteoporosis is characterized by decreased bone mass, microarchitectural deterioration of bone tissue and increased bone fragility.[1] Osteoporosis is defined as a bone mineral density (BMD) that is 2.5 standard deviations or more below the mean peak bone mass of young, healthy adults (T-score ≤ -2.5). Osteoporosis usually remains asymptomatic until a fracture occurs which frequently affects the hip, spine, and wrist.[2] Globally osteoporosis is a significant public health concern particularly among women. It is estimated that over 200 million people worldwide suffer from osteoporosis with women comprising approximately 80% of this population. The increasing life expectancy and changing lifestyle patterns contribute to the rising incidence of osteoporosis making it a major health issue globally.[3]

Osteoporosis results from an imbalance between bone resorption and bone formation. During the natural aging process bone resorption by osteoclasts exceeds bone formation by osteoblasts leading to net

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bone loss. This imbalance is influenced by several factors including hormonal changes, genetic predisposition, nutritional deficiencies and lifestyle factors.[4] Hormonal changes such as decline in estrogen levels, plays an important role in accelerating bone resorption. Estrogen is crucial for maintaining bone density as it inhibits osteoclast activity. A deficiency in estrogen as seen in postmenopausal women leads to rapid bone loss. Genetic factors and nutritional deficiencies (such as that of calcium and vitamin D) impair bone mineralization and promote bone loss. Lifestyle factors such as physical inactivity, smoking, alcohol consumption and chronic use of certain medications (glucocorticoids, anticonvulsants) can further exacerbate bone loss.[5]

Women are at a significantly higher risk of developing osteoporosis compared to men due to a combination of anatomical, hormonal and lifestyle factors. Women generally have lower peak bone mass as compared to men making them more vulnerable to bone loss as they age. Hormonal fluctuations throughout a woman's life contribute substantially to the risk of osteoporosis. Estrogen, which plays a crucial role in maintaining bone density declines sharply during menopause leading to an accelerated rate of bone resorption.[6] All these postmenopausal changes significantly increasing the risk of fractures in women. Furthermore, advancing age in postmenopausal women is linked to decreased calcium absorption, reduced renal synthesis of active vitamin D and impaired bone formation. All these changes further contribute to osteoporosis. The cumulative effect of hormonal changes and aging makes osteoporosis a critical health issue for perimenopausal and postmenopausal women.[7]

The most common clinical presentation of osteoporosis includes fragility fractures which occur with minimal trauma such as a fall from standing heigh. Vertebral compression fractures can present as acute back pain, loss of height, or kyphosis. Similarly hip and wrist fractures are associated with significant functional impairment and increased mortality.[8]

Evaluation of osteoporosis involves assessment of risk factors, clinical history, physical examination, and diagnostic investigations. Laboratory tests are conducted to exclude secondary causes of osteoporosis such as thyroid dysfunction, vitamin D deficiency or renal insufficiency. Dual X-ray absorptiometry (DEXA) scan is the gold standard for diagnosing osteoporosis. It measures BMD at clinically relevant sites, including the lumbar spine, hip and forearm, where osteoporotic fractures commonly occur.[9] The DEXA scan utilizes two X-ray beams with different energy levels to differentiate between bone and soft tissue allowing precise measurement of bone density. The T-score obtained from a DEXA scan compares the patient's BMD to the mean peak bone mass of a young, healthy reference population.[10]

Despite the well-documented prevalence of osteoporosis among women, significant knowledge gaps remain in understanding the prevalence and associated risk factors in women. This study aims to evaluate the prevalence of osteoporosis among women using DEXA scans.

MATERIALS AND METHODS

This comparative cross-sectional study was conducted to compare prevalence of osteoporosis in premenopausal and postmenopausal women using Dual Energy X-ray Absorptiometry (DEXA) scans. The study was conducted over a period of six months at the Index Medical College and Research Center, in the Department of endocrinology. The sample size consisted of 60 women out of which there were 30 premenopausal women and 30 postmenopausal women. Participants were selected through simple random sampling from patients visiting the outpatient department on the basis of a predefined inclusion and exclusion criteria. Written informed consent was obtained from all participants before enrolment in the study.

A detailed history was collected for all participants including demographic details, age, dietary habits, physical activity levels and history of medication use. Anthropometric measurements, including height and weight, were recorded to calculate the Body Mass Index (BMI) of each participant. In addition, blood samples were collected in the morning to measure serum calcium and Vitamin D levels (serum 25(OH)D levels). Vitamin D deficiency was defined as levels less than 20 ng/mL, vitamin D insufficiency as levels between 21 and 29 ng/mL and vitamin D sufficiency as levels greater than 30 ng/mL.

DEXA scans were performed to measure Bone Mineral Density (BMD) at the lumbar spine (L1–L4) and femoral neck (both right and left sides). The scans were conducted at the using standardized protocol to ensure accuracy and consistency in measurements. T-scores were used to classify the participants into three groups: normal (T-score ≥ -1), osteopenia (T-score between -1 and -2.5), and osteoporosis (T-score ≤ -2.5) [Table 1].

Table 1: Interpretation of DEXA Scan and T Scores.

T-Score Range	Category	Interpretation	Fracture Risk
T-Score ≥ -1.0	Normal BMD	Healthy bone density.	Low fracture risk
-1.0 > T-Score > -2.5	Osteopenia	Lower than normal bone density.	Moderate fracture risk
T-Score ≤ -2.5	Osteoporosis	Significantly reduced bone density.	High fracture risk

Statistical analysis was conducted using SPSS version 21.0. Quantitative data, including age, BMI, and BMD values, were presented as mean and standard deviation. Qualitative data, such as the

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presence of osteoporosis and osteopenia were presented as percentages and frequencies. To compare the prevalence of osteoporosis between the menopausal and postmenopausal groups, an unpaired t-test was used for continuous variables, while the Chi-square test was applied for categorical data. A p-value of <0.05 was considered statistically significant.

Inclusion Criteria:

1. Age above 40 years.
2. Those who gave consent to be part of study.
3. 30 premenopausal and 30 postmenopausal women were included.

Exclusion Criteria:

1. Those who refused consent.
2. Age less than 30 years.
3. Patients known to be having Hormonal disorders (e.g., thyroid dysfunction, Cushing's syndrome), chronic kidney disease or Autoimmune conditions (e.g., rheumatoid arthritis, lupus).
4. Use of medications affecting bone mineral density such as corticosteroids, Hormone Replacement Therapy (HRT), Bisphosphonates.
5. Recent history of fractures unrelated to osteoporosis.

RESULTS

The analysis of the age, BMI, and vitamin D levels among premenopausal and postmenopausal women showed that mean age of premenopausal and postmenopausal women was 40.12 ± 5.14 and 60.21 ± 4.95 years respectively. There was a statistically significant difference in the mean age of premenopausal and postmenopausal women ($p < 0.05$). BMI was also higher in postmenopausal women (27.15 ± 3.87 kg/m²) as compared to premenopausal women (25.58 ± 3.02 kg/m²) however this difference was not statistically significant ($p = 0.08$). Additionally, Serum Calcium and vitamin D levels were notably lower in postmenopausal women (7.6 ± 1.12, 18.58 ± 4.97 ng/mL) as compared to the premenopausal group (9.52 ± 0.60, 30.32 ± 5.24 ng/mL) ($p < 0.001$) [Table 2].

Table 2: Comparison of Mean age, Body Mass index, Sr calcium and Vitamin D.

Parameter	Premenopausal (n=30)	Postmenopausal (n=30)	P-Value
Age (years)	40.12 ± 5.14	60.21 ± 4.95	< 0.001*
BMI (kg/m²)	25.58 ± 3.02	27.15 ± 3.87	0.08
Serum Calcium	9.52 ± 0.60	7.6 ± 1.12	< 0.001*
Vitamin D (ng/mL)	30.32 ± 5.24	18.58 ± 4.97	< 0.001*

The analysis of serum 25(OH) D levels among premenopausal and postmenopausal women showed that vitamin D deficiency (< 20 ng/mL) was significantly more common in postmenopausal women (63.33%) compared to premenopausal women (16.67%). Vitamin D insufficiency (21–29 ng/mL) was observed in 23.33% of premenopausal women and 20.00% of postmenopausal women. Vitamin D sufficiency (> 30 ng/mL) was notably higher in premenopausal women (60.00%) compared to postmenopausal women (16.67%) (P=0.0012) [Figure 1].

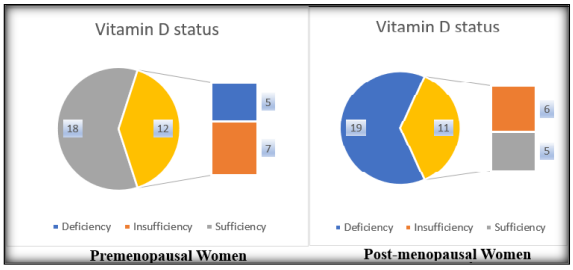

Figure 1: Comparison of Vitamin D status in premenopausal and postmenopausal women.

The analysis of bone mineral density (BMD) and T-scores at the femoral neck among premenopausal and postmenopausal women showed that postmenopausal women had significantly lower BMD (0.70 ± 0.11 g/cm²) compared to premenopausal women (0.91 ± 0.09 g/cm²), with a highly significant p-value (< 0.001). Additionally, the T-scores at the femoral neck were markedly lower in postmenopausal women (-3.00 ± 1.10) compared to the premenopausal group (-0.90 ± 0.90) ($p < 0.001$) [Table 3].

The analysis of bone mineral density (BMD) and T-scores at the lumbar spine among premenopausal and postmenopausal women showed that postmenopausal women had significantly lower BMD (0.83 ± 0.10 g/cm²) compared to premenopausal women (1.01 ± 0.08 g/cm²), with a highly significant p-value (< 0.001). Furthermore, the T-scores at the lumbar spine were considerably lower in postmenopausal women (-3.70 ± 1.01) compared to the premenopausal group (-1.12 ± 0.80) ($p < 0.001$) [Table 4].

Table 3: Comparison of Bone Mineral Density and D scores at Femoral Neck.

Parameter	Premenopausal (n=30)	Postmenopausal (n=30)	P-Value
BMD Femoral Neck (g/cm²)	0.91 ± 0.09	0.70 ± 0.11	< 0.001
T-Score Femoral Neck	-0.90 ± 0.90	-3.00 ± 1.10	< 0.001

Table 4: Comparison of Bone Mineral Density and D scores at Lumbar Spine.

Parameter	Premenopausal (n=30)	Postmenopausal (n=30)	P-Value
BMD Lumbar Spine (g/cm²)	1.01 ± 0.08	0.83 ± 0.10	< 0.001
T-Score Lumbar Spine	-1.12 ± 0.80	-3.70 ± 1.01	< 0.001

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The analysis of overall bone health status among premenopausal and postmenopausal women showed that normal bone mineral density (BMD) (of lumbar spine and neck of femur) was in 22 cases (73.33%) in premenopausal women as compared to only 5 cases (16.67%) in postmenopausal women. Osteopenia was observed in similar proportions in both groups, affecting 7 premenopausal women (23.33%) and 6 postmenopausal women (20.00%). However, osteoporosis was significantly more prevalent in postmenopausal women, with 19 cases (63.33%) compared to just 1 case (3.33 %) among premenopausal women. Abnormal bone mineral density was more commonly seen in postmenopausal women as compared to premenopausal women and the difference was found to be statistically significant (P<0.05) [Table 5].

Table 5: Prevalence of osteopenia and osteoporosis in studied cases.

Bone Health Status	Criteria (Mean T Score at Femoral Neck and Lumbar Spine)	Premenopausal (n=30)	Percentage (%)	Postmenopausal (n=30)	Percentage (%)
Normal BMD	T-score ≥ -1.0	22	73.33%	5	16.67%
Osteopenia	T-score -1.0 to -2.5	7	23.33%	6	20.00%
Osteoporosis	T-score < -2.5	1	3.33%	19	63.33%
P < 0.05 (Significant)					

DISCUSSION

Osteoporosis is a major public health problem particularly among women undergoing menopausal and postmenopausal transitions.[11] It is characterized by reduced bone mineral density (BMD) and increased fracture risk primarily due to hormonal changes that affect bone remodeling. Postmenopausal women are at a significantly higher risk of developing osteoporosis compared to their premenopausal counterparts.[12] Apart from hormonal changes, other risk factors contributing to osteoporosis include age, low body mass index, inadequate calcium and vitamin D intake, sedentary lifestyle and genetic predisposition.[13] Vitamin D deficiency is particularly concerning as it impairs calcium absorption further compromising bone health. Therefore, ensuring adequate vitamin D levels, along with lifestyle modifications such as weight-bearing exercises and balanced nutrition are essential preventive measures. Pharmacological interventions, including bisphosphonates, selective estrogen receptor modulators, and hormone replacement therapy, are commonly used in high-risk patients.[14]

We found significantly low serum calcium levels in postmenopausal women (P<0.001). The mean serum calcium level in premenopausal and postmenopausal women was 9.52 ± 0.60 and 7.6 ± 1.12 mg/dL respectively. Chetana K Patwa et al conducted a comparative study to evaluate and compare serum calcium levels in premenopausal and postmenopausal women and to investigate the effect of postmenopausal hormonal changes on serum calcium levels. The study found that the mean serum calcium level in postmenopausal women (8.96±0.66) was lower than that in premenopausal women (9.49±0.63), and this difference was statistically significant. On the basis of these findings, the authors concluded that postmenopausal women should be monitored for serum calcium levels.[15]

IN this study vitamin D levels were significantly lower in postmenopausal women (18.58 ± 4.97 ng/mL) compared to premenopausal women (30.32 ± 5.24 ng/mL) (p < 0.001). Vitamin D deficiency (< 20 ng/mL) was significantly more prevalent in postmenopausal women (63.33%) compared to premenopausal women (16.67%). Vitamin D insufficiency (21–29 ng/mL) was similar between the groups, observed in 23.33% of premenopausal and 20.00% of postmenopausal women. Significantly higher number of postmenopausal women were found to have vitamin D deficiency as compared to premenopausal women (P<0.05). Abdul Wali Khan et al conducted a cross-sectional study to explore the extent of vitamin D deficiency and its impact on bone mineral density (BMD) in premenopausal and postmenopausal women.[16] Serum vitamin D levels were measured in patients with suspected deficiency, and BMD was assessed using dual-energy x-ray absorptiometry (DEXA) scans. The study found that serum 25OHD concentration was significantly lower in postmenopausal women compared to premenopausal women (p<0.001). Severe vitamin D deficiency was observed in 36.0% of postmenopausal women, whereas only two premenopausal women exhibited severe deficiency. Similar high prevalence of vitamin D deficiency in postmenopausal women was also reported by the authors such as G Siregar MF et al.[17]

In our study Bone mineral density was normal in most of the premenopausal women (73.33 %) as compared postmenopausal women (16.67%). Osteopenia was observed at similar rates in both groups, affecting 23.33% of premenopausal and 20.00% of postmenopausal women. However, osteoporosis was significantly more prevalent among postmenopausal women (63.33%) compared to premenopausal women (3.33%). Overall, abnormal bone mineral density was more common in postmenopausal women (P<0.05). P Ravn et al conducted a cross-sectional study to investigate changes in bone mineral density (BMD) of the

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proximal femur in premenopausal and postmenopausal women.[18] The study found that in premenopausal women, no significant bone loss was observed before menopause, except for a decrease in BMD at the femoral neck and Ward's triangle by 0.3%/year and 0.6%/year, respectively ($p < 0.001$). In postmenopausal women, there was an exponential decline in BMD with increasing age and years since menopause (YSM), with YSM being a stronger predictor than age. The highest bone loss (9-13%) occurred in the first 5 years postmenopause, with an estimated 17-30% reduction after 20 years. On the basis of these findings, the authors concluded that premenopausal bone mass of the proximal femur remains stable, while postmenopausal bone loss is significant, particularly within the first 10-15 years after menopause. Similar findings of increased prevalence of osteoporosis in postmenopausal women was also reported by the authors such as Ji MX et al,[19] and Sanders S et al.[20]

CONCLUSION

Postmenopausal women were found to have a significantly high prevalence of osteoporosis as shown by significantly lower bone mineral density and T-scores on DEXA scans at the femoral neck and lumbar spine. Therefor early screening and preventive interventions are important to reduce the risk of osteoporosis-related fractures in postmenopausal women. Calcium and Vitamin D supplementation along with dietary modifications for perimenopausal women with osteopenia may prevent progression to osteoporosis with advancing age. Regular DEXA monitoring facilitates early detection and effective management of at-risk perimenopausal women.

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