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**Research Article**

# Role of DEXA scan in evaluating risk of osteoporotic hip fracture. in postmenopausal women

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## ABSTRACT

**Background:** Osteoporosis is a major public health problem among postmenopausal women and is associated with an increased risk of fragility fractures, particularly hip and vertebral fractures, leading to significant morbidity, disability, and mortality. Dual-Energy X-ray Absorptiometry (DEXA) scan is considered the gold standard method for assessment of bone mineral density and prediction of osteoporotic fracture risk.

**Aim:** To evaluate the role of DEXA scan in assessing the risk of osteoporotic hip and lumbar fractures among postmenopausal women attending NIMS Hospital, Jaipur.

**Materials and Methods:** A hospital-based observational study was conducted among 115 postmenopausal women at NIMS Hospital, Jaipur, from January 2023 to December 2025. Detailed demographic, clinical, and risk factor data were collected using a predesigned proforma. Bone mineral density assessment was performed using DEXA scan at the hip and lumbar spine regions. Participants were categorized as normal, osteopenic, or osteoporotic based on World Health Organization T-score criteria. Data were analyzed using Statistical Package for Social Sciences (SPSS) software, and appropriate statistical tests were applied. A p-value of less than 0.05 was considered statistically significant.

**Results:** The majority of participants belonged to the 51–60 years age group (43.5%). Osteopenia was observed in 47.0% of women, while osteoporosis was present in 31.3% of participants. Inadequate calcium intake and vitamin D deficiency were observed in 66.1% and 53.0% of women, respectively. Reduced bone mineral density was most commonly noted at the lumbar spine (35.7%). Moderate risk of osteoporotic hip and lumbar fractures was observed in 39.1% of participants, while 24.3% were at high risk. A statistically significant association was found between low bone mineral density and increased fracture risk.

**Conclusion:** DEXA scan was found to be an effective tool for early identification of osteoporosis and assessment of osteoporotic hip and lumbar fracture risk among postmenopausal women. Early screening and timely intervention may help reduce fracture-related morbidity and improve quality of life among postmenopausal women.

***Keywords****: Bone mineral density; DEXA scan; Hip fracture; Osteopenia; Osteoporosis; Postmenopausal women.*

## INTRODUCTION

Osteoporosis is a chronic systemic skeletal disorder characterized by reduced bone mass and deterioration of bone microarchitecture, resulting in increased bone fragility and increasing susceptibility to fractures. It is considered one of the major public health problems affecting postmenopausal women worldwide due to estrogen deficiency and age-related bone loss [1]. Osteoporotic fractures, particularly hip fractures, are associated with significant morbidity, mortality, disability, reduced quality of life, and increased healthcare expenditure. According to the International Osteoporosis Foundation, nearly one in three women over the age of 50 years is expected to experience osteoporotic fractures during their lifetime [2].

Hip fractures are among the most serious consequences of osteoporosis as they are frequently associated with prolonged hospitalization, reduced mobility, and increased mortality in elderly women. Globally, approximately 1.6 million hip fractures occur annually, and this number is expected to rise substantially with increasing life expectancy and aging populations [3]. India is also experiencing a growing burden of osteoporosis and fragility fractures due to increasing elderly population, nutritional deficiencies, sedentary lifestyle, and lack of awareness regarding bone health [4]. Studies from India have demonstrated that osteoporosis affects a substantial proportion of postmenopausal women, with prevalence rates ranging from 20% to 50% depending on age and geographic region [5].

Postmenopausal women are predominantly affected by osteoporosis because estrogen deficiency accelerates bone resorption and reduces bone mineral density (BMD)& bone remodelling. Reduction in BMD significantly increases the risk of fragility fractures, especially at the hip, vertebrae, and wrist [6]. Several risk factors including advancing age, low body mass index, inadequate calcium and vitamin D intake, physical inactivity, smoking, alcohol consumption, family history of fractures, and prolonged corticosteroid use contribute to the development of osteoporosis and fracture risk [7].

Assessment of bone mineral density is important for identifying individuals at increased risk of fractures. DEXA scan (Dual energy Xray absorptiometry)is preferred for measurement of BMD at clinically important sites such as the hip and lumbar spine and helps in estimating fracture risk as it is precise ,reliable & has minimal radiation exposure [8]. According to WHO criteria, osteoporosis is based on T-score values obtained by DEXA scan, where a T-score of $\leq -2.5$ indicates osteoporosis [9]. Early identification of low bone mineral density using DEXA allows timely initiation of preventive and therapeutic measures to reduce fracture risk.

Several studies have shown that reduced femoral neck BMD measured by DEXA is strongly associated with increased risk of osteoporotic hip fractures in postmenopausal women [10]. Evaluation of BMD in women at risk may therefore help in identifying high-risk individuals and reducing future fracture-related morbidity and mortality through early intervention.

The present study was undertaken to evaluate the role of DEXA scan in assessing the risk of osteoporotic hip fractures among postmenopausal women attending NIMS Hospital, Jaipur. The objectives of the study are to assess bone mineral density in postmenopausal women using DEXA scan, determine the prevalence of osteopenia and osteoporosis, evaluate the association between reduced bone mineral density and risk of osteoporotic hip fracture, and identify demographic and clinical risk factors associated with low bone mineral density in postmenopausal women..

## MATERIALS AND METHODS

The present hospital-based observational study was conducted at NIMS Hospital, Jaipur, Rajasthan, over a period of three years from January 2023 to December 2025. The study population included postmenopausal women attending the Departments of Orthopedics and Radiodiagnosis during the study period. A total of 115 postmenopausal women fulfilling the inclusion criteria were enrolled in the study.

Postmenopausal women aged more than 45 years who were willing to participate in the study were included after obtaining written informed consent. Women with a history of metabolic bone disease other than osteoporosis, chronic renal or hepatic disease, malignancy, prolonged immobilization, or those receiving medications known to affect bone metabolism such as long-term corticosteroids or hormone replacement therapy were excluded from the study.

Detailed demographic and clinical information including age, duration of menopause, body mass index, history of previous fractures including lumbar fractures, family history of osteoporosis, physical activity, dietary calcium intake, smoking, alcohol consumption, and associated comorbidities were recorded using a predesigned proforma. Clinical examination was performed for all participants.

Bone mineral density assessment was carried out using Dual-Energy X-ray Absorptiometry (DEXA) scan at the lumbar spine and hip region. Bone mineral density values and T-scores were recorded for each participant. Based on the World Health Organization criteria, participants were categorized as normal, osteopenic, or osteoporotic according to their T-score values. The risk of osteoporotic hip fracture and lumbar fracture was assessed in relation to bone mineral density findings and associated clinical risk factors.

**Statistical Analysis:** The collected data were entered into Microsoft Excel and analyzed using Statistical Package for Social Sciences (SPSS) software. Descriptive statistics such as mean, standard deviation, frequency, and percentage were calculated. Appropriate statistical tests including Chi-square test and Student's t-test were applied wherever required. A p-value of less than 0.05 was considered statistically significant.

**Ethical Approval:** Confidentiality and anonymity of participants were maintained throughout the study. Ethical approval for the study was obtained from the Institutional Ethics Committee prior to commencement of the study.

## RESULT

The present study included 115 postmenopausal women who underwent DEXA scan evaluation at NIMS Hospital, Jaipur, to assess the risk of osteoporotic hip and lumbar fractures. The majority of participants belonged to the age group of 51–60 years (43.5%), followed by 61–70 years (25.2%), while 60.0% of women were from urban areas. Regarding

body mass index, 43.5% of participants were overweight and 21.7% were obese. Duration of menopause between 5–10 years was observed in 47.0% of women.

Among the clinical risk factors associated with osteoporosis, inadequate calcium intake was observed in 66.1% of participants, while 60.9% had irregular or sedentary physical activity. Vitamin D deficiency was present in 53.0% of women, and 24.3% had a previous history of fracture including lumbar fractures. Family history of osteoporosis was noted in 19.1% of participants, while smoking history was present in 13.0% of women.

DEXA scan findings revealed osteopenia in 47.0% of participants and osteoporosis in 31.3%, while normal bone mineral density was observed in 21.7% of women. Reduced bone mineral density was most commonly observed at the lumbar spine, either alone or in combination with hip involvement. Lumbar spine involvement was observed in 35.7% of participants, hip region involvement in 27.8%, and both lumbar spine and hip involvement in 23.5% of women. The mean T-score was –2.2 ± 0.8, and the mean bone mineral density was 0.81 ± 0.13 g/cm².

Assessment of osteoporotic hip and lumbar fracture risk showed that 39.1% of women were at moderate risk, while 24.3% were at high risk of fracture. History of fragility fracture was present in 22.6% of participants, and 27.0% reported history of falls within the past one year. A statistically significant association was observed between osteoporosis diagnosed on DEXA scan and increased risk of osteoporotic hip and lumbar fractures ($p < 0.05$). The mean FRAX score among participants was 15.1 ± 5.4.

**Table 1: Demographic Characteristics of Postmenopausal Women (n = 115)**

| Variable | Category | Frequency (n) | Percentage (%) |
|---|---|---|---|
| Age Group (Years) | 45–50 | 27 | 23.5 |
| | 51–60 | 50 | 43.5 |
| | 61–70 | 29 | 25.2 |
| | >70 | 9 | 7.8 |
| Residence | Urban | 69 | 60.0 |
| | Rural | 46 | 40.0 |
| BMI Category | Normal | 40 | 34.8 |
| | Overweight | 50 | 43.5 |
| | Obese | 25 | 21.7 |
| Duration of Menopause | <5 years | 30 | 26.1 |
| | 5–10 years | 54 | 47.0 |
| | >10 years | 31 | 27.0 |

**Table 2: Clinical Risk Factors Associated with Osteoporosis (n = 115)**

| Variable | Category | Frequency (n) | Percentage (%) |
|---|---|---|---|
| History of Previous Fracture (Including Lumbar Fracture) | Present | 28 | 24.3 |
| | Absent | 87 | 75.7 |
| Family History of Osteoporosis | Present | 22 | 19.1 |
| | Absent | 93 | 80.9 |
| Physical Activity | Regular | 45 | 39.1 |
| | Irregular/Sedentary | 70 | 60.9 |
| Calcium Intake | Adequate | 39 | 33.9 |
| | Inadequate | 76 | 66.1 |
| Vitamin D Deficiency | Present | 61 | 53.0 |
| | Absent | 54 | 47.0 |
| Smoking History | Present | 15 | 13.0 |
| | Absent | 100 | 87.0 |

**Table 3: DEXA Scan Findings and Bone Mineral Density Status (n = 115)**

| Variable | Category | Frequency (n) | Percentage (%) |
|---|---|---|---|
| DEXA Scan T-score | Normal (> -1) | 25 | 21.7 |
| | Osteopenia (-1 to -2.5) | 54 | 47.0 |
| | Osteoporosis (< -2.5) | 36 | 31.3 |
| Site of Reduced BMD | Lumbar Spine | 41 | 35.7 |
| | Hip Region | 32 | 27.8 |
| | Both Sites | 27 | 23.5 |

| | | | |
|---|---|---|---|
| | Normal BMD | 25 | 21.7 |
| Mean T-score | Mean ± SD | -2.2 ± 0.8 | — |
| Mean BMD | Mean ± SD | 0.81 ± 0.13 g/cm² | — |

**Table 4: Association of DEXA Findings with Risk of Osteoporotic Hip and Lumbar Fracture (n = 115)**

| Variable | Category | Frequency (n) | Percentage (%) |
|---|---|---|---|
| Risk of Osteoporotic Hip and Lumbar Fracture | Low Risk | 42 | 36.5 |
| | Moderate Risk | 45 | 39.1 |
| | High Risk | 28 | 24.3 |
| History of Fragility Fracture | Present | 26 | 22.6 |
| | Absent | 89 | 77.4 |
| Fall History in Past 1 Year | Present | 31 | 27.0 |
| | Absent | 84 | 73.0 |
| Association Between Osteoporosis and Fracture Risk | Significant Association | $p < 0.05$ | — |
| Mean FRAX Score | Mean ± SD | 15.1 ± 5.4 | — |

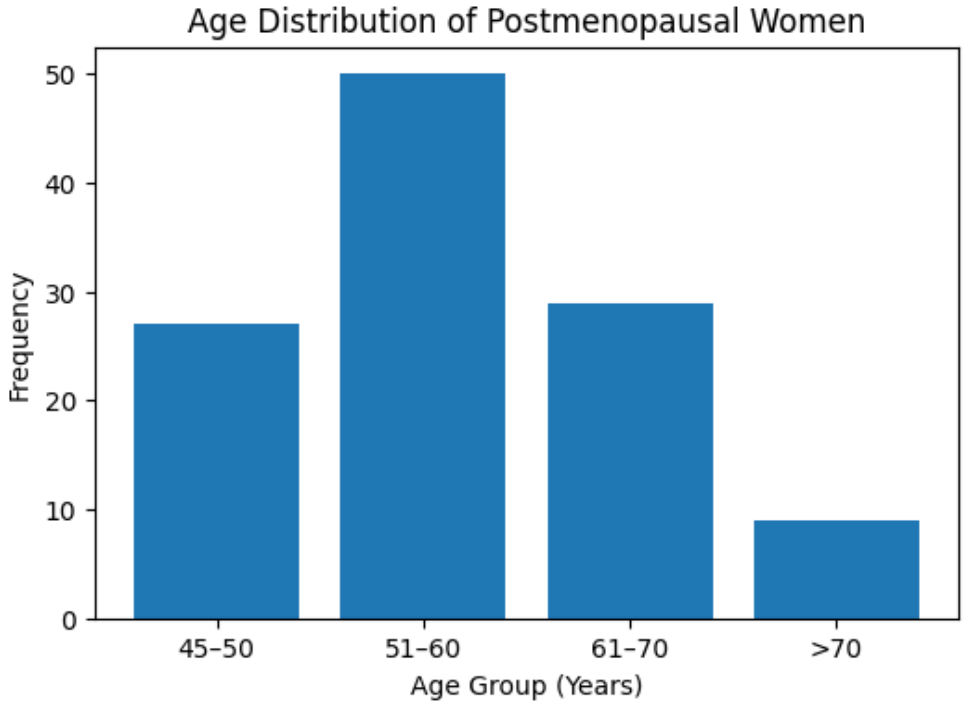


**Figure 1: Age Distribution of Postmenopausal Women**

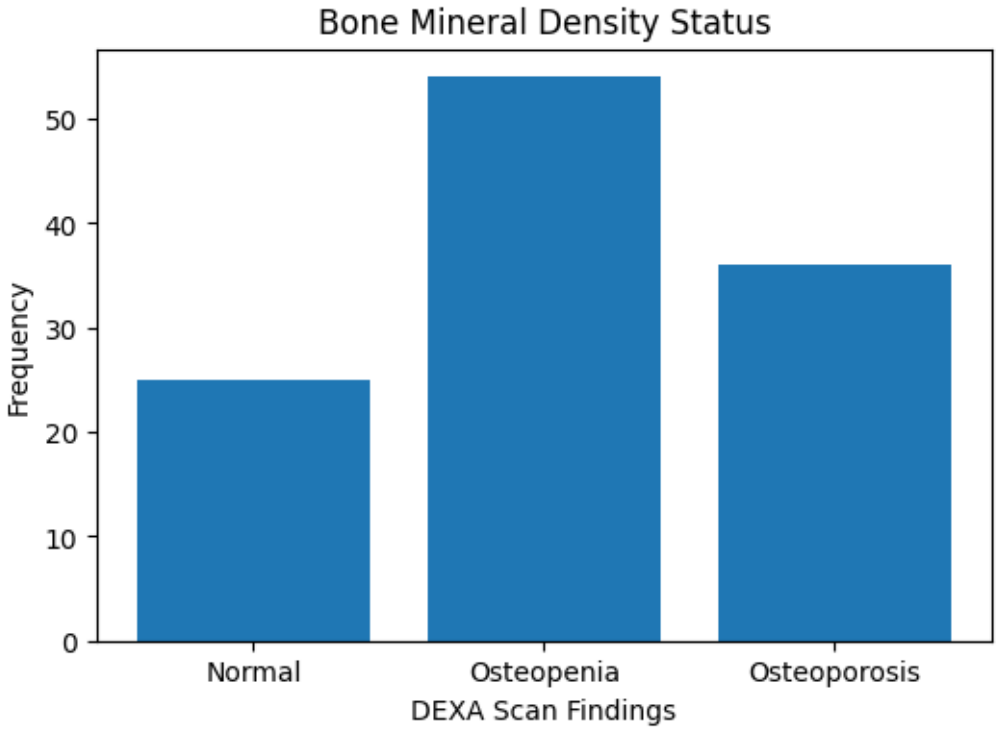


**Figure 2: Bone Mineral Density Status (DEXA Findings)**

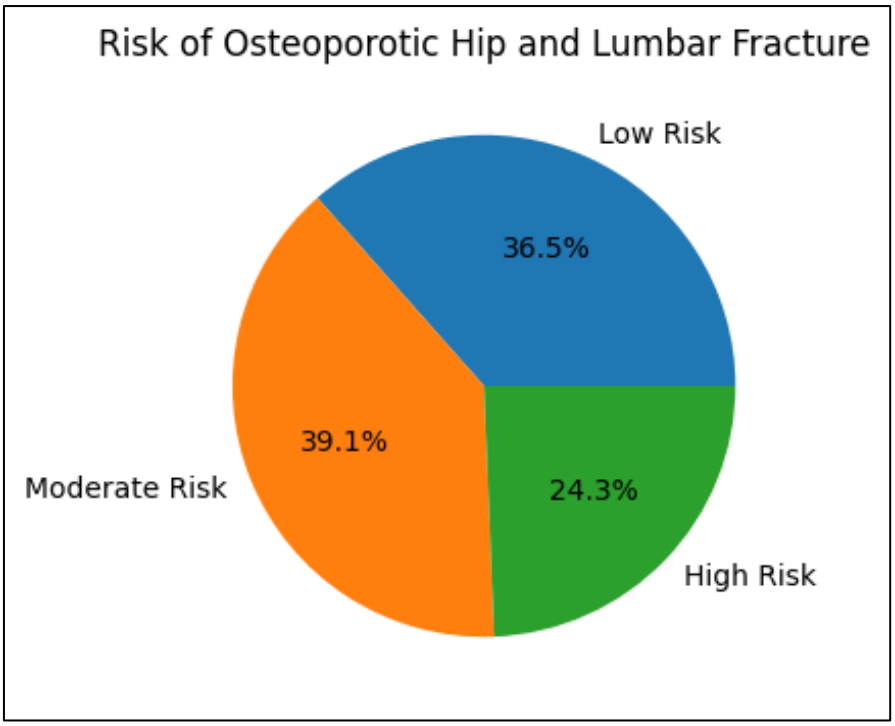


**Figure 3: Risk of Osteoporotic Hip and Lumbar Fracture**

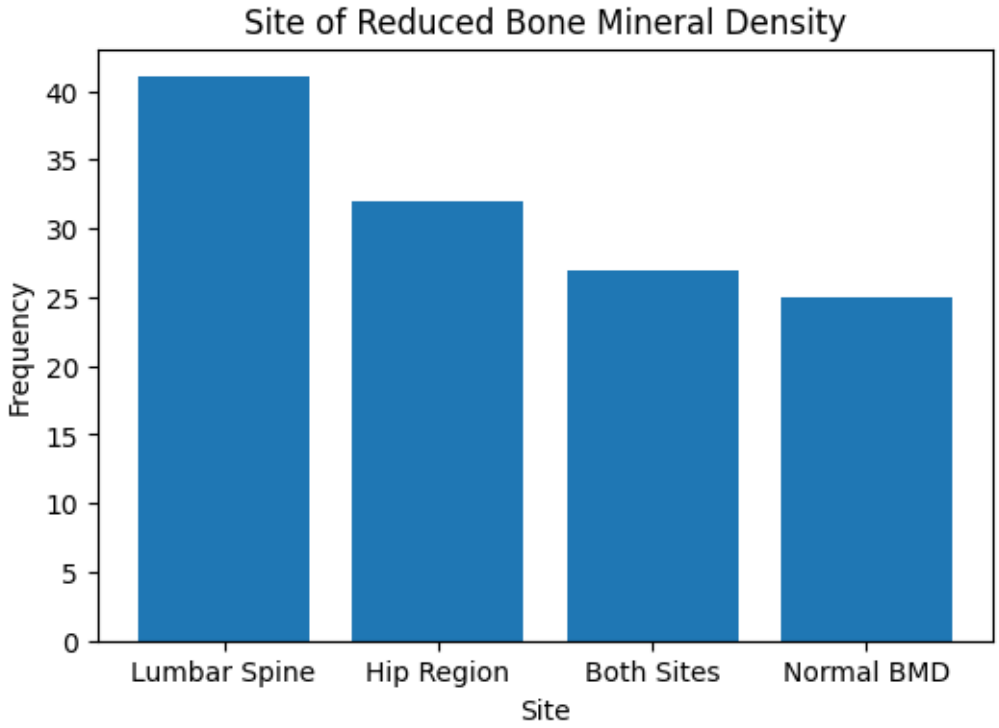


**Figure 4: Site of Reduced Bone Mineral Density**

## DISCUSSION

Osteoporosis is a common skeletal disorder among postmenopausal women and is an important predictor of fragility fractures, particularly hip and vertebral fractures. In the present study, DEXA scan was used to assess bone mineral density and the risk of osteoporotic hip and lumbar fractures among 115 postmenopausal women. The study showed that osteopenia was present in 47.0%, osteoporosis in 31.3%, and normal bone mineral density in 21.7% of women.

The majority of participants in the present study belonged to the 51–60 years age group (43.5%), followed by 61–70 years (25.2%). Aggarwal et al. reported that reduced bone mineral density was more common among peri- and postmenopausal women, with osteoporosis increasing significantly after 50 years of age [11]. Similarly, Sharma et al. observed that menopausal symptoms and bone health concerns were more frequent among women in the postmenopausal age group [12]. These findings support the present observation that advancing age and menopause are important contributors to reduced bone mineral density and increased fracture risk.

In the present study, 43.5% women were overweight and 21.7% were obese. Chugh et al. reported that body mass index and lifestyle factors significantly influenced bone mineral density among postmenopausal women, with altered body composition contributing to variations in osteoporosis risk [13]. Although some studies suggest that higher BMI may exert a partial protective effect on bone mineral density, sedentary lifestyle, nutritional deficiency, and vitamin D insufficiency may still predispose women to osteoporosis and fractures. Therefore, BMI alone may not reliably predict fracture risk without DEXA-based assessment.

Inadequate calcium intake was present in 66.1% of women, while vitamin D deficiency was observed in 53.0% of participants. Kadam et al. reported a high prevalence of osteoporosis among apparently healthy Indian adults above 40 years and emphasized the role of nutritional deficiency, inadequate calcium intake, and vitamin D insufficiency in reduced bone mineral density [14]. The findings of the present study are consistent with these observations and suggest that modifiable nutritional factors play a major role in the development of postmenopausal osteoporosis.

DEXA scan findings in the present study demonstrated osteopenia in 47.0% and osteoporosis in 31.3% of participants. Aggarwal et al. reported osteoporosis in 29.9% and osteopenia in 50.3% among peri- and postmenopausal Indian women, findings closely comparable to the present study [11]. Kadam et al. reported osteoporosis prevalence of 26% among apparently healthy adults above 40 years in Pune, which was slightly lower than the present study, possibly due to differences in menopausal status and study population [14]. These comparisons indicate that reduced bone mineral density is highly prevalent among Indian postmenopausal women.

Reduced bone mineral density in the present study was most commonly observed at the lumbar spine, either alone or in combination with hip involvement. Lumbar spine involvement was observed in 35.7% of participants, hip region involvement in 27.8%, while both lumbar spine and hip involvement were present in 23.5% of women. Chugh et al. reported reduced bone mineral density at both lumbar spine and femoral neck sites among postmenopausal women, emphasizing the importance of site-specific DEXA assessment for accurate diagnosis [13]. Since hip and vertebral bone

mineral density are strongly associated with future fracture risk, assessment at both lumbar spine and hip sites is clinically important.

The present study observed moderate fracture risk in 39.1% and high fracture risk in 24.3% of women. History of fragility fracture was present in 22.6%, while fall history during the past year was reported by 27.0% of participants. Kanis et al. demonstrated that fracture probability increases significantly when low bone mineral density is associated with clinical risk factors such as age, previous fracture, and tendency to fall [15]. Siris et al. reported that women with undiagnosed low bone mineral density had significantly higher fracture risk compared to women with normal bone mineral density [16]. These findings support the present study observation that DEXA scan is useful in identifying women at increased risk of osteoporotic hip and lumbar fractures.

Overall, the findings of the present study were comparable with previous Indian and international studies. The prevalence of osteopenia and osteoporosis was similar to that reported by Aggarwal et al. and Kadam et al., while the association between low bone mineral density and fracture risk was supported by Kanis et al. and Siris et al. The findings highlight the importance of routine DEXA screening among postmenopausal women, particularly those with inadequate calcium intake, vitamin D deficiency, previous fractures, sedentary lifestyle, or history of falls. Early diagnosis and preventive interventions may help reduce osteoporosis-related morbidity and improve quality of life among postmenopausal women.

## CONCLUSION

The present study demonstrated a high prevalence of osteopenia and osteoporosis among postmenopausal women. DEXA scan proved to be an effective and reliable tool for assessment of bone mineral density and evaluation of the risk of osteoporotic hip and lumbar fractures. A significant association was observed between low bone mineral density and increased fracture risk among postmenopausal women.

Advancing age, prolonged duration of menopause, inadequate calcium intake, vitamin D deficiency, sedentary lifestyle, previous fragility fractures, and history of falls were identified as important risk factors associated with osteoporosis. The findings of the present study emphasize the importance of routine DEXA screening in postmenopausal women for early diagnosis and timely preventive intervention.

Early identification and appropriate management of osteoporosis through lifestyle modification, nutritional supplementation, and regular monitoring may help reduce fracture-related morbidity and improve the overall quality of life among postmenopausal women.

## LIMITATIONS

The study was conducted at a single tertiary care hospital, which may limit generalizability of the findings to the broader population. The sample size was relatively limited, and long-term follow-up for occurrence of future fractures could not be performed. Certain biochemical parameters related to bone metabolism were not evaluated in all participants due to resource limitations. Lifestyle and dietary information were partially based on self-reporting, which may have introduced recall bias. In addition, causal association between risk factors and osteoporosis could not be fully established due to the observational nature of the study.

## RECOMMENDATIONS

Routine osteoporosis screening using DEXA scan should be encouraged among postmenopausal women, particularly those with advancing age, prolonged menopause, nutritional deficiency, previous fractures, or history of falls. Public health initiatives focusing on calcium and vitamin D supplementation, regular physical activity, lifestyle modification, and awareness regarding bone health should be strengthened. Early identification and treatment of osteopenia may help prevent progression to osteoporosis and reduce osteoporotic hip fractures. Larger multicentric studies with long-term follow-up are recommended to further evaluate fracture outcomes and effectiveness of preventive interventions among postmenopausal women.

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