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PREVALENCE OF OSTEOPENIA AND OSTEOPOROSIS AND ASSOCIATED RISK FACTORS AMONG PATIENTS UNDERGOING DEXA SCAN IN A TERTIARY CARE HOSPITAL IN KERALA

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Abstract :

Background: Osteoporosis is a progressive skeletal disorder characterized by reduced bone mass and micro architectural deterioration, increasing fracture risk. Early identification through bone mineral density (BMD) assessment is essential, particularly among older adults and postmenopausal women. Data from South Indian populations regarding prevalence and associated risk factors remain limited.

Objectives: The primary objective was to assess the prevalence of osteopenia and osteoporosis at the lumbar spine and femoral neck among patients undergoing DEXA scan in a tertiary care hospital in Kerala. The secondary objectives included evaluating the correlation of age and body mass index (BMI) with bone mineral density (BMD) and identifying factors associated with low BMD.

Methods: A retrospective descriptive study was conducted among 551 adults undergoing DEXA scan at AIMS. Lumbar spine and femoral neck BMD, T-scores, and Z-scores were recorded. Demographic and anthropometric data, including age, sex, and BMI, were collected. The association between age, gender, and BMI with BMD categories at the lumbar spine and femoral neck will be assessed using chi-square test or Fisher's exact test, as appropriate. Correlations between age, BMI, and BMD will be analysed using Spearman's correlation coefficient (ρ). A p-value < 0.05 will be considered statistically significant.

Results: A total of 551 participants were included (mean age 59.3 ± 11.4 years; 82% females; mean BMI 26.3 ± 4.6 kg/m²). At the lumbar spine, 41.6% had osteoporosis and 35.0% had osteopenia, while at the femoral neck, 10.7% had osteopenia and 4.2% had osteoporosis. Age correlated negatively with BMD at both the lumbar spine ($\rho = -0.246$, $p < 0.001$) and femoral neck ($\rho = -0.373$, $p < 0.001$), whereas BMI showed a positive correlation (lumbar spine: $\rho = 0.315$; femoral neck: $\rho = 0.348$; $p < 0.001$). At the lumbar spine, age, female gender, and lower BMI were significant predictors of osteoporosis ($p < 0.001$), while at the femoral neck, age and BMI were the major determinants of bone health, with no significant gender association.

Conclusion: Reduced BMD, particularly at the lumbar spine, is highly prevalent in this population. Age, female sex, and low BMI are significant risk factors. Routine screening and targeted preventive interventions are warranted to mitigate fracture risk and improve skeletal health.

IndexTerms: **Osteoporosis,Bonemineral density,Osteopenia.**

INTRODUCTION

Osteoporosis is a chronic, progressive skeletal disorder characterized by decreased bone mass and microarchitectural deterioration of bone tissue, resulting in increased bone fragility and fracture risk. It represents a major global public health challenge due to its association with significant morbidity, mortality, and healthcare burden, particularly among postmenopausal women and the elderly[1].

Globally, the lifetime risk for osteoporotic fractures is approximately 30–40% in women and 13–22% in men, making it one of the most common chronic conditions worldwide [2]. In India, osteoporosis tends to occur at an earlier age compared to Western populations, possibly due to differences in nutrition, body composition, and lifestyle factors[3] .A community-based study from Delhi reported that 35.1% of adults above 50 years had osteoporosis and 49.5% had osteopenia, with significantly higher prevalence among women [4].Bone mineral density (BMD) is influenced by multiple determinants including age, sex, hormonal status, body weight, and physical activity. Several Indian studies have demonstrated a positive correlation between BMI and BMD, while low BMI has consistently emerged as an independent risk factor for osteopenia and osteoporosis [5]. Additionally, modifiable factors such as inadequate calcium intake, vitamin D deficiency, low physical activity, and early menopause play crucial roles in bone loss and fracture risk [6]. Dual-energy X-ray absorptiometry (DEXA) remains the gold standard for BMD assessment at critical sites such as the lumbar spine and femoral neck. Quantifying site-specific BMD allows clinicians to stratify fracture risk and identify individuals who may benefit from early intervention strategies [7]. Understanding the prevalence and risk factors of osteopenia and osteoporosis in tertiary-care populations can thus provide vital insights for preventive bone health programs in India.

Methods

This was a retrospective descriptive study conducted at Amrita Institute of Medical Sciences (AIMS), Kochi, a tertiary care teaching hospital in South India. Medical records of adult patients who underwent bone mineral density (BMD) assessment by dual-energy X-ray absorptiometry (DEXA) in the Endocrinology Department during the study period were reviewed. The study aimed to estimate the prevalence of osteopenia and osteoporosis and to identify associated demographic and clinical factors. Ethical approval was obtained from the Institutional Ethics Committee of Amrita Institute of Medical Sciences, Kochi. As anonymized hospital records were used, individual informed consent was waived, and confidentiality was maintained throughout the study.

The required sample size was estimated based on the study by Kaushal et al., which reported the prevalence of osteoporosis as 6.9% and osteopenia as 34% among individuals undergoing DEXA scans. Using the formula $n = Z^2\, p(1-p)/d^2$, where Z is the standard normal deviate at a 95% confidence level (1.96), p is the expected prevalence (0.34 for osteopenia, which yields the larger sample size), and d is the absolute precision (0.04), the minimum required sample size was calculated to be 539 records. All adult patients aged 18 years and above who had undergone BMD assessment during the defined study period and whose data met the inclusion criteria were included. Records of patients with known metabolic bone disorders other than osteoporosis (such as osteomalacia or Paget's disease), chronic kidney disease stage 4 or higher, malignancies with skeletal metastasis, or those on prolonged corticosteroid therapy (≥3 months in the past year) were excluded. Records of pregnant women and those with prior hip or spinal surgery that could interfere with scan interpretation were also excluded.

Data were extracted retrospectively from hospital electronic medical records and DEXA scan reports using a structured data abstraction form. Information on demographic variables (age, sex) and anthropometric parameters (height, weight, and body mass index [BMI]) was retrieved, with BMI calculated as weight in kilograms divided by height in meters squared (kg/m^2). Bone mineral density was measured using a dual-energy X-ray absorptiometry (DEXA) scanner following the manufacturer's standardized procedures. BMD values (g/cm^2) and T-scores at the lumbar spine (L1–L4) and both femoral necks were obtained from the scan reports. The mean of the left and right femoral neck BMD values was calculated to derive a single femoral BMD estimate. The lowest T-score from either site was used for diagnostic categorization according to the World Health Organization (WHO) criteria: normal (T-score ≥ -1.0), osteopenia (T-score between -1.0 and -2.5), and osteoporosis (T-score ≤ -2.5).

The data were entered into Microsoft Excel and analysed using IBM SPSS Statistics version 22 (IBM Corp., Armonk, NY, USA). Descriptive statistics were used to summarize the data. Continuous variables were presented as mean ± standard deviation (SD) for normally distributed data or as median (interquartile range [IQR]) for skewed data, while categorical variables were summarized as frequencies and percentages. The distribution of bone mineral density (BMD) categories (normal, osteopenia, and osteoporosis) at the lumbar spine and femoral neck was summarized using frequency tables. Associations between age, gender, and body mass index (BMI) with BMD categories at the lumbar spine and femoral neck were assessed using the chi-square test or Fisher's exact test, as appropriate. Correlations between age, BMI, and BMD were analysed using Spearman's correlation coefficient (ρ). A p-value < 0.05 was considered statistically significant.

Result

The study included 551 participants, and the analysis focused on the distribution of bone mineral density at the lumbar spine and femoral neck, along with its association with demographic and anthropometric factors.

The median age of the study participants was 60.4 years [53.25, 67.00], and the mean age was 59.35 ± 11.41 years. More than half of the participants (53.4%) were aged ≥60 years, and the majority were females (82%). The median BMI of the study participants was 25.97 kg/m² [23.30, 28.85], and the mean BMI was 26.34 ± 4.56 kg/m². Most participants were classified as obese (61.5%), while only 3.1% were underweight (Table 1).

Table 1: Socio-demographic and Anthropometric Characteristics of Study Participants (n = 551)

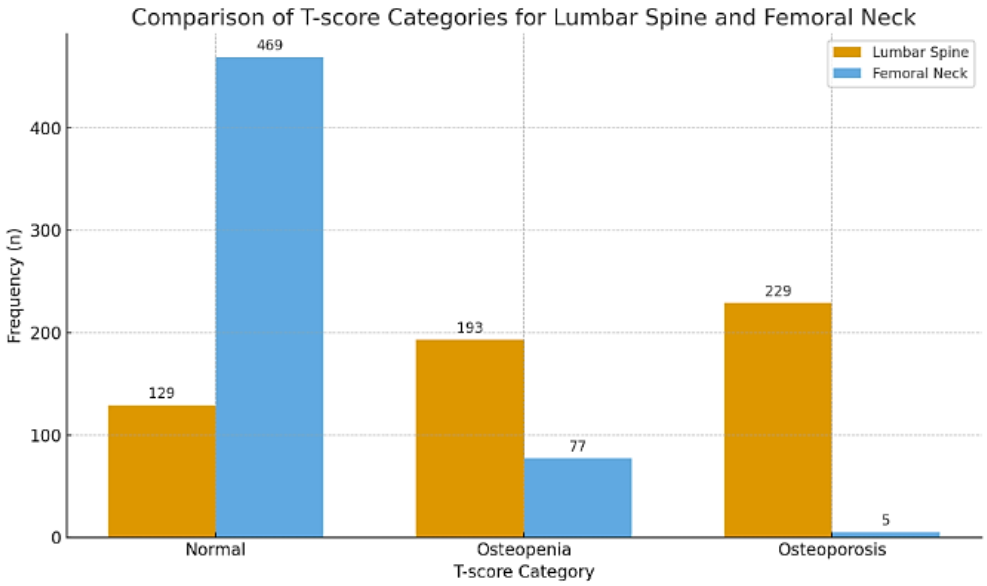
Variable	Category	Frequency (n)	Percentage (%)
Age Category	<40 years	38	7.2
	40–59 years	209	39.4
	≥60 years	283	53.4
Gender	Male	99	18
	Female	452	82
BMI Category	Underweight	17	3.1
	Normal	101	18.3
	Overweight	94	17.1
	Obese	339	61.5

Among participants undergoing DEXA scan, 41.6% had osteoporosis and 35.0% had osteopenia at the lumbar spine.At the femoral neck, 85.1% of participants had normal bone mineral density, while only 14.9% showed reduced BMD (osteopenia or osteoporosis).The median BMD of the lumbar spine was 0.932 g/cm² [0.815, 1.045], with a mean of 0.935 ± 0.185 g/cm², while the median BMD of the femoral neck was 0.852 g/cm² [0.755, 0.958], with a mean of 0.858 ± 0.163 g/cm². (Table 2)

Table 2: Distribution of Bone Mineral Density Categories at the Lumbar Spine and Femoral Neck (n = 551)

Category	Frequency (n)	Percentage (%)
Lumbar Spine (T-score)		
Normal	129	23.4
Osteopenia	193	35
Osteoporosis	229	41.6
Femoral Neck (T-score)		
Normal	469	85.1
Osteopenia	77	14
Osteoporosis	5	0.9

Figure 1:



The median T-score at the lumbar spine was −2.10 [−3.10, −1.10], and the mean was −2.05 ± 1.52. Age showed a significant negative correlation with BMD of the lumbar spine (ρ= −0.246, p<0.001) and BMI positively correlation with BMD of the lumbar spine (ρ = 0.315, p < 0.001). (Table 3)

Table 3: Spearman's Correlation Between Age and BMI with Bone Mineral Density (BMD) of Lumbar Spine (n = 551)

Variables	Age	BMI (kg/m²)
BMD (Lumbar Spine)	−0.246*	0.315*

*Spearman's rho values are shown. *p < 0.001 for all marked correlations.*

Figure 2: Correlation between Age and BMI with Bone Mineral Density (BMD) of Lumbar Spine

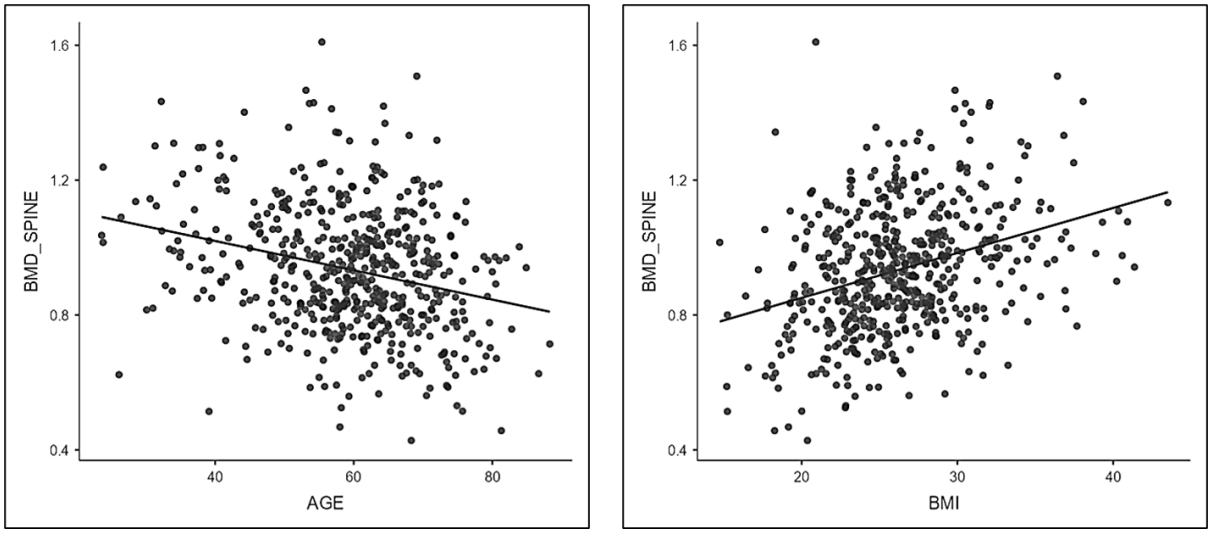


Figure 2 Legend: Correlation between age and BMI with bone mineral density (BMD) of the lumbar spine. The left panel shows a negative correlation between age and lumbar spine BMD, indicating a decline in bone density with advancing age. The right panel shows a positive correlation between BMI and lumbar spine BMD, suggesting that higher BMI is associated with better bone mineral density.

Age showed a significant negative correlation with BMD of the femoral neck ($\rho = -0.373$, $p<0.001$). BMI ($\rho = 0.348$, $p<0.001$) showed a significant positive correlations with femoral neck BMD.(Table 4)

Table 4: Spearman's Correlation Between Age and BMI with Bone Mineral Density (BMD) of Femoral Neck (n = 551)

Variables	Age	BMI (kg/m²)
BMD (Femoral Neck)	−0.373*	0.348*

*Spearman's rho values are shown. *p < 0.001 for all marked correlations.*

Figure 3: Correlation Between Age and BMI with Bone Mineral Density (BMD) of Femoral Neck

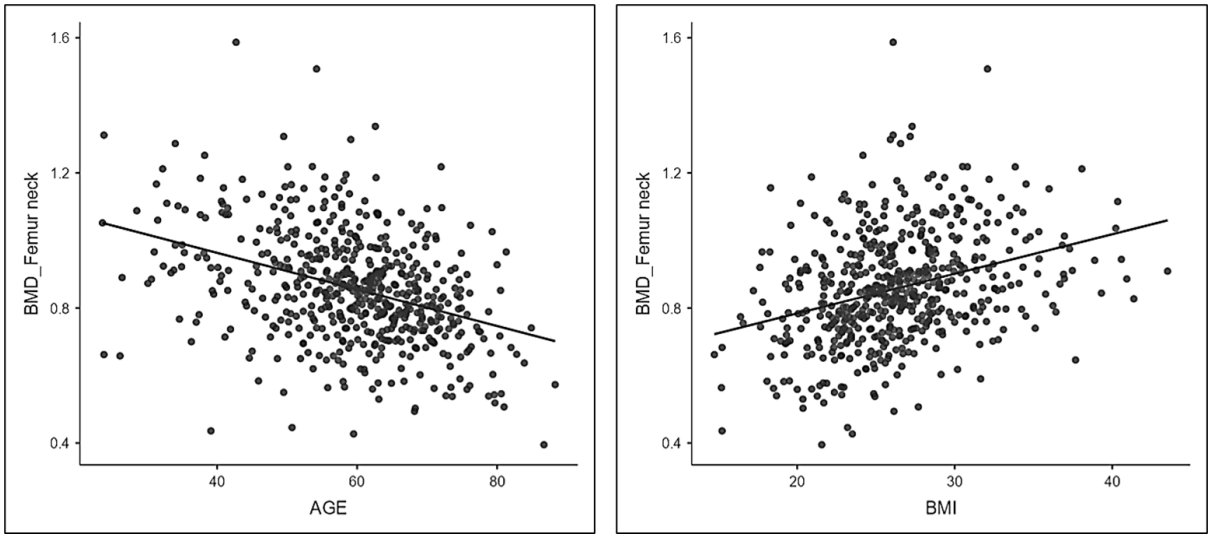


Figure 3 Legend. Correlation between age and BMI with bone mineral density (BMD) of the femoral neck. The left panel shows a negative correlation between age and femoral neck BMD, indicating a decline in bone density with increasing age. The right panel shows a positive correlation between BMI and femoral neck BMD, suggesting a protective effect of higher BMI on bone density.

On performing univariate analysis of lumbar spine bone mineral density revealed a significant association with age, gender, and BMI (Table 7). The prevalence of osteoporosis increased with age, from 21.1% in participants aged <40 years to 47.7% in those ≥60 years ($p < 0.001$). Females had a higher proportion of osteoporosis (44.2%) compared to males (29.3%, $p = 0.005$). BMI showed a strong influence on bone status, with the highest prevalence of osteoporosis observed in underweight participants (76.5%), while overweight individuals had a lower prevalence (36.3%, $p < 0.001$). These findings indicate that older age, female sex, and lower BMI are significant risk factors for reduced lumbar spine bone mineral density.(Table 5)

Table 5: Association of Age, Gender, and BMI with Lumbar Spine Bone Mineral Density Category (n = 551)

Variable	Category	Normal	Osteopenia	Osteoporosis	p-value
Age Category	<40 years	16 (42.1%)	14 (36.8%)	8 (21.1%)	**<0.001***
	40–59 years	60 (28.7%)	67 (32.1%)	82 (39.2%)	
	≥60 years	47 (16.6%)	101 (35.7%)	135 (47.7%)	
Gender	Male	34 (34.3%)	36 (36.4%)	29 (29.3%)	**0.005**
	Female	95 (21.0%)	157 (34.7%)	200 (44.2%)	
BMI Category	Underweight	2 (11.8%)	2 (11.8%)	13 (76.5%)	**<0.001***
	Normal	15 (14.9%)	27 (26.7%)	59 (58.4%)	
	Overweight	112 (25.9%)	164 (37.9%)	157 (36.3%)	

**Fisher's exact test*

At the femoral neck, the majority of participants (85.1%) had normal bone mineral density, with only 14.9% showing reduced BMD (Table 8). Osteopenia and osteoporosis were more common among younger participants (<40 and 40–59 years), whereas those aged ≥60 years predominantly had normal femoral neck BMD ($p < 0.001$). Gender was not significantly associated with femoral neck bone status ($p = 0.333$), with similar distributions observed in males and females. BMI was significantly associated with femoral neck BMD ($p < 0.001$), with underweight individuals showing the highest proportion of osteopenia (23.5%) and osteoporosis (11.8%), while overweight participants largely maintained normal bone density (88.2%). These findings suggest that age and BMI, but not gender, are important determinants of femoral neck bone health in this population (Table 6)

Table 6: Association of Age, Gender and BMI with Femur Neck Bone Status (n = 551)

Variable	Category	Normal n (%)	Osteopenia n (%)	Osteoporosis n (%)	p-value
Age Category	< 40 years	28 (73.7%)	8 (21.1%)	2 (5.3%)	**< 0.001***
	40–59 years	169 (80.9%)	38 (18.2%)	2 (1.0%)	
	≥ 60 years	254 (89.8%)	29 (10.2%)	0 (0.0%)	
Gender	Male (1)	80 (80.8%)	18 (18.2%)	1 (1.0%)	0.333*
	Female (2)	389 (86.1%)	59 (13.1%)	4 (0.9%)	
BMI Category	Underweight	11 (64.7%)	4 (23.5%)	2 (11.8%)	**< 0.001***
	Normal	76 (75.2%)	24 (23.8%)	1 (1.0%)	
	Overweight	382 (88.2%)	49 (11.3%)	2 (0.5%)	

**Fisher's exact test*

Discussion

This retrospective descriptive study assessed bone mineral density (BMD) among adults attending a tertiary care hospital in South India and found a strikingly high prevalence of osteoporosis and osteopenia, particularly at the lumbar spine. In our study, 41.6% of participants were osteoporotic and 35.0% were osteopenic at the lumbar spine, whereas only 14.9% had low bone mass at the femoral neck. This finding demonstrates the site-specific variability in bone loss, a pattern consistently reported in earlier studies Osteoporosis was present in 23.6% subjects (female, 25.4%; male, 21.1%) and osteopenia in 41.1% subjects (female, 40.9%; male, 41.4%) [4].The greater trabecular composition of the spine makes it more metabolically active and susceptible to early demineralization, whereas the predominantly cortical femoral neck tends to preserve density longer[8].

The prevalence of osteoporosis observed in our study (41.6%) is comparable to that reported in several Indian cohorts. Paul et al. (2018), in the Tamil Nadu Osteoporosis Study involving 1,524 adults, reported an overall osteoporosis prevalence of 42% in women and 18% in men. Similarly, Marwaha et al observed that 39.9% of postmenopausal women and 24.6% of men aged ≥50 years had osteoporosis at one or more skeletal sites [9] Shetty et al. (2020) reported osteoporosis in 43.3% of postmenopausal women in urban South India[10] , while Khadilkar et al noted rates ranging from 20% to 50% in various Indian regions, depending on the study population and diagnostic criteria[11]. The slightly higher prevalence in our study may reflect the older age composition (mean age 59.3 years) and higher female predominance (82%), both established risk factors for bone loss.

The observed age-related decline in BMD in our study aligns with biological and epidemiological evidence. We found a significant negative correlation between age and lumbar spine BMD ($\rho = -0.246$, $p < 0.001$), consistent with other reports. A population-based study from Delhi demonstrated a 10–15% decline in lumbar spine BMD across successive age decades after 40 years [9]. Globally, similar patterns have been documented; for instance, using NHANES data from the United States, reported osteoporosis prevalence increasing from 6% in adults aged 50–59 years to 26% among those aged ≥80 years [12]. These findings confirm that aging remains a dominant determinant of bone loss, mediated by reduced osteoblast function, hormonal decline, and calcium/vitamin D insufficiency [13].

Gender differences were also prominent in our study, with females showing a significantly higher prevalence of osteoporosis (44.2%) compared to males (29.3%). Similar sex disparities have been extensively reported in both Indian and international literature. In the multicentric Indian MENOS study, 50–65% of postmenopausal women were osteoporotic depending on the skeletal site [5]. Globally, women are estimated to have a fourfold higher lifetime risk of osteoporosis-related fractures compared to men [1].The accelerated bone loss following menopause is attributed to estrogen deficiency, which increases bone resorption and disrupts trabecular architecture[14].

BMI emerged as a significant determinant of bone health in our cohort, showing a positive correlation with BMD ($\rho = 0.315$, $p < 0.001$). Participants classified as underweight had the highest proportion of osteoporosis (76.5%), while overweight individuals demonstrated better bone mass preservation. These findings are in agreement with the meta-analysis by De Laet et al. , which found that each 1 kg/m² increase in BMI reduced the risk of osteoporotic fracture by approximately 7% [15]. A recent NHANES analysis also confirmed that low BMI remains one of the most powerful predictors of reduced BMD, particularly in older adults. [16]. Mechanistically, higher body weight increases skeletal loading and estrogen production from adipose tissue, both of which protect against bone resorption [17]. However, excessive adiposity can adversely affect bone microarchitecture, indicating a complex, nonlinear association.

Interestingly, the proportion of participants with reduced femoral neck BMD was markedly lower than those with lumbar spine involvement. Only 0.9% were osteoporotic at the femur neck in our study, compared to 41.6% at the spine. Similar disparities have been observed in other Indian studies, where femoral osteoporosis ranged from 1% to 10% versus 30–45% at the lumbar spine [10]. This may be partially explained by degenerative changes such as osteophyte formation and aortic calcification leading to spuriously elevated lumbar BMD readings, while the femoral neck—being weight-bearing and less prone to such artifacts—shows physiologically preserved density [8].

The high burden of low bone mass in this study underscores the need for routine BMD screening among postmenopausal women and elderly men in India. The results also highlight the necessity of integrating bone health assessment into routine metabolic check-ups. Preventive strategies including adequate calcium and vitamin D intake, regular weight-bearing exercise, and avoidance of smoking and alcohol can significantly mitigate bone loss[17]. In India, vitamin D deficiency affects over 70–90% of adults across urban and rural populations and its correction should remain a key national health priority[18].

Overall, our findings align with national and global trends, reaffirming that osteoporosis remains underdiagnosed and undertreated, particularly in women and older adults. Early detection through DEXA screening and targeted lifestyle and pharmacologic interventions can substantially reduce fracture burden and improve quality of life.

Conclusion

The present retrospective descriptive study highlights a considerable burden of low bone mineral density among patients attending the Endocrinology Department of a tertiary care center in South India. The observed prevalence of osteopenia and osteoporosis is comparable to that reported in previous Indian studies, emphasizing the growing public health concern of skeletal fragility in the country. Routine BMD assessment using DXA, coupled with the calculation of FRAX scores, can help identify individuals at high fracture risk even before overt osteoporosis develops. Given the strong association between modifiable risk factors such as age, postmenopausal status, sedentary lifestyle, and vitamin D deficiency with reduced BMD, early lifestyle modification and nutritional interventions should be prioritized.

Future studies with larger community-based cohorts are warranted to explore regional differences in bone health and to develop tailored preventive strategies. Integrating routine osteoporosis screening into endocrinology and primary care practice may serve as an effective step toward reducing the national burden of fragility fractures and associated morbidity.

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