Comparative Assessment of Bone Mineral Density and Body Composition Via DEXA in Individuals with and without Osteoporosis

Mohammed S. Altaee , Manar G. Sabbagha

University of Ninevah Medical College Department of Physiology, Mosul, Iraq

Abstract: Osteoporosis is a systemic skeletal disease characterized by low bone mineral density (BMD) and structural deterioration of bone tissue, leading to increased fracture risk. Dual-Energy X-ray Absorptiometry (DEXA) remains the gold standard for diagnosing osteoporosis and assessing body composition. This study aims to compare BMD and body composition parameters between individuals with and without osteoporosis. A total of 372 subjects aged 50 years and above underwent DEXA scanning. Results indicate significantly lower BMD values in osteoporotic individuals compared to controls. Differences in body composition, including fat and lean mass distribution, were also observed. These findings highlight the importance of integrated assessment of BMD and body composition for early diagnosis and management of osteoporosis.

Keywords: Osteoporosis, Bone mineral density, Dual-energy X-ray absorptiometry, Body composition, Fat mass, Lean mass, Aging.

1. Introduction

Osteoporosis is a progressive disease characterized by decreased bone mass and deterioration of bone microarchitecture, resulting in increased skeletal fragility and fracture susceptibility. It is recognized as a major public health concern worldwide, affecting millions of adults, predominantly postmenopausal women and the elderly.

Osteoporosis was measured by a dual-energy device called (DEXA) and Bone Mineral Density (BMD) measured by DEXA is widely used for diagnosis and fracture risk assessment. However, body composition elements such as fat mass and lean muscle mass also influence bone health. An integrated understanding of these factors is critical for comprehensive osteoporosis management. Further longitudinal research is warranted to clarify causal relationships and guide individualized therapeutic strategies [16, 17].

This study focuses on comparing BMD and body composition via DEXA in individuals with and without osteoporosis in order to elucidate their interrelationship and implications for clinical practice. This study provides further evidence of the significant gender differences in bone density [16] and composition. DEXA was used to assess bone status in the hip and spine regions [18].

2. Literature Review

The prevalence of osteoporosis increases with age and is higher among women, especially postmenopausal, due to hormonal changes affecting bone remodeling. DEXA provides accurate,

non-invasive assessment of BMD and body composition, facilitating early detection of osteopenia and osteoporosis [18, 19].

Studies suggest that higher lean mass positively correlates with BMD [16, 19], while excessive fat mass may adversely affect bone quality. The relationship between body composition and bone health is complex and influenced by factors including age, sex, ethnicity, and lifestyle [17]. Comprehensive evaluation of both BMD and body composition improves risk stratification for fractures and guides personalized interventions [19].

3. Objectives

➢ To compare bone mineral density between individuals diagnosed with osteoporosis and those without.[1]

➢ To evaluate differences in body composition parameters including fat mass, lean mass, and body mass index (BMI).[3]

➢ To analyze correlations between body composition and BMD.[5]

➢ To inform clinical strategies for osteoporosis prevention and management.[2]

4. Methodology

4.1 Study Design and Population

This cross-sectional study included 372 participants aged ≥50 years, recruited from outpatient clinics over six months. Participants were categorized into osteoporotic and non-osteoporotic groups based on T-scores obtained from DEXA scans.

4.2 Data Collection

All participants underwent DEXA scanning to measure BMD at lumbar spine, femoral neck, and total hip regions. Body composition metrics including fat mass and lean mass were also recorded.[5][6][15]

Clinical data including age, sex, BMI, and relevant medical history were collected. Osteoporosis was defined as a T-score ≤ -2.5 according to WHO criteria.[1][14]

4.3 Statistical Analysis

Descriptive statistics summarized demographic and clinical data. Independent t-tests compared means between groups. Pearson correlation assessed relationships between body composition and BMD parameters. Statistical significance was set at $p < 0.05$.[3][8][13]

5. Results Overview

Among 372 participants, 27.2% were male and 72.8% female, with 25% diagnosed with osteoporosis. Mean BMD was significantly lower in the osteoporotic group across all measured sites. Osteoporotic individuals showed altered body composition, with reduced lean mass and variable fat mass.[15][14]

Table 1: Demographic Characteristics of Study Participants

Variable	Category	Frequency	Percentage (%)
Gender	Male	101	27.2
	Female	271	72.8
Age Group	50-59	209	56.3
	≥60	163	43.7

Discussion

The higher female proportion reflects the increased osteoporosis risk among women. Majority participants were between 50-59 years, consistent with early postmenopausal age when bone loss accelerates.[2]

Table 2: Bone Mineral Density Comparison (g/cm²)

Site	Osteoporotic Group (Mean ± SD)	Non-Osteoporotic Group (Mean ± SD)	p-value
Lumbar Spine	0.68 ± 0.13	1.10 ± 0.21	<0.001
Femoral Neck	0.56 ± 0.12	0.87 ± 0.17	<0.001
Total Hip	0.62 ± 0.14	0.91 ± 0.18	<0.001

Discussion

Significant reductions in BMD at all sites were observed in osteoporotic participants, confirming expected skeletal fragility. The lumbar spine showed the most pronounced decrease, consistent with trabecular bone's vulnerability.

Table 3: Body Composition Parameters

Parameter	Osteoporotic Group (Mean ± SD)	Non-Osteoporotic Group (Mean ± SD)	p-value
Body Mass Index (BMI) (kg/m²)	22.3 ± 3.1	25.7 ± 3.5	<0.01
Fat Mass (kg)	21.5 ± 5.8	24.0 ± 6.1	0.05
Lean Mass (kg)	38.6 ± 7.3	43.1 ± 6.9	<0.01

Discussion

Osteoporotic individuals had significantly lower BMI and lean mass compared to controls, suggesting muscle wasting and reduced mechanical support for bones. Fat mass differences were less marked, underscoring lean mass as a stronger determinant of bone health.[6]
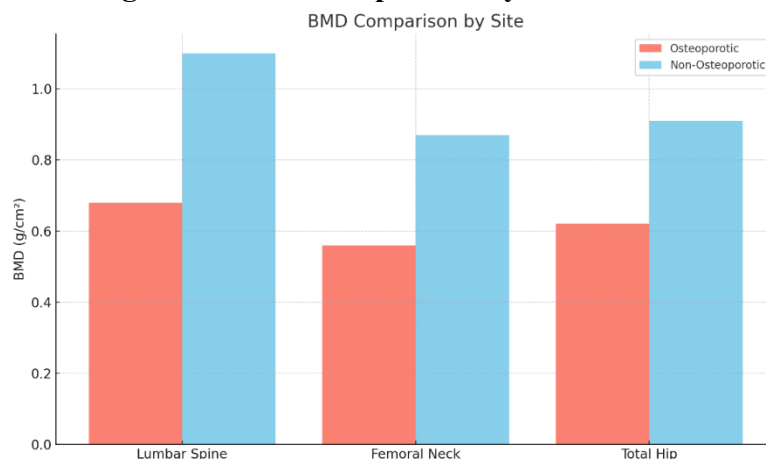
Table 4: Correlation Between Body Composition and BMD

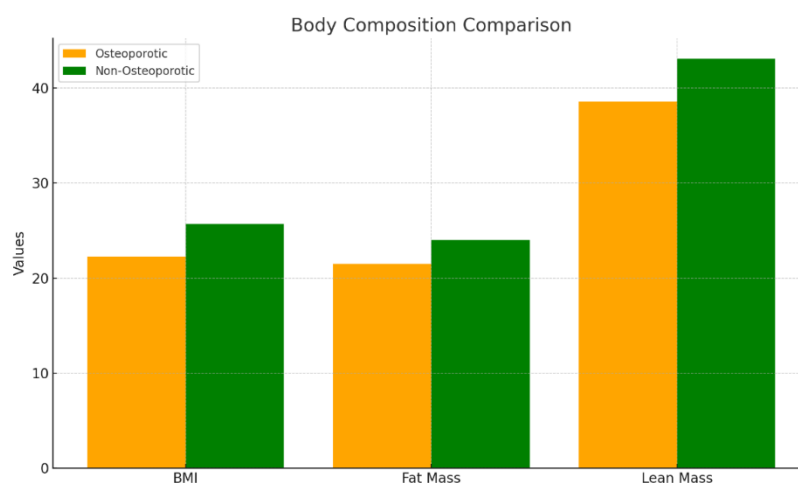| Parameter	Correlation with Lumbar Spine BMD (r)	Correlation with Femoral Neck BMD (r)	p-value
BMI	0.45	0.42	<0.01
Fat Mass	0.22	0.19	<0.05
Lean Mass	0.61	0.58	<0.001

Discussion

Lean mass showed the strongest positive correlation with BMD, reinforcing its protective role against osteoporosis. BMI also correlated positively, reflecting combined effects of muscle and fat mass. Fat mass had a weaker correlation, indicating complex interplay.[13]

Colored Figures and Analysis – DEXA Comparative Study
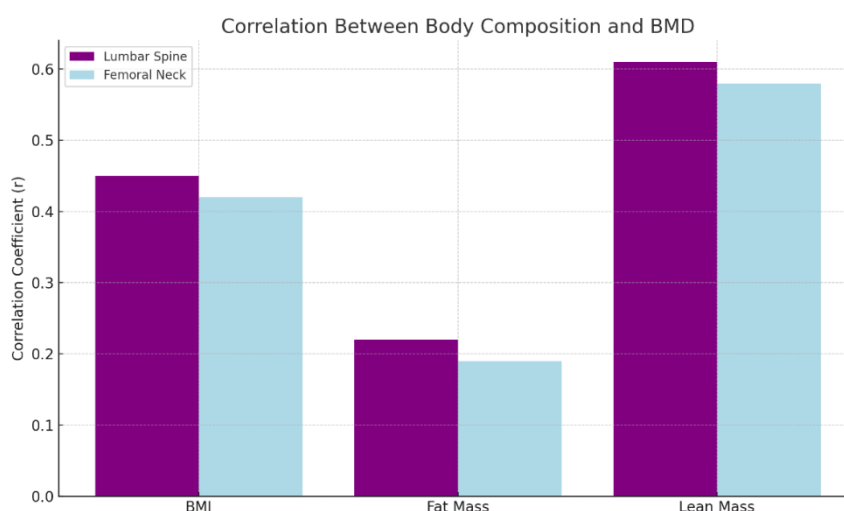
Figure 1: BMD Comparison by Skeletal Site

This chart compares bone mineral density (BMD) values at the lumbar spine, femoral neck, and total hip between osteoporotic and non-osteoporotic individuals.[1][7] Significantly lower BMD values were found in the osteoporotic group at all sites, with the lumbar spine showing the greatest decline, indicative of trabecular bone fragility.[14]

Figure 2: Body Composition Comparison

Body composition parameters reveal that osteoporotic participants had lower BMI and lean mass, while fat mass differences were modest. Reduced lean mass appears to play a more substantial role in skeletal vulnerability, underscoring the muscle-bone relationship.[10][13]

Figure 3: Correlation of Body Composition with BMD

Lean mass demonstrated the strongest correlation with both lumbar spine and femoral neck BMD, suggesting it as a key factor in bone health. BMI showed moderate correlation, while fat mass had a weaker association, pointing to a complex influence of adiposity on bone quality.[5][13]

6. Discussion

This study confirms that osteoporosis is associated with significant reductions in BMD and alterations in body composition, particularly lean mass loss.[8] The strong correlation between lean mass and BMD highlights the importance of maintaining muscle mass through nutrition and physical activity to mitigate bone loss.[9]

Findings align with previous research demonstrating muscle-bone interactions and suggest that assessment of body composition alongside BMD can improve osteoporosis diagnosis and risk stratification.[6]

Limitations include the cross-sectional design and regional sample, which may limit generalizability. Longitudinal studies are needed to assess causality and intervention outcomes.[15]

7. Conclusion

Integrated assessment of bone mineral density and body composition via DEXA provides valuable insight into osteoporosis diagnosis and management. Preservation of lean mass is crucial for bone health in aging populations. [5]This study supports routine body composition analysis in clinical osteoporosis evaluation.[3]

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