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Bone Health Crisis: Analyzing Osteoporosis and Bone Loss in the Pakistani Population

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Abstract

***Objective*:** This study evaluates bone mineral density (BMD) and osteoporosis prevalence among individuals in Karachi, Pakistan, using dual-energy X-ray absorptiometry (DEXA).

***Methods*:** A cross-sectional study was conducted at Jinnah Postgraduate Medical Centre (JPMC), Karachi, involving 350 participants aged 13–96 years. BMD was assessed at the lumbar spine (A/P-L/S) and hip regions using DEXA. T-scores were interpreted according to WHO criteria. Data were analyzed using SPSS v.22.

***Results*:** The mean age was 50.59 ± 14.71 years. Of the total, 89.7% were female and 10.3% male. In the lumbar spine, 24.9% had osteoporosis (T-score ≤ -2.5), 38% had osteopenia (-2.5 < T < -1.0), and 37.1% had normal BMD (T ≥ -1.0). At the hip, 5.7% had osteoporosis, 24% had osteopenia, and 70.3% had normal BMD. The highest prevalence of low BMD was observed in the 51–60-year age group. Notably, males showed a higher-than-expected rate of osteopenia and osteoporosis, particularly in the lumbar spine.

***Conclusion*:** A significant proportion of the studied population, including males, exhibits reduced BMD, indicating a growing public health concern. These findings underscore the need for early screening, targeted interventions, and nationwide surveillance of bone health in Pakistan.

Keywords: Bone health, bone mineral density, densitometric measurements, osteoporosis, DEXA scan.

1. INTRODUCTION

Osteoporosis is a silent metabolic bone disorder characterized by decreased bone mass and microarchitectural deterioration, leading to increased fracture risk [1]. It is a major global health burden, with over 8.9 million fractures annually attributed to the condition [2]. In Pakistan, limited epidemiological data, poor awareness, and inadequate diagnostic infrastructure contribute to underdiagnosis and delayed intervention.

Despite its high morbidity and mortality particularly from hip fractures osteoporosis often remains asymptomatic until a fragility fracture occurs [3]. Dual-energy X-ray absorptiometry (DEXA) remains the gold standard for diagnosing osteoporosis based on T-scores, as defined by the World Health Organization. However, population-specific data from South Asia, especially Pakistan, remain sparse.

Key determinants such as gender, age, vitamin D deficiency, physical inactivity, dietary calcium intake, and socioeconomic status significantly influence BMD but are understudied in the Pakistani context [4, 5]. While postmenopausal women are widely recognized as high-risk, emerging evidence suggests that men are also vulnerable, yet they are rarely screened or included in preventive programs [6].

This study aims to assess the prevalence of osteopenia and osteoporosis in a tertiary care setting in Karachi, with particular attention to gender disparities and age-related trends. By analyzing DEXA results across different demographic groups, we seek to highlight the extent of the bone health crisis in Pakistan and advocate for improved clinical and public health strategies.

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The World Health Organization (WHO) criteria are widely used to interpret bone mineral density (BMD) through the T-score. According to Kanis and Glüer [7], a T-score of –1.0 or above is considered normal, values between –1.0 and –2.5 indicate osteopenia, and a T-score of –2.5 or lower is diagnostic of osteoporosis. These thresholds help classify bone health status and guide clinical decision-making.

2. METHODOLOGY

A cross-sectional observational study was carried out in the Medicine Outpatient Department (OPD) of Jinnah Postgraduate Medical Centre (JPMC), Karachi, from January to December 2020. As a leading tertiary referral hospital, JPMC caters to patients from varied socioeconomic backgrounds across Sindh province. The study received ethical clearance from the Institutional Review Board (IRB) of JPMC (Approval No. IRB/JPMC/2020/017), and written informed consent was obtained from every participant.

A total of 350 participants, aged 13-96 years, were enrolled consecutively. Eligible individuals included adults with nonspecific bone pain, a family history of osteoporosis, previous fragility fractures, or those who were ambulatory. Exclusion criteria comprised pregnancy, recent use of iodine or barium contrast agents (within the past 7 days), nuclear isotope studies, or ongoing treatment with bisphosphonates, calcium, or vitamin D supplements. Although the age range was broad, it was representative of real-world patients referred for DEXA scans. To better capture age-related changes, subgroup analyses were conducted by decade.

Recruitment was carried out in the medicine OPD, as many patients with undiagnosed osteoporosis initially present with vague complaints such as chronic fatigue or back pain rather than overt musculoskeletal injuries. This makes internal medicine clinics an important site for early recognition and diagnosis of osteoporosis, supporting the notion highlighted by Johnell and Kanis [3] that such settings play a pivotal role in timely detection.

3. RESULTS

A total of 350 patients completed the study protocol and were included in the final analysis. Bone mineral density (BMD) was evaluated using T-scores, and no adverse events were reported during or after the DEXA scans. The mean age of participants was 50.6 ± 14.7 years. The mean T-score was −1.51 ± 1.44 at the anteroposterior lumbar spine (AP/LS) and 0.56 ± 1.17 at the hip (Table **1**).

Table 1: Mean age and T-scores of study participants (n = 350).

Variable	**Mean ± S. D**
AGE (yrs.)	50.59±14.714
T-SCORE (AP/LS)	-1.507±1.4405
T-SCORE (Hip)	0.555±1.1747

The demographic distribution of the study population is summarized in Table **2**. Females constituted the majority (n = 314, 89.7%), while males represented 10.3% (n = 36). The largest age group was 51-60 years (n = 118, 33.7%), followed by those aged >60 years (n = 79, 22.6%).

Table 2: Demographic characteristics of the study population (n=350) with frequency of osteopenia and

Parameter	**Frequency**	**Percentage**	**Osteopenia (n)**	**Osteoporosis (n)**
Male	36	10.3%	14	9
Female	314	89.7%	119	78
13-30 yrs	41	11.7%	16	10
31-40 yrs	39	11.1%	15	10
41-50 yrs	73	20.9%	28	18
51-60 yrs	118	33.7%	45	29
>60 yrs	79	22.6%	30	20
Total	**350**	**100%**	**133**	**87**

Table 3: Regional distribution of T-scores (n = 350).

Region	Distribution	T-Score			Total
		Normal (>-1)	Osteopenia (-1 To -2.4)	Osteoporosis (<-2.5)	
A/P(Ls)	Frequency	130	133	87	350
	Percentage	37.10%	38%	24.90%	100%
Hip	Frequency	246	84	20	350
	Percentage	70.30%	24%	5.70%	100%

T-score analysis revealed regional variation in bone health (Table **3**). At the AP/LS site, 130 participants (37.1%) had normal bone density, 133 (38.0%) had osteopenia, and 87 (24.9%) were classified as osteoporotic. At the hip, 246 participants (70.3%) had normal bone density, 84 (24.0%) had osteopenia, and 20 (5.7%) were osteoporotic. The highest frequency of osteopenia (n = 51) and osteoporosis (n = 32) was observed in the 51–60-year age group (Fig. **1**).

Gender-specific comparisons are shown in Table **4**. In the AP/LS region, 34% of females had osteopenia and 24% had osteoporosis, whereas 42% of males had osteopenia and 28% had osteoporosis. Hip measurements revealed osteopenia in 23% of females and 33% of males, while osteoporosis was present in 5% and 8%, respectively.

Although the overall burden of low bone mass was higher in females due to their predominance in the sample, males demonstrated comparable proportions of osteopenia and osteoporosis.

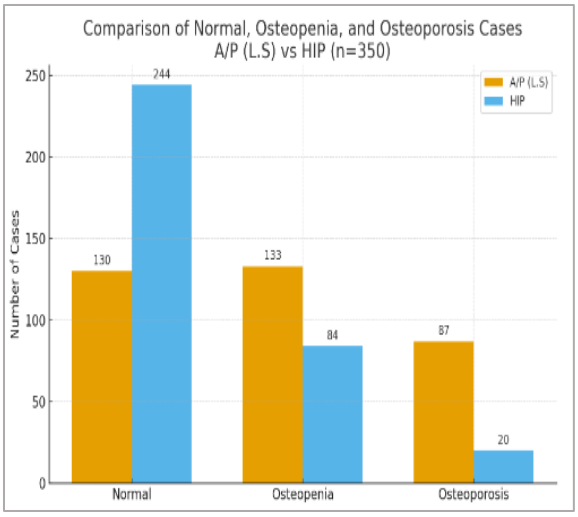

Figure 1: Regional distribution of osteoporosis cases, showing 87 cases in the AP/LS region and 20 cases in the hip.

Table 4: Gender-wise distribution of T-scores in AP/LS and hip regions (n = 350).

Gender	AP/LS Normal (>-1)	AP/LS Osteopenia (-1 to -2.4)	AP/LS Osteoporosis (<-2.5)	HIP Normal (>-1)	HIP Osteopenia (-1 to -2.4)	HIP Osteoporosis (<-2.5)	Total
Male	11	15	10	21	12	3	36
Female	119	118	77	225	72	17	314
Total	130	133	87	246	84	20	350

4. DISCUSSION

This study reveals a substantial burden of low bone mineral density in a representative cohort from Karachi, Pakistan, with over 60% of participants exhibiting either osteopenia or osteoporosis at the lumbar spine. Alarmingly, even among males constituting only 10.3% of the sample nearly 28% had osteoporosis in the lumbar region, challenging the misconception that osteoporosis is primarily a female disease.

These findings align with global trends showing rising osteoporosis prevalence in men, particularly in aging populations [6]. However, in Pakistan, cultural norms, lack of awareness, and absence of routine screening likely led to underdiagnosis in males, delaying intervention until fractures occur.

Bone Mineral Density is a vital tool for evaluating bone health, predicting fracture risk, and diagnosing osteoporosis and osteopenia. Low bone mineral density individuals are at a significantly higher risk of osteoporosis and fractures. Osteoporosis is a condition that decreases bone strength, leading to fractures in the hip, spine, and wrist. Hip fractures are a significant health concern, often necessitating surgery and leading to high mortality rates in elderly patients. Complications of surgery and prolonged bed rest can include infections, blood clots, and cardiorespiratory failure [8, 9] assert that bone mineral density development is influenced by genetics, metabolic activity, and lifestyle habits. Darling *et al*. [10] emphasize that dietary nutrient intake is a crucial factor in the development and progression of low bone mineral density. Rizzoli *et al*. [11] emphasize the importance of consuming essential nutrients like protein, calcium, vitamin D, and phosphorus for maintaining bone health and reducing bone loss. Traditional research often overlooks interactions among different nutrients, as societies evolve and dietary patterns become more complex, focusing on individual nutrients' impact on diseases.

Dietary pattern analysis is a crucial method for investigating the correlation between diet and the likelihood of developing chronic diseases [12]. The literature review indicates that factor analysis and cluster analysis are the most commonly used methods for analyzing dietary patterns. Factor analysis categorizes dietary patterns into quartiles, producing factor scores that can reduce statistical detail [13]. The cluster analysis, which includes Q-type (sample clustering) and R-type (variable clustering), provides distinct advantages. Q-type clustering efficiently groups dietary variables but lacks insight into the dietary patterns within groups. R-type clustering is effective in identifying population groups, but its interpretability is hindered by the complexity and interrelations among dietary items [14].

Osteoporosis in men is a condition that is often underdiagnosed, with hormonal changes playing a significant role in its pathogenesis. Khosla [15] highlighted the significant influence of hormonal changes, including testosterone, on bone density in aging men, a crucial aspect often overlooked in relation to postmenopausal osteoporosis. The current knowledge gap in male osteoporosis screening and treatment strategies, especially in regions like Pakistan, can be addressed to enhance patient care. The relationship between genetic mechanisms associated with apoptosis and environmental factors in osteoporosis, especially in the Pakistani population, is still underexplored. Lo *et al*'.s [16] research on genetic drivers linking rheumatoid arthritis and osteoporosis emphasizes the importance of understanding how these pathways interact with lifestyle and dietary factors. A comprehensive strategy that combines genetic data with environmental factors could facilitate targeted prevention and personalized treatments. This research is crucial for addressing Pakistan's bone health crisis and improving patient outcomes through customized strategies.

The connection between dietary patterns and bone health is understudied, particularly in terms of comprehensive dietary regimens rather than individual nutrients. Kerstetter *et al*.'s [17] research highlights the link between low protein intake and reduced bone density, emphasizing the importance of balanced nutrition for maintaining bone health. The study suggests that examining diverse dietary patterns, including Mediterranean and Western diets, could offer valuable insights into osteoporosis prevention. Studies can inform public health strategies and dietary guidelines to reduce osteoporosis risk, especially in populations like Pakistan.

Limited longitudinal data exists on bone density changes in individuals with type 1 diabetes, especially regarding age-related variations and treatment impact.

Jiang *et al*. [18] highlight bone measurement disparities in young women with type 1 diabetes, urging for more comprehensive studies to understand long-term bone health in this population. Research can enhance diabetes management by identifying bone loss prevention strategies and implementing targeted interventions, thereby contributing to the prevention of osteoporosis in populations like Pakistan.

Psychological stress is linked to osteoporosis, necessitating a multi-factorial approach involving

traditional, alternative, and adjunctive therapies to address the overlapping pathways between stress and bone health. Limited evidence links chronic stress to osteoporosis, but personalized strategies for high-risk populations, like Pakistan's, can enhance outcomes by integrating mental health support with osteoporosis management [19].

The approval of Prolia® (denosumab) in China for postmenopausal osteoporosis highlights the crucial role of real-world evidence (RWE) in regulatory decisions. Storm *et al*. [20] highlighted the effectiveness and safety of Prolia in clinical practice in Taiwan and Hong Kong, aligning its global trial outcomes. The innovative approach streamlined clinical trials, expedited patient access, and highlighted the potential of Randomized Trials (RWE) in supplementing traditional data. Strategies like these could enhance osteoporosis management and regulatory practices in regions like Pakistan, ensuring timely access to effective treatments.

The genetic and environmental factors that contribute to osteoporosis risk exhibit significant gender-specific variations, affecting its etiology and phenotypic presentation. Karasik and Ferrari [21] highlighted that heritability patterns, allelic associations, and quantitative-trait loci often vary by gender, possibly due to sex chromosomes, hormones, or external factors like estrogen levels and physical activity. Future studies should consider gender-specific genetic and environmental factors to improve understanding of osteoporosis, especially in diverse populations like Pakistan, and enhance prevention and treatment strategies.

Dastmanesh *et al*.'s [22] health communication campaign in Iran showed significant improvements in knowledge and attitude among 60-75-year-old rural women, but less pronounced behavioral changes. A health communication campaign is crucial for preventing osteoporosis, particularly among rural elderly women in Pakistan, where cultural, dietary, and healthcare disparities exacerbate the issue.

Osteopenia, a precursor to osteoporosis, frequently causes low-impact fractures and bone pain despite being asymptomatic. The evaluation for underlying causes involves tests for calcium, phosphate, vitamin D, and PTH. Sufficient vitamin D (>30 ng/L), lifestyle modifications (e.g., smoking cessation, reduced alcohol intake, weight-bearing exercises), and monitoring high-risk individuals (e.g., corticosteroid users) are essential [23]. Pakistan faces bone health challenges due to limited awareness, poor nutrition, and diagnostic facilities, necessitating prevention, early detection, and education strategies to reduce osteopenia and osteoporosis.

Low bone density evaluation involves tests for BUN, creatinine, albumin, calcium, phosphate, alkaline phosphatase, 25-hydroxyvitamin D, and PTH, with vitamin D deficiency (<20 ng/mL) or insufficiency (20-30 ng/mL) increasing fracture risk. Lee and Vasikaran [24] recommend additional screenings for anemia, plasma cell myeloma, malabsorption, thyrotoxicosis, hypogonadism, and celiac disease as needed. Pakistan's high rate of undiagnosed deficiencies and limited diagnostic access highlight the need for enhanced screening protocols to mitigate bone health issues.

5. CONCLUSION

Osteopenia and osteoporosis are highly prevalent in the studied population, affecting both women and men. The unexpectedly high rate of low BMD in males emphasize the importance of inclusive screening policies.

Addressing nutritional, behavioral, and systemic healthcare gaps is essential to mitigate the growing burden of bone disease in Pakistan. Public health strategies must prioritize early detection, education, and accessible interventions to prevent debilitating fractures and improve quality of life.

ETHICAL APPROVAL

The study received ethical clearance from the Institutional Review Board (IRB) of JPMC (Approval No. IRB/JPMC/2020/017).

CONSENT TO PARTICIPATE

Written informed consent was obtained from every participant. The study was conducted in accordance with the ethical principles of the Declaration of Helsinki (2013 revision).

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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AUTHOR'S CONTRIBUTION

AS: Substantial contributions to the conception and design of the work, as well as drafting and critically revising the content for intellectual significance.

FA: Google search, literature review, contributing to background research.

HS: Data collection, analysis and interpretation of data for the work

RI: Supervisor

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