Original Article

Unveiling a Hidden Health Crisis: Frequency of Osteopenia and Osteoporosis in the adult Population of Pakistan

Zahid Masood, Kamran Arzoo, Sana Zahid, Mudaser Hussain Abbasi, Sayed Muhammad Yadain, & Wajeeha

ABSTRACT

Objective: To evaluate the frequency of osteoporosis and osteopenia among young adults in Faisalabad and Sargodha, Pakistan. Through this study, we also tried to assess the risk factors and harmful contributors to osteoporosis and osteopenia in young adults to reveal any novel implications that have been missed until now.

Methodology: After ethical approval, this cross-sectional study was conducted at Rai Medical College, Sargodha, recruiting 382 adults (age 18 years and above) from Faisalabad and Sargodha between August and September 2023, using non-probability convenience sampling. Bone mineral density (BMD) was assessed using a SONOST 3000 calcaneal quantitative ultrasound device (measuring BUA and SOS), and participants were classified according to WHO-adapted T-score criteria as normal, osteopenia (T score greater than -2.5 and less than or equal to -1.0), and osteoporosis (T score less than or equal to -2.5).

Results: Normal BMD was observed in 76.7 percent (n=293) of participants, osteopenia in 16.2 percent (n=62), and osteoporosis in 7.1 percent (n=27). A strong age-related increase was evident (p value less than 0.001); participants over 60 years had 34.5 percent osteopenia and 22.4 percent osteoporosis, accounting for 26 of the 27 osteoporosis cases. Gender analysis showed that 13.9 percent of women were osteoporotic, with all osteoporosis cases occurring in females.

Conclusion: Females aged 50 years and above in Punjab exhibit the highest burden of low bone density, driven by aging, sedentary behavior, malnutrition, and socioeconomic factors. Implementing early, affordable QUS screening and gender-focused public health interventions is essential to reduce future fracture risk in Pakistan.

KEYWORDS: Bone Loss, Bone Mineral Density, Gender Disparities, Osteopenia, Osteoporosis

INTRODUCTION

Osteoporosis, with an estimated incidence of over 200 million people globally, has become a serious public health issue, with approximately 10 million cases in the USA. The prevalence of osteoporosis is on the rise in Pakistan, affecting approximately 9.9 million people in the country, which includes a highis expected to rise, with projections indicating that approximately 11.3 million individuals may be affected by 2025–26, and nearly 12.9 million by 2050. Recent local data suggest that high sedentary lifestyles and vitamin D deficiency contribute significantly to bone loss.

Osteopenia is characterized by low bone mineral density (BMD), and affects mostly elderly people. With the deterioration of the bone tissues, osteopenia can progress to the skeletal ailment recognized as osteoporosis. Osteoporosis worsens the quality of life by increasing the risk of fragility number of women—about 7.2 million. This number

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fractures, which may lead to increased morbidity and mortality. Osteoporosis can affect a person regardless of age, gender, or ethnicity; moreover, the incidence of this disease is expected to rise as the person gets older.[1]

Osteoporosis is known to manifest as a silent disease until substantial secondary health problems develop.[2] Recent studies reported a high risk of osteoporosis in post-menopausal women over 50 years of age with low socioeconomic status. The disease was observed in elderly men in North-western China who exhibited lifestyle habits such as consumption of alcohol or smoking and had metabolic complications.[3] However, females tend to lose bone at higher rates as compared to males; it is estimated that yearly femoral neck bone loss is 0.96% in females and 0.82% in males.[4] For this reason, osteoporosis is considered a complex condition, often polygenetic in nature, with no single factor fully accounting for its development and progression. Postmenopausal females affected by osteoporosis perceived it as a condition that interfered with their daily lives and had negative repercussions.[5] The fractures related to osteoporosis can occur in one out of every two females and one out of every eight males after the age of 50.[6]

The International Osteoporosis Foundation (IOF) elaborated multiple factors—such as longevity, sedentary lifestyle, metabolic problems, and nutritional deficiencies—that make individuals more prone to osteoporosis and osteopenia in developing countries.[7,8] Underdeveloped countries are ill-equipped and have limited resources to cope with the disease burden. This situation is further exacerbated by a lack of education and poor understanding and awareness of the disease.[9] According to studies conducted in Pakistan, 75.3 percent of postmenopausal women are prone to osteoporosis, with 55 percent falling into this category between the ages of 45 and 55.[8] As shown in a study conducted in Pakistan, it was suggested that 72.6% of the participants lead an unhealthy and sedentary lifestyle.[10] These concerning factors ultimately lead to the development of osteoporosis and osteopenia later in life.

Osteoporosis in young adults is a relatively infrequent phenomenon. However, studies suggest that young females are more prone to the disease, yet they are less aware of osteoporosis. Nevertheless, reasonable information has been reported in a few studies.

METHODOLOGY

The study was conducted at Rai Medical College, Sargodha, and initiated after receiving approval from the institutional review board (ERC No: RMCS/ERC/24/23, dated 11th July, 2023). A sample of 382 patients was recruited from Faisalabad and Sargodha regions during the months of August-September, 2023. The sample size was calculated after applying Cochrane's formula to the finite sampling frame. Participants were included if aged 18 or above and those who were willing to provide consent. Non-probability convenience sampling was employed given the cross-sectional nature of study and feasibility of patient availability. Verbal informed consent was obtained from the patients after explaining the study protocol and informing them of no risk of exposure to radiation. Participants were excluded if they were under 18 years, pregnant or lactating, had metabolic bone disorders other than osteoporosis, used medications affecting bone metabolism, had recent fractures or calcaneal surgery, severe systemic diseases, active malignancy, or inability to provide consent.

Bone mineral density was assessed using the SONOST 3000 (OsteoSys Co., Ltd., South Korea), a calcaneal quantitative ultrasound device. The device measures broadband ultrasound attenuation (BUA) and speed of sound (SOS) through the calcaneus, calculating a T-score based on the manufacturer's Asian reference database. Measurements were performed on the right calcaneus unless contraindicated. These were undertaken by trained physicians who were supported by skilled nursing staff. Daily calibration

was performed using the manufacturer's phantom, and all measurements were conducted at room temperature (22-25°C) using standard ultrasound coupling gel. Diagnosis of osteoporosis and osteopenia was based on WHO-adapted T-score criteria (T-score ≤ -2.5 for osteoporosis, -2.5 < T-score < -1.0 for osteopenia).

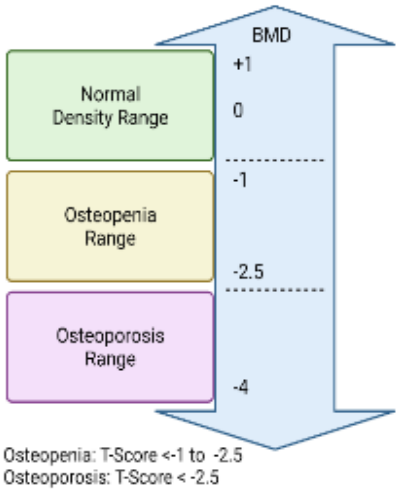
Statistical analyses were conducted using SPSS version 27. We performed descriptive analyses and created cross-tabulations to evaluate the distribution of osteoporosis by gender and age based on BMD criteria. Pearson's Chi-square test was used to determine the statistical significance of these differences. A significance level of $p < 0.05$ was set a priori, as this threshold is widely accepted in clinical and epidemiological research to reduce the likelihood of Type I error while maintaining adequate sensitivity for detecting meaningful group differences.

RESULTS

The sample included 382 participants across five age groups (Fig. 3). Individuals older than 60 years represented the largest proportion of the sample (n =116, 30.4%), followed by those aged 50–59 years (n =96, 25.1%). Participants aged 40–49 years accounted for 22.8% (n =87) of the sample, while younger adults aged 29–39 years (n =50, 13.1%) and 18–28 years (n =33, 8.6%) constituted the smallest proportions. Overall, nearly two-thirds (n =250, 65.5%) of participants were aged 50 years and above. This skew toward older age groups aligned with the study's focus, as osteoporosis and low bone mineral density are more prevalent in older populations.

Fig. 1. Study instrument (SONOST 3000)

Fig. 2. WHO T-score Cutoffs for Normal BMD, Osteopenia, and Osteoporosis



Of the 382 participants, 49.2% were male (n = 188) and 50.8% were female (n = 194). The sample was therefore nearly evenly distributed by gender, with a slight predominance of females (Fig. 4). This balanced representation supports meaningful gender-based comparisons in subsequent analyses.

Fig. 3. Age distribution of sample

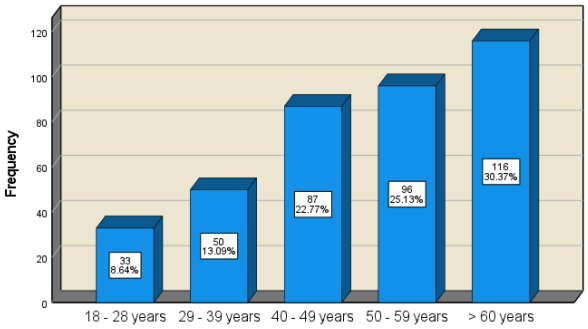
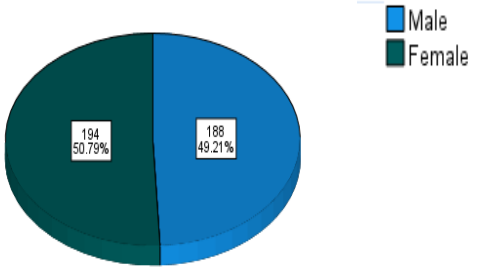


Fig. 4. Gender distribution of sample



Based on WHO T-score criteria, most participants had normal bone mineral density (Table 1). Among the 382 individuals assessed, 76.7% (n = 293) fell within the normal range, while 16.2% (n = 62) were classified as having osteopenia. Osteoporosis was identified in 7.1% (n = 27) of the sample. Overall, nearly one in four participants (23.3%) exhibited reduced bone density (osteopenia or osteoporosis), indicating a meaningful proportion of individuals at elevated risk for future fractures.

Table 1. Proportion of sample by bone mineral density (BMD) categories

		Frequency	Percent
BMD Category	Normal	293	76.7
	Osteopenia	62	16.2
	Osteoporosis	27	7.1
	Total	382	100.0

A strong and statistically significant association was observed between age and osteoporosis ($p < 0.001$). The prevalence of reduced bone density increased progressively with age, showing a clear age-related gradient (Table 2).

All participants aged 18–28 and 29–39 years had normal BMD, indicating an absence of early-onset osteopenia or osteoporosis in the younger age groups. Early signs of bone loss began to appear in the 40–49 year age group, where 4.6% (n = 4) showed osteopenia while no cases of osteoporosis were detected. A more pronounced shift emerged in the 50–59 year group, with 18.8% exhibiting osteopenia and 1.0% meeting the criteria for osteoporosis, suggesting that midlife marks the first substantive transition toward low bone density.

The most striking pattern was observed among participants older than 60 years. In this group, only 43.1% retained their normal BMD, while 34.5% developed osteopenia and 22.4% had osteoporosis. This age group accounted for the vast majority of osteoporosis cases (26 of 27), demonstrating a steep rise in bone fragility with advancing age.

Table 2. Proportion of BMD categories by age

		Normal	Osteopenia	Osteoporosis		p-value
Age Distribution	18 - 28 years	33 (100%)	0 (0%)	0 (0%)	33	<0.001
	29 - 39 years	50 (100%)	0 (0%)	0 (0%)	50	
	40 - 49 years	83 (95.4%)	4 (4.6%)	0 (0%)	87	
	50 - 59 years	77 (80.2%)	18 (18.8%)	1 (1.0%)	96	
	> 60 years	50 (43.1%)	40 (34.5%)	26 (22.4%)	116	
Total		293 (76.7%)	62 (16.2%)	27 (7.1%)	382	

Note. Pearson's Chi-square test: $\chi^2 = 127.574$, $\mathbf{p} < 0.001$.

A significant association also emerged between gender and BMD category ($p < 0.001$), revealing a strong gender-specific pattern (Table 3). While more than 95% of men had normal BMD, women showed a progressive shift toward low bone density, with 27.8% classified as osteopenic and 13.9% as osteoporotic. Notably, all osteoporosis cases occurred among women, highlighting a substantial female burden in this population.

Table 3. Proportion of BMD categories by gender

		Normal	Osteopenia	Osteoporosis		p-value
Gender Distribution	Male	180 (95.7%)	8 (4.3%)	0 (0%)	188	< 0.001
	Female	113 (58.2%)	54 (27.8%)	27 (13.9%)	194	
Total		293 (76.7%)	62 (16.2%)	27 (7.1%)	382	

Note. Pearson's Chi-square test: $\chi^2 = 76.374$, $\mathbf{p} < 0.001$.

DISCUSSION

Despite growing public awareness of osteoporosis and osteopenia and the availability of standardized national and international treatment guidelines, both treatment initiation and long-term adherence remain major challenges. Our study highlighted the frequencies of osteopenia and osteoporosis amongst adult male and female populations in Punjab, Pakistan, revealing pronounced gender- and age-related disparities. The distribution

illustrated a clear stepwise decline in bone density across the lifespan, with normal BMD predominating at younger ages, the emergence of osteopenia in midlife, and a substantial burden of osteoporosis in older adults. Notably, women exhibited significantly higher rates of low bone density than men, accounting for nearly all osteoporotic cases, underscoring the heightened vulnerability of older female populations and the need for targeted prevention and management strategies.[20,21]

As presented in Table 1, 7.1% of our sample demonstrated the occurrence of osteoporosis. These results were comparable with known figures for Asian region, as reflected in multiple studies such as the meta-analysis done by Chandran et al., which suggested that 5-10% in Asian-Pacific countries suffer from the disease.[12] They were inconsistent with other studies conducted in Pakistan, with a recent study from Lahore reporting much higher levels of prevalence in its sample.[13] However, it is important to note that most studies focus exclusively on female cohorts—particularly postmenopausal women—which limits compara-bility and restricts the generalizability of their findings to the broader adult population.[14,15] Levels of osteopenia, which can progress to osteoporosis if left untreated, were 16.2% in our sample and more consistent with local data.[16]

Raised prevalence of osteopenia and osteoporosis in females was consistent with previous research which indicates that gender disparities in bone mineral density prevailed due to socioeconomic factors.[6,7] Similar results were also found in various developing countries, where lower levels of physical activities coupled with unbalanced dietary habits contributed to higher incidence rates of osteoporosis, especially among females. A study conducted in Pakistan by Khan et al. reviewed the current evidence on osteoporosis in Pakistan and highlighted the high prevalence of low bone mineral density and fragility fractures among the population, particularly in postmenopausal women and the elderly.[8]

As age increased, there was a decline in normal bone density with females consistently showing lower values across the study samples.[13] This suggests that females are more prone to bone density loss over time. Such results may be attributed to hormonal changes, inadequate nutrition, postmenopausal effects, and lifestyle factors, which play a crucial role in developing countries like Pakistan.[17, 18] The impact of these factors is reflected in multiple studies across the region which highlight an increased risk for developing osteoporosis with advancing age and onset of menopause such as the multi-center study performed by Hassan and colleagues in Bahrain[19] and Fan et al. in the Chinese population.[11]

Similar findings have been reported in other populations, where low bone mineral density and osteoporosis in adults aged ≥50 years were significantly associated with sedentary lifestyle, poor nutritional status, and inadequate calcium intake. Additionally, socioeconomic constraints, unhealthy dietary patterns, and metabolic disturbances have been shown to contribute to increased vulnerability to osteopenia and osteoporosis.[22,23]

This study had several strengths, including the use of a calcaneal quantitative ultrasound (QUS) device for bone health assessment, which provided standardized T-score estimates and enabled consistent screening across participants, as well as the inclusion of both men and women across a broad adult age range, contributing much-needed local evidence in a setting where mixed-gender BMD data have been limited. However, the findings should be interpreted in light of several limitations. The single-center, cross-sectional design and the use of non-probability convenience sampling restrict the generalizability of the results and introduce the potential for selection bias. Additionally, reliance on a single QUS device may carry measurement variability related to calibration and operator technique, and the absence of key clinical variables such as menopausal status, BMI, vitamin D levels, and lifestyle factors limits our

ability to explore additional determinants of low BMD. These methodological constraints underscore the need for larger, multicenter, and longitudinal studies—ideally incorporating DEXA—to better understand osteopenia and osteoporosis risk patterns in Pakistan.

CONCLUSION

Our study concluded that females aged 50 and above living in the Faisalabad and Sargodha regions are more prone to develop lower bone mineral density and develop osteopenia and osteoporosis. Multiple factors like sedentary lifestyle, malnutrition, socio-economic issues, and metabolic problems may lead to these diseases. We strongly suggest that public health awareness programs regarding preventive measures and early screening be integrated into routine care provision, especially for younger adults who may be at risk for developing major bone problems without knowing.

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