



## Original Article



## Correlation between Vitamin D Deficiency and Osteopenia in Women Residing in Karachi, Pakistan

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## ABSTRACT

Osteopenia is one of the primary health concerns among Pakistani women. **Objective:** To assess the Correlation Between Vitamin D Deficiency and Osteopenia in Women in Karachi, Pakistan. **Methods:** A cross-sectional survey was conducted among 200 women in Karachi, Pakistan. A self-reported questionnaire was given to all participants so that they could fill in the demographic data. Only participants who were willing to participate in the study were included, and those who failed to provide any data regarding the status of menopause were excluded. SPSS version 23.0 was used to analyze the data. **Results:** The 200 women in the study had a high reproductive burden (mean pregnancies = 12), with a mean age of 65.2 years and a BMI of 25.6 kg/m<sup>2</sup>. Age-related decreases in bone mineral density were significant ( $p=0.0002$ ), and osteoporosis was most prevalent in older age groups. The distribution of vitamin D deficiency across age groups was not statistically significant ( $p=0.22$ ), but it was associated with ageing ( $p=0.011$ ). **Conclusions:** It was concluded that although vitamin D deficiency is common among women, age is a better indicator of deteriorating bone mineral density. Age-focused bone health interventions are needed, as osteoporosis and osteopenia were significantly correlated with advancing age.

## INTRODUCTION

The long-term health of the ageing population is being negatively impacted by osteoporosis and osteopenia, which raises the risk of death, reduces autonomy, increases hospitalization rates, and places a significant financial and social load on the healthcare system. The longer life expectancy is linked to a higher prevalence of age-related illnesses, including osteopenia [1]. Osteopenia is one of the biggest health issues faced by Pakistani women currently [2]. The World Health Organization (WHO) defines osteopenia as having a T-score between -1.0 and -

2.5, which indicates that bone density is lower than usual but not low enough to be categorized as osteoporosis [3]. A T-score of -2.5 or less indicates osteoporosis, which is characterized by a more severe loss of bone mass [4]. A degenerative disease that affects all of the bones in the body is called osteoporosis [5]. When the levels of bone mass density are below normal, it is called osteopenia [6]. Osteopenia is 40.40% and osteoporosis is 19.75% prevalent worldwide [7]. Hence, the burden of these conditions has been rising for almost three decades [8]. It



has a complex etiology since numerous factors affect bone health, such as exercise and diet [9, 10]. Pakistani women's osteopenia rates are high due to sedentary lifestyles, a deficiency in foods high in calcium, and the popularity of fast food. Osteopenia is primarily linked to inadequate vitamin D intake or lack of availability of sufficient sunlight [11]. Serum levels of 25-hydroxyvitamin D (25 (OH)D) are commonly used to determine vitamin D status, and classifications have become more uniform in recent years. Gupta et al., 2022 define vitamin D deficiency as serum 25 (OH)D levels below 12 ng/mL (30 nmol/L), insufficiency as levels between 12 and 20 ng/mL (30 and 50 nmol/L), and sufficiency as levels above 20 ng/mL (50 nmol/L). These cutoff points are used for screening and treatment decisions in both adult and pediatric populations, and they are based on correlations with outcomes related to bone health [12]. The main causes of vitamin D deficiency are nutritional deficiencies, limited sun exposure among women, and other chronic conditions. Appropriate amounts of vitamin D are available in the subcontinent with adequate sun exposure. The body uses vitamin D as a hormone, and it is crucial for the mineralization of bones. It also supports immunological function, muscular integrity, and cell proliferation. It contributes to healthy skin development, reproduction, and other metabolic processes. Given its increasing significance, scientists advise taking it at a dosage of at least 1000 IU. Worldwide, the prevalence of vitamin D deficiency is estimated to be 50%. Obesity and malnutrition can be detrimental to one's health and can cause bone problems such as osteoporosis, osteoarthritis, sarcoidosis-related osteoporosis, and osteopenia. Food, medication, and nutritional supplements are used to treat metabolic bone disease [13]. Pakistan is underfunded to address this disease's burden because of its slow progression and high cost of care. A population-based study found that osteopenia and osteoporosis affect millions of people in Pakistan [14]. The Osteoporosis Risk Assessment Instrument now includes current estrogen therapy in addition to the Osteoporosis Self-Assessment Tool and OST for people residing on the Asia continent. Hence, the prognostic instruments (OST, OSTA, and Osteoporosis Index) of Risk, as well as straightforward computed osteoporosis risk estimation. Concentrate on postmenopausal women's osteoporosis risk. Certain biomarkers, such as blood or urine indicators, are readily available during normal medical examinations and have been shown to enhance the sensitivity of osteoporosis prediction at the preclinical stage [15]. Despite the high prevalence of osteopenia and vitamin D deficiency among women in Pakistan, there is limited local evidence exploring their direct correlation, particularly using standardized biomarkers in specific populations. This lack of context-specific data restricts early

identification, risk assessment, and targeted prevention strategies for bone health in women. Therefore, this study aims to assess the correlation between vitamin D deficiency and osteopenia among women residing in Karachi, Pakistan.

## METHODS

In Karachi, Pakistan, 200 participants with an average age of 65.2 years were recruited for this cross-sectional study between June and September 2024. With  $Z=1.96$  at a 95% confidence level,  $p$ =expected prevalence, and  $d$ =margin of error (0.05), the sample size was calculated using open epi based on past research conducted by Khan et al., [16] showing high rates among Karachi women (an expected prevalence of 75% for vitamin D deficiency). We recruited 200 participants to account for the estimated sample size of 196 with an 80% power and a 5% margin of error. A non-probability purposive sampling strategy was used to find participants from outreach clinics and community health centers located throughout Karachi. Women who were at least 45 years old, Karachi residents, and willing to give informed consent were among the requirements for inclusion. Women who reported not being menopausal or who were receiving treatment for any bone-related conditions or recent fractures were not included in the study. To further reduce confounding, people taking vitamin D supplements or having comorbid conditions like liver or kidney disease were not included. The Sir Syed Medical and Dental College for Girls' Ethical Review Committee granted ethical approval for the study (Ref. No: 032 SSCMS-Ethics/2024). After being made aware of the goals and methods of the study, each participant gave their written informed consent. A structured, self-reported questionnaire that was pilot-tested and approved by public health specialists for relevance and clarity was used to gather data. Age, weight, height, number of pregnancies, lifestyle factors, history of vitamin D supplementation, sun exposure, and known comorbidities were all included in the questionnaire. Where possible, laboratory studies were used to supplement clinical data. Dual-Energy X-ray Absorptiometry (DEXA) scans were used to measure bone mineral density (BMD). According to WHO guidelines, osteoporosis was defined as a T-score  $\leq -2.5$ , and osteopenia as a T-score between  $-1.0$  and  $-2.5$ . According to Gupta et al., vitamin D status is classified as deficient ( $<12$  ng/mL), insufficient (12–20 ng/mL), and sufficient ( $>20$  ng/mL) based on serum 25-hydroxyvitamin D [(5(OH)D) levels [12]. SPSS version 23.0 was used for statistical analysis. Standard deviations and means were used to summarize continuous variables. For non-parametric data, independent samples were compared using the Mann-Whitney U test. Since vitamin D status and BMD were both ordinal/non-parametric variables, the relationship

between them was evaluated using Spearman's rank correlation coefficient. Unless otherwise noted, all tests were two-tailed and performed at a 5% level of significance. Correlation analyses took into account confounding variables like age and BMI.

## RESULTS

The results of the study revealed that the demographic characteristics of the participants, showing an average age of 65.2 years, mean BMI of 25.6 kg/m<sup>2</sup> (overweight range), and a high average number of pregnancies (12), reflecting a population at elevated risk for bone health issues (Table 1).

**Table 1:** Participants' Demographic Details

Variables	Mean
Age (Years)	65.2
Weight (kg)	59
Height (m)	1.51
BMI (kg/m <sup>2</sup> )	25.6
No. of Pregnancies	12

The mean age of participants is categorized by vitamin D classification and bone mineral density (BMD) status. The mean age of the 200 participants was 67.3 ± 9.3 years for those with normal BMD (n=28), whereas the mean ages of those with osteopenia (n=117) and osteoporosis (n=55) were higher at 68.5 ± 8.6 years and 74.2 ± 9.9 years, respectively. Growing older is linked to a higher risk of having less bone mineral density, as evidenced by the statistically significant difference in mean age between the BMD categories (p=0.002). Similarly, participants with vitamin D deficiency (n=74) had the highest mean age of 71.5 ± 9.4 years, followed by those with sufficient levels (n=16; 69.3 ± 9.1 years) and those with insufficient levels (n=110; 68.6 ± 8.5 years). Additionally, this difference was statistically significant (p=0.011), pointing to a possible connection between deteriorating vitamin D levels and ageing. These results highlight the link between vitamin D deficiency, ageing, and deteriorating bone health in the population under study (Table 2).

**Table 2:** The Average Patient Age (in Years) for Osteopenia and Vitamin D3

Variables	n	Age Mean ± SD	p-Value
<b>Classification of Bone Mineral Density</b>			
Normal	28	67.3 ± 9.3	0.002
Osteopenia	117	68.5 ± 8.6	
Osteoporosis	55	74.2 ± 9.9	
<b>Classification of Vitamin D</b>			
Deficiency	74	71.5 ± 9.4	0.011
Insufficient	110	68.6 ± 8.5	
Sufficient	16	69.3 ± 9.1	

Age and BMD status were found to be significantly

correlated (p=0.005). Osteoporosis prevalence rose steadily with age, rising from 1% in the 45–59 age group to 14% in the 80–99 age group. Osteopenia also became more common as people aged, reaching a peak of 15% in those aged 60 to 79. On the other hand, the percentage of women with normal bone mineral density was highest in the 60–79 age range and decreased in the oldest group, indicating a definite age-related decrease in bone mineral density. Hence, there was no statistically significant variation in the distribution of vitamin D status among age groups (p=0.220). While vitamin D insufficiency was consistently seen in all age groups, ranging from 7% to 13%, vitamin D deficiency was most common in the 70–79 age group (13%). While vitamin D deficiency was consistently found in all age groups, ranging from 7% to 15%, vitamin D deficiency was most common in the 70–79 age group (13%). It's interesting to note that the percentage of participants with adequate vitamin D levels was essentially constant across age groups, with the oldest group experiencing a minor increase (5%) (Table 3).

**Table 3:** Correlation of Women's Age with Each Variable

Variables	45–59 Years	60–69 Years	70–79 Years	80–99 Years	p-Value
<b>Bone Mineral Density</b>					
Normal	6 (3%)	15 (7%)	15 (7%)	12 (6%)	0.005
Osteopenia	9 (4%)	30 (15%)	31 (15%)	19 (9%)	
Osteoporosis	3 (1%)	13 (6%)	19 (9%)	28 (14%)	
<b>Vitamin D Status</b>					
Deficiency	10 (5%)	21 (10%)	27 (13%)	15 (7%)	0.220
Insufficient	16 (8%)	30 (15%)	30 (15%)	14 (7%)	
Sufficient	6 (3%)	11 (5%)	9 (4%)	11 (5%)	

## DISCUSSION

Osteopenia is a symptom of osteoporosis and a major indicator of bone health among women in Asia [18]. Deficits in vitamin D, which is essential for calcium absorption, are uncommon in young, healthy people but common in elderly persons, particularly in areas with little sunshine [19]. The results of our investigation showed that while vitamin D deficiency is widespread, its association with osteopenia is complicated and is probably impacted by confounding variables such as age, body mass index, and reproductive history. Interestingly, the results indicated that there was no correlation between vitamin D levels and BMD status across age groups (p=0.220), even though 74 out of 200 people had vitamin D deficiency. The lack of a statistically significant correlation between vitamin D levels and BMD status (p=0.110) implies that while vitamin D may affect bone health, age may be a more relevant predictor of BMD. Women with osteoporosis had a considerably higher mean age (74.2 ± 9.9 years) than those with osteopenia (68.5 ± 8.6 years) and normal bone mineral density (67.3 ± 9.3 years), which supports the notion that ageing-related

physiological changes have a major impact on bone density ( $p=0.002$ ). Deteriorating bone health may also result from the cumulative demands on calcium stores during pregnancy and lactation [20]. This problem is especially important in South Asia, where there are several lifestyle variables, limited sun exposure, and low consumption of foods high in vitamin D [21]. According to this study, women with osteopenia and osteoporosis frequently have vitamin D deficiency, and age seems to have a bigger influence on their BMD status in this group.

This study was limited by its cross-sectional design, which restricts the ability to establish causal relationships between vitamin D levels and bone mineral density. Additionally, potential confounding factors such as dietary intake, physical activity, sun exposure, and socio-economic status were not fully accounted for. Future studies should consider longitudinal methods, looking at additional important elements including exercise, dietary patterns, and socio-economic status.

## CONCLUSIONS

It was concluded that bone mineral density (BMD) significantly decreases with age, and osteopenia and vitamin D deficiency are highly prevalent among older women in Karachi. Despite being widespread, vitamin D deficiency did not statistically significantly correlate with BMD status, indicating that ageing is a more reliable indicator of declining bone health. To prevent bone-related complications in postmenopausal women, these findings emphasize the necessity of early screening and age-targeted interventions.

## Authors' Contribution

Conceptualization: YB, SM

Methodology: YB, KP, NA, SM

Formal analysis: BZ, SM

Writing and Drafting: AH, KP, NA, PR

Review and Editing: YB, AH, BZ, KP, NA, PR, SM

All authors approved the final manuscript and take responsibility for the integrity of the work

## Conflicts of Interest

All the authors declare no conflict of interest.

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