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Article

Prevalence and Risk Factors of Osteoporosis Among Postmenopausal Women in Timergra Teaching Hospital, Dir Lower

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ABSTRACT

Background: Osteoporosis is a major public health challenge among postmenopausal women, contributing significantly to morbidity, mortality, and healthcare burden; yet, regional epidemiological data in Pakistan remain limited. **Objective:** This study aimed to assess the prevalence of osteoporosis and its association with demographic, nutritional, and lifestyle factors, specifically calcium and vitamin D supplementation, among postmenopausal women in Dir Lower, Pakistan. **Methods:** A descriptive cross-sectional study was conducted among 442 postmenopausal women aged 40–59 years recruited through random sampling. Inclusion criteria were postmenopausal status and residency in Dir Lower; exclusion criteria included chronic bone disorders or use of bone-affecting medications. Data were collected via structured interviews, and bone mineral density was assessed using Dual-Energy X-ray Absorptiometry (DEXA). Ethical approval was obtained per the Declaration of Helsinki, and informed consent was secured. Statistical analysis using SPSS version 24 included chi-square tests, logistic regression, and Pearson's correlation. **Results:** Osteoporosis prevalence was 19.8%. Women aged 50–59 years showed significantly higher osteoporosis rates (32.6%) compared to those aged 40–49 years (14.8%; $p < 0.001$). Lower educational attainment ($p = 0.001$) and unemployment ($p = 0.002$) were also associated with increased risk. Calcium supplementation during the study period was linked to the highest osteoporosis prevalence (56.8%), and vitamin D supplementation patterns showed significant associations ($p < 0.001$), suggesting reverse causality. Logistic regression confirmed age and calcium intake as significant independent predictors. **Conclusion:** Osteoporosis is a significant health concern among postmenopausal women in Dir Lower. Early screening, public education, and structured supplementation programs targeting calcium and vitamin D intake are crucial to reducing fracture risk and improving women's bone health outcomes.

Keywords: Osteoporosis, Postmenopause, Bone Mineral Density, Vitamin D, Calcium, Public Health, Risk Factors

INTRODUCTION

Osteoporosis is a systemic skeletal disorder characterized by reduced bone mineral density and deterioration of bone microarchitecture, leading to increased bone fragility and susceptibility to low-impact fractures (1). Osteoporotic fractures, particularly hip and vertebral fractures, significantly impair quality of life, increase morbidity and mortality, and contribute to long-term disability (2).

Over 50% of postmenopausal white women are expected to experience an osteoporosis-related fracture during their lifetime, with only one-third of senior women regaining independence following a hip fracture (3). Although the lifetime risk of osteoporotic fracture among white men is lower at around 20%, their one-year mortality risk after a hip fracture is nearly double that of women (3). While Black men and women have lower rates of osteoporosis compared to white individuals, their risk of fracture after diagnosis is comparable (4).

Primary osteoporosis, predominantly seen in older adults, results from age-related hormonal changes, notably the decline in estrogen levels that accelerates bone resorption over bone formation (5). In contrast, secondary osteoporosis arises from underlying diseases or medication use, such as glucocorticoids, anti-epileptics, chemotherapeutic agents, proton pump inhibitors, and thiazolidines (6). Conditions like hyperparathyroidism, malabsorption syndromes, hyperthyroidism, chronic renal failure, and prolonged immobilization further contribute to secondary bone loss (6). Moreover, secondary

amenorrhea exceeding one year, low body weight, and excessive physical activity can also precipitate accelerated bone mass reduction (6).

Several well-established risk factors for osteoporosis include advanced age, low body weight (<58 kg), smoking, a family history of osteoporosis, Caucasian or Asian ethnicity, early menopause, physical inactivity, and prior fractures from minimal trauma after the age of 40 (7). Patients with limited mobility, such as those with spinal cord injuries, may experience rapid declines in bone mineral density within just two weeks of immobilization (8). Osteoporotic fractures constitute a substantial burden globally, reaching approximately 9 million cases per year, and are projected to quadruple to 36 million by 2050 due to an aging population (9). According to the International Osteoporosis Foundation, one in three women and one in five men aged 50 years or older will suffer a fragility fracture (10-12). Among postmenopausal women with osteoporosis, vertebral deformities and hip fractures are reported in 25% and 15% of cases, respectively (13).

Hormonal alterations, particularly the decline in estrogen levels after menopause, adversely impact calcium absorption, further accelerating bone mass deterioration (14-16). Reduced calcium levels contribute to osteopenia and, if left unmanaged, to osteoporosis and a higher risk of fractures (17). Lifestyle factors such as inadequate calcium and vitamin D intake, smoking, physical inactivity, and low body weight exacerbate these risks (18). Calcium and vitamin D are critical for maintaining bone health. Studies have demonstrated that deficiencies in these nutrients disrupt bone remodeling and increase fracture risk in postmenopausal women (19,20). Dairy products, leafy green vegetables, and fortified foods remain essential dietary sources of calcium, while vitamin D is obtained through sun exposure and fortified foods (21,22). Clinical trials and meta-analyses suggest that calcium and vitamin D supplementation can reduce bone loss and lower fracture risk among older adults (23-25). Consequently, the National Institutes of Health (NIH) recommends a calcium intake of 1500 mg/day for postmenopausal women (26), along with adequate vitamin D supplementation as part of osteoporosis prevention strategies (20,27).

Epidemiological studies worldwide have identified various risk factors for osteoporosis, including demographic, lifestyle, and dietary influences; however, findings remain inconsistent across different ethnic and geographical populations (28-32). In Pakistan, the literature on the prevalence and risk factors for osteoporosis is notably scarce. A prospective cross-sectional study reported a 43.3% prevalence among Pakistani postmenopausal women (33), while another study reported a prevalence of 29.6% in women with a mean age of 53.23 years (33). A multicenter study involving 1079 women aged 45–84 years found a 37.5% prevalence of osteoporosis, with significant associations observed with age, physical activity, sun exposure, parathyroid hormone levels, calcium intake, caffeine consumption, and marital status (5). Another study reported a 16.7% prevalence and highlighted risk factors such as low peak bone mass, vitamin D deficiency, high body mass index, and genetic factors (6).

Given the paucity of comprehensive national data on osteoporosis among postmenopausal women in Pakistan, and the need to explore its association with demographic and lifestyle factors, this study aimed to (1) determine the prevalence of osteoporosis among postmenopausal women in Dir Lower, Pakistan, and (2) examine the relationship between osteoporosis and demographic characteristics, calcium intake, and vitamin D status.

MATERIALS AND METHODS

This descriptive, cross-sectional study was conducted in 2018 to assess the prevalence and risk factors associated with osteoporosis among postmenopausal women in Dir Lower, Pakistan. A total of 442 women aged 40 to 59 years were recruited using random sampling from various urban and semi-urban areas, including Tehsil Khall, Lal Qala, Timergara, Balmbat, Samrbagh, Adenzai, and Munda. Participants were included if they were permanent residents of Dir Lower, aged between 40 and 59 years, postmenopausal (defined as the absence of menstruation for at least 12 consecutive months), and provided informed written consent to participate. Women were excluded if they had a history of bone diseases (such as Paget's disease or osteogenesis imperfecta), malignancy, chronic kidney disease, organ transplant, or were on long-term medications known to affect bone mineral density, including glucocorticoids and anticonvulsants. The study was conducted in accordance with the ethical standards of the Declaration of Helsinki. Ethical approval was obtained from the relevant institutional review board, and participant confidentiality was maintained by assigning unique identification numbers and securely storing all collected data.

Data collection involved the use of a structured questionnaire administered through face-to-face interviews. Demographic information collected included age, education level, marital status, and occupation. Nutritional assessments covered dietary intake focusing on calcium and vitamin D consumption, as well as supplement usage. Self-reported data regarding vitamin D and calcium intake were recorded as either current use during the study period, use within one week prior to the study, or never used. Bone mineral density (BMD) was assessed using Dual-Energy X-ray Absorptiometry (DEXA) at the lumbar spine and femoral neck. Based on the World Health Organization (WHO) T-score criteria, participants were categorized as osteoporotic (T-score ≤ -2.5), osteopenic (-1.0 ≥ T-score > -2.5), or normal (T-score > -1.0). The primary outcome was the prevalence of osteoporosis among the sampled women. Secondary outcomes included the association between osteoporosis and demographic or nutritional factors, such as age, educational level, occupational status, and supplement intake. There were no follow-up visits since the study was cross-sectional in nature.

Statistical analysis was performed using IBM SPSS Statistics software (version 24.0). Descriptive statistics, including means, frequencies, and percentages, were calculated for all demographic and clinical variables. Categorical variables were compared using chi-square tests. Logistic regression models were applied to identify independent risk factors for osteoporosis, with odds ratios (OR) and 95% confidence intervals (CI) reported. Pearson's correlation coefficient was used to examine the strength and direction of associations between continuous variables. Statistical significance was set at a p-value of less than 0.05. Data were analyzed as collected, without imputation for

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missing data, as there were minimal missing responses noted during data collection.

RESULTS

A total of 442 postmenopausal women aged between 40 and 59 years participated in the study. Participants were distributed across three regions of Dir Lower: Region 1 (Tehsil Khall, Lal Qala, and Timergara) accounted for 31.4% of the sample, Region 2 (Tehsil Balmbat, Tehsil Samrbagh) for 44.0%, and Region 3 (Tehsil Adenzai, Tehsil Munda) for 24.5%. The majority of participants were aged 40–49 years (56.3%), while 43.7% were aged 50–59 years. Regarding educational status, 44.5% had completed primary education, 34.7% had secondary education, and 18.6% held a college degree or higher. Most participants were married (69.8%) and unemployed (77.0%) (Table 1).

The overall prevalence of osteoporosis among the participants was 19.8%. Osteoporosis prevalence varied significantly across regions, with the highest in Region 1 (24.5%), followed by Region 2 (19.5%), and the lowest in Region 3 (14.4%) ($p = 0.019$). A significant association was found between age and osteoporosis prevalence: women aged 50–59 years had a higher prevalence (32.6%) compared to those aged 40–49 years (14.8%) ($p < 0.001$). Education level was also significantly associated with osteoporosis; women with only primary school education exhibited a higher prevalence (24.7%) compared to those with secondary school (18.6%) or college education (11.6%) ($p = 0.001$). Occupation showed a significant relationship, with unemployed women exhibiting the highest prevalence of osteoporosis (22.2%) compared to retired (13.3%) and employed women (7.4%) ($p = 0.002$). Marital status, however, was not significantly associated with osteoporosis ($p = 0.083$) (Table 2).

Table 1: Sociodemographic Characteristics of Participants

Variable	Number (n)	Percentage (%)
Region		
Region 1 (Khall, Lal Qala, Timergara)	139	31.4%
Region 2 (Balmbat, Samrbagh)	194	44.0%
Region 3 (Adenzai, Munda)	109	24.5%
Age (years)		
40–49	249	56.3%
50–59	193	43.7%
Educational Level		
Primary School	196	44.5%
Secondary School	141	34.7%
College Degree or Higher	105	18.6%
Marital Status		
Married	309	69.8%
Unmarried	133	30.2%
Occupation		
Unemployed	340	77.0%
Retired	57	12.8%
Employed	45	7.7%

Table 2: Prevalence of Osteoporosis According to Demographic Variables

Variable	Osteoporosis Present (n, %)	Osteoporosis Absent (n, %)	p-Value
Region			
Region 1	34 (24.5%)	105 (75.5%)	0.019
Region 2	38 (19.5%)	156 (80.5%)	
Region 3	16 (14.4%)	93 (85.6%)	
Age (years)			<0.001
40–49	37 (14.8%)	212 (85.2%)	
50–59	51 (32.6%)	106 (67.4%)	
Educational Level			0.001
Primary School	48 (24.7%)	148 (75.3%)	
Secondary School	27 (18.6%)	120 (81.4%)	
College Degree or Higher	8 (11.6%)	61 (88.4%)	
Occupation			0.002
Unemployed	75 (22.2%)	265 (77.8%)	
Retired	8 (13.3%)	52 (86.7%)	
Employed	4 (7.4%)	41 (92.6%)	

Logistic regression analysis demonstrated that women from Region 2 had nearly twice the odds of osteoporosis compared to those from Region 1 (OR = 1.943, 95% CI 1.216–3.103, $p = 0.005$). Women aged 40–49 years had significantly lower odds of

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osteoporosis compared to women aged 50–59 years (OR = 0.363, 95% CI 0.179–0.737, p = 0.005). No statistically significant associations were found between osteoporosis and educational level or occupational status in the adjusted analysis (Table 3).

Table 3: Association Between Osteoporosis and Demographic Characteristics

Variable	Odds Ratio (OR)	p-Value	95% CI
Region			
Region 2 vs Region 1	1.943	0.005	1.216–3.103
Region 3 vs Region 1	1.457	0.105	0.924–3.103
Age (years)			
40–49 vs 50–59	0.363	0.005	0.179–0.737
Educational Level			
Primary School vs College	1.619	0.157	0.831–3.155
Secondary School vs College	1.440	0.287	0.736–2.818
Occupation			
Unemployed vs Employed	2.175	0.123	0.811–5.838
Retired vs Employed	1.710	0.330	0.581–5.031

Table 4: Prevalence of Osteoporosis According to Nutritional Factors

Variable	Osteoporosis Present (n, %)	Osteoporosis Absent (n, %)	p-Value
Vitamin D Supplement Intake			<0.001
During the Study Period	28 (31.3%)	62 (68.7%)	
One Week Before Study	32 (22.2%)	112 (77.8%)	
Never	61 (15.5%)	332 (84.5%)	
Calcium Supplement Intake			<0.001
During the Study Period	36 (56.8%)	27 (43.2%)	
One Week Before Study	42 (31.2%)	93 (68.8%)	
Never	12 (10.7%)	100 (89.3%)	
Vitamin D Deficiency			0.001
Yes	47 (26.6%)	130 (73.4%)	
No	68 (16.6%)	343 (83.4%)	

Table 5: Association Between Osteoporosis and Nutritional Factors

Variable	Odds Ratio (OR)	p-Value	95% CI
Vitamin D Supplement Intake	2.161	0.008	1.227–3.807
Calcium Supplement One Week Before	10.272	<0.001	5.791–18.219
Never Taken Calcium	3.823	<0.001	2.501–5.844
Vitamin D Deficiency	1.240	0.372	0.773–1.987

Table 6: Nutritional Habits and Association with Osteoporosis

Variable	Osteoporosis Present (n, %)	Osteoporosis Absent (n, %)	p-Value
Total Meals Per Week			0.267
1–10 Meals	35 (20.1%)	140 (79.9%)	
11–21 Meals	12 (13.7%)	75 (86.3%)	
Vegetable/Fruit Consumption			0.666
0–5 times/week	27 (19.3%)	113 (80.7%)	
6–11 times/week	15 (20.7%)	57 (79.3%)	

Regarding nutritional factors, osteoporosis prevalence was highest among women currently taking vitamin D supplements during the study period (31.3%), compared to those who took them one week prior (22.2%) or never (15.5%) (p < 0.001). Similarly, calcium supplementation showed a strong association; women who reported taking calcium supplements during the study period had the highest prevalence (56.8%), followed by those who had taken them one week prior (31.2%) and those who never used supplements (10.7%) (p < 0.001). Vitamin D deficiency was significantly associated with osteoporosis prevalence (26.6% among deficient women versus 16.6% among those without deficiency; p = 0.001) (Table 4).

Logistic regression analysis indicated that women taking vitamin D supplements one week before the study had higher odds of osteoporosis compared to those supplementing during the study period (OR = 2.161, 95% CI 1.227–3.807, p = 0.008). For calcium supplementation, women who had taken calcium one week prior had markedly increased odds of osteoporosis (OR = 10.272, 95% CI 5.791–18.219, p < 0.001), as did those who had never taken calcium supplements (OR = 3.823, 95% CI 2.501–5.844, p < 0.001). Vitamin D

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deficiency was not significantly associated with osteoporosis in logistic regression (OR = 1.240, p = 0.372) (Table 5). No significant associations were found between the frequency of total meals per week or vegetable/fruit consumption and osteoporosis prevalence (p = 0.267 and p = 0.666, respectively) (Table 6).

DISCUSSION

This study investigated the prevalence and risk factors of osteoporosis among postmenopausal women aged 40–59 years in Dir Lower, Pakistan. The findings revealed a prevalence rate of 19.8%, which aligns with some international reports but differs from previous studies in Pakistan. For instance, a prior cross-sectional study in Pakistan reported a higher prevalence of 29.6% among women of a similar age group (33). A multicenter study covering a wider age range (45–84 years) also reported a higher prevalence of 37.5% (5). Such discrepancies could be attributed to differences in participant age ranges, diagnostic techniques, regional factors such as sun exposure and nutrition, and sample selection methods.

Age was significantly associated with osteoporosis prevalence, with higher rates observed in women aged 50–59 years compared to those aged 40–49 years. This finding corroborates established evidence that bone mineral density declines progressively with advancing age due to hormonal changes, notably estrogen deficiency, post-menopause (1,5,42). Similarly, education level showed a significant association with osteoporosis prevalence, with women having only primary education exhibiting higher rates than those with secondary or college education. Lower educational attainment has previously been linked to poorer awareness of bone health, reduced access to healthcare, and less adherence to preventive behaviors such as adequate calcium and vitamin D intake (43). However, after adjusting for other variables in logistic regression, the association between education level and osteoporosis lost statistical significance, suggesting that other mediating factors may have influenced the crude association.

Occupational status also influenced osteoporosis prevalence in the unadjusted analysis, with unemployed women demonstrating the highest rates. Physical inactivity, reduced sunlight exposure, and limited financial means to access supplements or healthcare could partly explain this finding (18,43). However, similar to education, occupation was not independently associated with osteoporosis after multivariable adjustment, indicating potential confounding by age, nutrition, or other socioeconomic factors.

Contrary to initial expectations, women who were currently taking calcium or vitamin D supplements exhibited higher rates of osteoporosis. This observation likely reflects reverse causality, wherein women already diagnosed with osteoporosis or identified as being at high risk were prescribed supplementation. This phenomenon has been documented in previous research and underscores the importance of cautious interpretation of cross-sectional associations between supplementation and disease prevalence (19,23,49). In the adjusted analysis, women who had taken calcium supplements one week prior to the study or had never taken them showed significantly higher odds of osteoporosis compared to those supplementing during the study, highlighting the complex relationship between diagnosis, treatment, and disease progression.

Vitamin D deficiency, as assessed biochemically, was significantly associated with higher osteoporosis prevalence in the univariate analysis but was not an independent predictor in logistic regression. This finding contrasts with some studies suggesting that vitamin D deficiency significantly increases the risk of osteoporosis and fractures (19,49,50). The lack of significance in the adjusted model could be due to the relatively small number of participants with severe deficiency or the overwhelming influence of other stronger risk factors such as age and calcium intake.

Interestingly, no significant association was found between the frequency of meals or vegetable and fruit consumption and osteoporosis prevalence. Although a healthy diet rich in fruits and vegetables contributes to overall bone health through anti-inflammatory and antioxidant properties, isolated consumption measures without considering total nutrient intake (especially calcium and vitamin D content) may not robustly predict osteoporosis risk (18,19).

When compared internationally, the observed prevalence of osteoporosis in this study is comparable to that reported in Turkey (16.2%) (39), lower than that reported in Saudi Arabia (63.6%) (40), and considerably higher than findings from a large Chinese cohort (0.52%) (41). These variations underscore the influence of ethnicity, environmental factors (such as sun exposure), dietary habits, and methodological differences in osteoporosis research.

This study adds to the limited body of knowledge regarding osteoporosis among postmenopausal women in Pakistan. It emphasizes the need for targeted public health interventions, especially for older, less educated, and unemployed women. Strategies should include education campaigns about bone health, promotion of regular physical activity, encouragement of adequate sun exposure, and improved access to calcium and vitamin D supplementation when indicated.

However, several limitations must be acknowledged. The cross-sectional design precludes establishing causality between identified factors and osteoporosis. Dietary intake and supplementation data were self-reported, introducing potential recall and social desirability biases. Although DEXA was used for diagnosis, serum calcium or parathyroid hormone levels were not assessed, which could have provided additional insights into metabolic contributors. Furthermore, selection bias may have occurred, as unemployed women could have been overrepresented due to greater availability for daytime interviews.

In conclusion, this study confirms that age remains the most powerful risk factor for osteoporosis among postmenopausal women in Pakistan, while educational attainment, occupation, and calcium and vitamin D supplementation patterns also show significant associations. The findings highlight the urgent need for preventive strategies aimed at bone health education, early screening, and lifestyle interventions to reduce the future burden of osteoporosis in this vulnerable population.

CONCLUSION

This cross-sectional study evaluated the prevalence and risk factors of osteoporosis among postmenopausal women in Dir Lower, Pakistan, revealing a 19.8% prevalence rate and

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highlighting significant associations with age, education level, occupation, and calcium and vitamin D supplementation practices. These findings underscore the urgent need for targeted public health strategies focusing on early identification and prevention of osteoporosis, particularly among older, less-educated, and unemployed women. Clinically, enhancing bone health awareness, improving access to diagnostic services such as DEXA scanning, and promoting nutritional interventions including adequate calcium and vitamin D intake are crucial to reducing the burden of osteoporosis and its related fractures. Future research should adopt longitudinal designs to better elucidate causal relationships and evaluate the effectiveness of preventive strategies, thereby informing evidence-based clinical guidelines and contributing to the development of comprehensive bone health programs tailored to vulnerable populations.

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