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Prevalence of Osteoporosis in Postmenopausal Women with Cardiovascular Comorbidities: A Cross-Sectional Study

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ABSTRACT

Background: Osteoporosis and cardiovascular disease (CVD) are major health concerns in postmenopausal women. Both conditions share overlapping risk factors such as aging, estrogen deficiency, sedentary lifestyle, and metabolic disturbances. However, data on the coexistence of osteoporosis and CVD in South Asian populations remain limited.

Objective: To determine the prevalence of osteoporosis among postmenopausal women with cardiovascular comorbidities and to evaluate the association between bone health and metabolic as well as clinical risk factors.

Methods: This descriptive cross-sectional research was carried out at two tertiary care facilities in Punjab, Pakistan, between March 2024 and April 2025. Purposive sampling was used to recruit 100 postmenopausal women between the ages of 50 and 75 who had at least one cardiovascular comorbidity, such as hypertension, ischemic heart disease, or chronic heart failure. Anthropometric measures, clinical history, and demographic information were documented. Dual-energy X-ray absorptiometry (DEXA) was used to quantify bone mineral density (BMD) at the lumbar spine and femoral neck. The results were classified based on WHO guidelines. Serum calcium, vitamin D, lipid profile, fasting blood glucose, and HbA1c were measured. Chi-square tests and logistic regression were used in the statistical study to find osteoporosis predictors.

Results: The prevalence of osteoporosis was 48%, while 32% had osteopenia and 20% normal BMD. Osteoporosis was more common in women with ischemic heart disease (57.1%) compared with hypertension (45.8%) and chronic heart failure (46.2%). Poor glycemic control (HbA1c >7%), vitamin D deficiency, and uncontrolled systolic hypertension were significantly associated with osteoporosis. Independent predictors included age ≥65 years, diabetes mellitus, menopause >15 years, and vitamin D deficiency.

Conclusion: Osteoporosis is highly prevalent in postmenopausal women with cardiovascular comorbidities. Integrated screening and management of skeletal and cardiovascular risk factors are essential to reduce morbidity and improve quality of life in this high-risk group.

Keywords: Osteoporosis, Postmenopausal women, Cardiovascular comorbidities, Bone mineral density, Vitamin D deficiency, Glycemic control

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INTRODUCTION

Osteoporosis is a progressive skeletal disorder characterized by reduced bone mass and deterioration of bone microarchitecture, leading to increased susceptibility to fractures [1]. It is recognized as a major public health challenge worldwide, particularly among postmenopausal women. The drop in estrogen levels following the menopause speeds up the resorption of bone leading to a rapid drop in bone mineral density (BMD). According to the World Health Organization, osteoporosis affects nearly 200 million women worldwide, with one in three women over the age of 50 to suffer an osteoporotic fracture in their lifetime. Such fractures, particularly of the hip and the vertebrae, are linked with significant morbidity, mortality and socioeconomic burden [2,3].

Cardiovascular diseases (CVDs) such as hypertension, ischemic heart disease, and heart failure are another common cause of death and disability for postmenopausal women. The prevalence of CVD increases dramatically after menopause because the protective vascular effects of estrogen are lost as well as age-related metabolic changes such as dyslipidemia, insulin resistance and increased oxidative stress [4]. Importantly, there are common risk factors for osteoporosis and CVD, including old age, hormone imbalance, sedentary lifestyle, smoking, vitamin D deficiency and chronic inflammation. Emerging evidence also suggests biological relationships between the two conditions, including endothelial dysfunction, vascular calcification and impaired bone-vascular signalling pathways [5].

In clinical practice, the co-occurrence of osteoporosis and cardiovascular co-morbidities in postmenopausal women remains un-recognized despite the profound health implications. Women with CVD are known to be at increased risk for decreased bone density, but bone health assessments are not part of routine cardiology care. Similarly, the strategies for the management of osteoporosis often do not take into account the cardiovascular status and this results in fragmented care and lost chances to provide early intervention [6]. The consequences of this dual burden are significant as fractures in women with cardiovascular comorbidities are associated with increased rates of complications, longer hospital stays, and increased mortality [7].

In populations of South Asia including Pakistan, the incidence of both osteoporosis and CVD is increasing due to population aging, urbanisation, inadequate nutrition and lack of awareness regarding preventive healthcare. However, information on the interaction between these conditions in postmenopausal women is still limited. Most of the studies that have been available have evaluated osteoporosis or cardiovascular disease separately, and the convergence between the two entities is poorly documented [8,9].

Given this gap, the current study was intended to identify the prevalence of osteoporosis in postmenopausal women with known cardiovascular comorbidities, and to investigate the correlation between bone and cardiometabolic factors. Identifying such an association can inform an integrated screening program, enhance clinical outcomes and reduce the long-term burden of bone and cardiovascular complications in this vulnerable population [10].

MATERIALS AND METHODS

This descriptive cross-sectional study was conducted in a period of 14 months, from March 2024 to April 2025, in two tertiary care centres of Punjab, Pakistan. The study population was postmenopausal women attending cardiology and endocrinology outpatient clinics for the management of cardiovascular diseases. Eligibility criteria included women between the ages of 50 and 75

years with natural menopause for at least one year, with at least one diagnosed cardiovascular co-morbidity, such as hypertension, ischemic heart disease or chronic heart failure. Women with secondary causes of osteoporosis—such as chronic renal insufficiency, thyroid disorders, prolonged corticosteroid use, or malignancy—were excluded to minimize confounding factors.

A total of 100 participants were recruited using non-probability purposive sampling. After obtaining informed written consent, data were collected through structured interviews and medical records. Sociodemographic details including age, educational status, socioeconomic background, and lifestyle habits were recorded. Clinical history was noted with particular emphasis on the duration of menopause, presence and duration of cardiovascular illness, medication use, and family history of osteoporosis or heart disease. Anthropometric measurements, including weight, height, and body mass index (BMI), were taken using standardized methods.

Dual-energy X-ray absorptiometry (DEXA) was used to evaluate bone mineral density (BMD) at the lumbar spine and femoral neck. A T-score of < -2.5 indicated osteoporosis, > -1.0 indicated osteopenia, and ≥ -1.0 was deemed normal, under the World Health Organization's (WHO) categorization. A calibrated sphygmomanometer was used to monitor blood pressure, and the average of two readings was noted. Serum calcium and vitamin D levels, lipid profiles, glycated hemoglobin (HbA1c), and fasting blood glucose were measured in fasting blood samples. A pre-made proforma was used to capture all of the data, which were then imported into SPSS version 26.0 for analysis. The mean ± standard deviation was used to represent continuous variables like age, BMI, and biochemical parameters, while frequencies and percentages were used to represent categorical variables like osteoporosis, osteopenia, and normal BMD. Continuous data was compared using independent t-tests, while relationships between categorical variables were evaluated using the chi-square test. After controlling for confounders such age, menopausal duration, BMI, diabetes, and hypertension, binary logistic regression analysis was used to find independent predictors of osteoporosis. Statistical significance was defined as a p-value of less than 0.05.

The Institutional Review Boards of the two involved tertiary care institutions provided their ethical clearance. Participants with osteoporosis were directed to endocrinology services for further counseling and treatment, and confidentiality was rigorously maintained.

RESULTS

Demographic Characteristics:

A total of 100 postmenopausal women with cardiovascular comorbidities were included. The mean age was 62.4 ± 6.9 years, ranging from 50 to 75 years. As shown in Table 1, the largest age group was 60–69 years (42%), followed by 50–59 years (34%) and ≥70 years (24%). The mean duration since menopause was 13.8 ± 7.1 years, with 47% of women reporting more than 15 years since menopause. Educational status was generally low, with 58% of women having only primary or no formal education, while only 15% had attained higher education. Socioeconomic distribution showed that 61% belonged to lower, 29% to middle, and 10% to higher socioeconomic classes. These findings demonstrate that older age, longer menopausal duration, and lower education were predominant features among the study population.

Table-1: Demographic Distribution of Study Participants (n = 100)

Variable	Frequency (n)	Percentage (%)
Age Group (years)		
50–59	34	34.0
60–69	42	42.0
≥70	24	24.0
Education Level		
No / Primary	58	58.0
Secondary	27	27.0
Higher	15	15.0
Socioeconomic Status		
Low	61	61.0
Middle	29	29.0
High	10	10.0
Duration of Menopause		
≤10 years	29	29.0
11–15 years	24	24.0
>15 years	47	47.0

**Table 1 indicates that most participants were older, with prolonged duration of menopause, lower education, and lower socioeconomic status contributing to osteoporosis risk.*

Cardiovascular Comorbidities:

All participants had one or more cardiovascular diseases. As illustrated in Table 2, hypertension was the most common condition (59%), followed by ischemic heart disease (28%) and chronic heart failure (13%). A significant number of women had multiple comorbidities, particularly the overlap of hypertension with ischemic heart disease. Women with ischemic heart disease were older (mean age 64.8 ± 5.9 years) compared to hypertensive women (mean age 61.2 ± 6.3 years).

Table-2: Distribution of Cardiovascular Comorbidities (n = 100)

Cardiovascular Condition	Frequency (n)	Percentage (%)
Hypertension	59	59.0
Ischemic Heart Disease	28	28.0
Chronic Heart Failure	13	13.0

**Table 2 highlights that hypertension was the most common comorbidity, followed by ischemic heart disease and chronic heart failure.*

Bone Mineral Density (BMD) Status:

Bone health evaluation with DEXA showed that nearly half of the participants had osteoporosis. As shown in Table 3, osteoporosis was detected in 48%, osteopenia in 32%, while only 20% had normal BMD. The prevalence of osteoporosis increased with advancing age: 35.3% among women aged 50–59, 50.0% among those 60–69, and 62.5% in those ≥70 years. Prolonged menopause also strongly correlated with bone loss; 57.4% of women with menopause >15 years had osteoporosis compared to only 27.6% of those ≤10 years.

Table-3: Bone Mineral Density (BMD) Status of Participants (n = 100)

Bone Health Category	Frequency (n)	Percentage (%)
Normal	20	20.0
Osteopenia	32	32.0
Osteoporosis	48	48.0

**Table 3 demonstrates that osteoporosis was widespread, affecting nearly half of postmenopausal women with cardiovascular comorbidities.*

Osteoporosis Across Cardiovascular Comorbidities:

The prevalence of osteoporosis differed according to type of cardiovascular condition. As shown in Table 4, osteoporosis was most frequent in women with ischemic heart disease (57.1%), followed by hypertension (45.8%) and chronic heart failure (46.2%). Women with multiple cardiovascular conditions had significantly higher osteoporosis prevalence compared with those with a single condition (p = 0.04).

Table-4: Prevalence of Osteoporosis Across Cardiovascular Comorbidities

Cardiovascular Comorbidity	Total (n)	Osteoporosis n (%)
Hypertension	59	27 (45.8%)
Ischemic Heart Disease	28	16 (57.1%)
Chronic Heart Failure	13	6 (46.2%)

**Table 4 shows that ischemic heart disease was most strongly associated with osteoporosis compared with other comorbidities.*

Biochemical and Metabolic Parameters:

Metabolic analysis revealed strong links with bone health. The mean fasting blood glucose was 118.7 ± 22.5 mg/dL, and mean HbA1c was 7.1 ± 1.2%. Poor glycemic control (HbA1c > 7%) was observed in 44% of women, of whom 63.6% were osteoporotic compared to only 35.7% with HbA1c ≤ 7% (p < 0.01). Mean serum vitamin D was 18.2 ± 6.7 ng/mL; deficiency (<20 ng/mL) was found in 61% of women. Osteoporosis was more common in vitamin D deficient women (55.7%) than in those with sufficient levels (37.5%) (p = 0.02). Elevated systolic blood pressure (>140 mmHg) was also significantly associated with reduced BMD (58.7% vs. 38.9%, p = 0.03).

Table-5: Biochemical and Metabolic Parameters of Participants (n = 100)

Parameter	Mean ± SD / Category	Osteoporosis Prevalence (%)	p-value
Fasting Blood Glucose (mg/dL)	118.7 ± 22.5	—	—
HbA1c (%)	7.1 ± 1.2	—	—
HbA1c ≤ 7% (n = 56)	Good control	35.7	<0.01
HbA1c > 7% (n = 44)	Poor control	63.6	<0.01
Serum Vitamin D (ng/mL)	18.2 ± 6.7	—	—
Vitamin D ≥ 20 ng/mL (n = 39)	Sufficient	37.5	0.02
Vitamin D < 20 ng/mL (n = 61)	Deficient	55.7	0.02
Systolic BP ≤ 140 mmHg (n = 54)	Controlled	38.9	0.03
Systolic BP > 140 mmHg (n = 46)	Uncontrolled	58.7	0.03

**Table 5 demonstrates that poor glycemic control, vitamin D deficiency, and uncontrolled systolic hypertension were significantly associated with higher osteoporosis prevalence.*

Logistic Regression Analysis:

Binary logistic regression identified several independent predictors of osteoporosis (Table 6). After adjusting for confounding variables, age ≥65 years (OR 2.3, 95% CI 1.2–4.6, p = 0.02) and diabetes mellitus (OR 2.8, 95% CI 1.5–5.1, p < 0.01) remained the strongest predictors. Prolonged menopause >15 years (OR 1.9, 95% CI 1.1–3.4, p = 0.03) and vitamin D deficiency (OR 1.7, 95% CI 1.0–3.0, p = 0.04) were also significant contributors.

Table-6: Logistic Regression Analysis of Predictors of Osteoporosis

Predictor Variable	Odds Ratio (OR)	95% CI	p-value
Age ≥65 years	2.3	1.2 – 4.6	0.02
Diabetes Mellitus	2.8	1.5 – 5.1	<0.01
Menopause >15 years	1.9	1.1 – 3.4	0.03
Vitamin D Deficiency	1.7	1.0 – 3.0	0.04

**Table 6 shows that advanced age, diabetes mellitus, prolonged menopause, and vitamin D deficiency were independent predictors of osteoporosis.*

Overall, this study demonstrates that osteoporosis was highly prevalent among postmenopausal women with cardiovascular comorbidities, affecting nearly half of the participants. Demographically, older age, longer menopausal duration, lower education, and lower socioeconomic class were strongly associated. Clinically, ischemic heart disease patients had the highest osteoporosis rates. Metabolic factors such as poor glycemic control, vitamin D deficiency, and uncontrolled blood pressure further increased osteoporosis risk. Logistic regression confirmed age ≥65 years, diabetes mellitus, menopause >15 years, and vitamin D deficiency as independent predictors. These results emphasize the urgent

need for integrated screening and preventive care in postmenopausal women with cardiovascular diseases.

DISCUSSION

This study demonstrated that osteoporosis is a common comorbidity among postmenopausal women with cardiovascular disease, with almost half of the participants diagnosed with osteoporosis and an additional one-third with osteopenia [10]. The prevalence observed here is consistent with previous studies reporting osteoporosis rates ranging from 40% to 55% in women with cardiovascular disorders, reflecting the shared risk factors and underlying pathophysiological mechanisms [11].

Age and menopausal duration were strongly associated with reduced bone mineral density. Women aged ≥65 years and those with menopause exceeding 15 years showed significantly higher rates of osteoporosis, a finding supported by established evidence that estrogen deficiency accelerates bone resorption and contributes to cardiovascular dysfunction. The dual effect of aging and hormonal decline explains why this group is particularly vulnerable [12,13].

Ischemic heart disease was most strongly associated with osteoporosis in this study. Previous research has highlighted the role of vascular calcification, endothelial dysfunction, and impaired bone-vascular signalling as key biological mechanisms linking cardiovascular disease and skeletal fragility. This reinforces the concept that bone and vascular health are interdependent, and deterioration in one system often parallels dysfunction in the other [14].

Metabolic parameters, particularly poor glycemic control and vitamin D deficiency, were important contributors to bone fragility. Women with HbA1c >7% had significantly higher osteoporosis prevalence, highlighting the impact of chronic hyperglycaemia on bone remodelling through advanced glycation end-products and oxidative stress [15]. Similarly, vitamin D deficiency, observed in 61% of participants, was independently associated with osteoporosis. Deficiency of this hormone not only weakens skeletal integrity but also exacerbates cardiovascular risk, thus acting as a unifying risk factor for both conditions. The fact that uncontrolled systolic hypertension is also associated with decreased bone density further demonstrates the interplay between vascular dysfunction and bone metabolism [16].

Logistic regression analysis verified that advanced age, diabetes mellitus, long period of menopause, and vitamin D deficiency were independent risk factors of osteoporosis. These data confirm the multifactoriality of osteoporosis in women with cardiovascular disease and suggest that risk stratification includes both skeletal and cardiovascular risk factors [17,18].

The clinical implications of these findings are significant. Fractures in women with cardiovascular comorbidities are associated with higher morbidity, increased time to recovery and increased mortality. However, osteoporosis screening is not a part of the routine practice of cardiology in many healthcare systems, including Pakistan [19]. The findings of this study highlight the importance of combined preventive measures, including regular bone health monitoring, proper control of metabolic parameters, sufficient vitamin D and calcium intake and lifestyle changes. By targeting both the cardiovascular and the skeletal system at the same time, the overall burden of morbidity and mortality in postmenopausal women can be decreased [20,21].

CONCLUSION

Osteoporosis is very common among postmenopausal women with cardiovascular

comorbidities, especially in the elderly age group, women with long menopausal period, and women with ischemic heart disease. Inadequate glycemic control, vitamin D deficiency and uncontrolled hypertension are major risk factors for bone weakness. Early recognition and integrated management of CV and skeletal risk factors is important to reduce fracture and improve outcomes in this high-risk population.

Conflict of Interest:

The authors report no conflicts of interest.

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Authors' contributions:

SZ: Conceptualization, drafting.

SA: Data collection, analysis.

MA: Methodology, investigation.

NS: Literature review, editing, final approval.

Data Availability Statement:

The data used in this study are available upon reasonable request from the corresponding author, subject to ethical and institutional guidelines.

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