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Original Research Article

Assessment of Bone Mineral Density in Postmenopausal Women

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Abstract: ***Background*:** Osteoporosis is a major public health concern among postmenopausal women, leading to increased fracture risk and morbidity. Bone mineral density (BMD) assessment is the most reliable method for early detection, with Dual-Energy X-ray Absorptiometry (DEXA) considered the gold standard. Identifying factors associated with reduced BMD is essential for timely preventive interventions, especially in populations with limited healthcare access. ***Methods*:** This cross-sectional study was conducted in the Department of Orthopedics, District Sadar Hospital, Rajbari, Bangladesh, from February 2020 to January 2022. A total of 300 postmenopausal women aged ≥45 years, with spontaneous cessation of menstruation for at least one year, were included through purposive sampling. Demographic and clinical data were collected and BMD was measured at the lumbar spine and femoral neck using DEXA. Data were analyzed using SPSS version 25, with Chi-square tests to assess associations between BMD and age, duration since menopause and body mass index (BMI). ***Results*:** Among 300 participants, the mean age was 58.6 ± 7.4 years and the mean duration since menopause was 9.2 ± 5.8 years. Osteopenia was most prevalent (45.7%), followed by normal BMD (28.3%) and osteoporosis (26%). Osteoporosis prevalence increased with age (from 9.2% in 45–50 years to 52.9% in >65 years, $p < 0.001$) and longer menopausal duration (10.4% in <5 years to 40.7% in >15 years, $p = 0.002$). Underweight women had the highest prevalence of osteoporosis (48.8%), while overweight and obese women had higher rates of normal BMD (38.9% and 38.5%, respectively, $p = 0.015$). ***Conclusion*:** Reduced BMD is highly prevalent among postmenopausal women in rural Bangladesh. Advancing age, longer menopausal duration and lower BMI are significant risk factors, highlighting the need for early screening and preventive strategies.

Keywords: Postmenopausal Women, Bone Mineral Density, Osteoporosis, Osteopenia, BMI.

INTRODUCTION

Osteoporosis is a major public health problem worldwide, particularly among postmenopausal women [1]. It is characterized by reduced bone mass and microarchitectural deterioration of bone tissue, leading to increased bone fragility and susceptibility to fractures [2]. Among women, the abrupt decline in estrogen levels following menopause plays a critical role in accelerating bone loss [3]. This process begins soon after menopause and continues progressively, often remaining asymptomatic until a fracture occurs. Hip, vertebral and wrist fractures are among the most common complications of osteoporosis and are associated with significant morbidity, mortality and socioeconomic burden [4].

Globally, it is estimated that one in three women over the age of 50 will experience osteoporotic fractures during their lifetime [5]. The prevalence of

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osteoporosis is higher in Asian populations, including Bangladesh, due to lower calcium intake, vitamin D deficiency and reduced physical activity levels [6]. Moreover, lack of awareness, limited screening facilities and low socioeconomic conditions further contribute to the underdiagnosis and late detection of osteoporosis in developing countries [7]. In postmenopausal women, bone loss is influenced by multiple factors such as age, duration of menopause, body mass index (BMI), nutritional status, lifestyle habits and genetic predisposition. Lower BMI has been consistently associated with reduced bone mineral density (BMD), while obesity may have a partial protective effect due to higher estrogen levels derived from peripheral conversion of androgens [8].

Assessment of bone mineral density is the most reliable method for diagnosing osteoporosis and evaluating fracture risk [9]. Dual-Energy X-ray Absorptiometry (DEXA) is considered the gold standard for BMD measurement, providing accurate and reproducible results at various skeletal sites such as the lumbar spine and femoral neck [10]. The World Health Organization (WHO) classification of BMD based on T-scores allows early detection of osteopenia and osteoporosis, enabling timely preventive measures [11]. Early identification of women at risk is crucial to implement lifestyle modifications, calcium and vitamin D supplementation and pharmacological interventions to reduce fracture incidence and improve quality of life [12].

In Bangladesh, data on bone mineral density and osteoporosis among postmenopausal women are still limited. Most women in rural and semi-urban areas remain unaware of the importance of bone health and preventive measures after menopause [13]. Identifying the prevalence and associated risk factors of low BMD in this population can help in planning effective screening and awareness programs [14].

Therefore, the present study was conducted to assess the bone mineral density among postmenopausal women and to evaluate its association with age, duration of menopause and body mass index. This research aims to provide valuable insight into the magnitude of bone loss in this vulnerable group and to emphasize the need for routine screening and early intervention to prevent osteoporosis-related complications.

METHODOLOGY & MATERIALS

This cross-sectional study was conducted in the Department of Orthopedics, District Sadar Hospital, Rajbari, Bangladesh, over a two-year period from February 2020 to January 2022. A total of 300 postmenopausal women were included through purposive sampling. Postmenopausal women aged 45 years and above who had experienced spontaneous cessation of menstruation for at least one year were included in the study. Women with secondary causes of osteoporosis, those on corticosteroid or hormone replacement therapy, with chronic renal, hepatic, thyroid, or parathyroid disorders, or who had undergone surgical menopause were excluded. After obtaining informed written consent, data on age, duration of menopause and anthropometric measurements were collected using a pretested structured questionnaire. Height and weight were measured to calculate body mass index (BMI) using the formula weight (kg)/height (m^2). Bone Mineral Density (BMD) was assessed using Dual-Energy X-ray Absorptiometry (DEXA) at the lumbar spine and femoral neck. According to the World Health Organization (WHO) criteria, a T-score ≥ -1 was considered normal, between -1 and -2.5 was classified as osteopenia and ≤ -2.5 as osteoporosis. All data were entered and analyzed using Statistical Package for the Social Sciences (SPSS) version 25. Descriptive statistics such as frequency, percentage, mean and standard deviation were calculated for relevant variables. The Chi-square (χ^2) test was applied to assess the association between categorical variables such as age group, duration of menopause, BMI and BMD categories. A p-value <0.05 was considered statistically significant.

RESULTS

Table 1: Demographic and Clinical Characteristics of the Study Population (n = 300)

Variable	Category	Frequency (n)	Percentage (%)
Age group (years)	45–50	54	18
	51–55	71	23.7
	56–60	82	27.3
	61–65	59	19.7
	>65	34	11.3
Mean ± SD age (years)		58.6 ± 7.4	
Duration since menopause (years)	<5	67	22.3
	5–10	96	32
	11–15	78	26
	>15	59	19.7
Mean ± SD duration (years)		9.2 ± 5.8	
BMI (kg/m^2)	<18.5 (Underweight)	41	13.7

	18.5–24.9 (Normal)	148	49.3
	25–29.9 (Overweight)	72	24
	≥30 (Obese)	39	13
Mean ± SD BMI		24.7 ± 3.8	

Table 1 shows the demographic and clinical characteristics of the 300 postmenopausal women included in the study. The majority of participants were aged 56–60 years (27.3%), followed by 51–55 years (23.7%) and 61–65 years (19.7%), with a mean age of 58.6 ± 7.4 years. Regarding duration since menopause, 32% had been menopausal for 5–10 years, 26% for 11–15 years and 22.3% for less than 5 years, with a mean duration of 9.2 ± 5.8 years. Most women had a normal BMI (49.3%), while 24% were overweight, 13% were obese and 13.7% were underweight, with an overall mean BMI of 24.7 ± 3.8 kg/m².

Table 2: Distribution of Bone Mineral Density (BMD) Categories (n = 300)

BMD Category	Frequency (n)	Percentage (%)
Normal	85	28.3
Osteopenia	137	45.7
Osteoporosis	78	26
Total	**300**	**100**

Table 2 presents the distribution of bone mineral density (BMD) among the 300 postmenopausal women. Osteopenia was the most common finding, observed in 45.7% of participants, followed by normal BMD in 28.3% and osteoporosis in 26% of women, indicating that nearly three-quarters of the study population had reduced bone density.

Table 3: Association between Age Group and Bone Mineral Density (n = 300)

Age Group (years)	Normal n (%)	Osteopenia n (%)	Osteoporosis n (%)	p-value
45–50	28 (51.9)	21 (38.9)	5 (9.2)	<0.001
51–55	25 (35.2)	35 (49.3)	11 (15.5)	
56–60	20 (24.4)	41 (50.0)	21 (25.6)	
61–65	9 (15.3)	27 (45.8)	23 (39.0)	
>65	3 (8.8)	13 (38.2)	18 (52.9)	

Table 3 shows the association between age groups and bone mineral density (BMD) among the 300 postmenopausal women. The proportion of women with normal BMD decreased with increasing age, from 51.9% in the 45–50 years group to 8.8% in those over 65 years, while osteoporosis prevalence increased from 9.2% to 52.9% across the same age groups. Osteopenia was most common in the 56–60 years group (50%). The association between age and BMD was statistically significant ($p < 0.001$), indicating that advancing age is strongly related to reduced bone density.

Table 4: Association between Duration of Menopause and Bone Mineral Density (n = 300)

Duration of Menopause (years)	Normal n (%)	Osteopenia n (%)	Osteoporosis n (%)	p-value
<5	36 (53.7)	24 (35.8)	7 (10.4)	0.002
5–10	28 (29.2)	47 (49.0)	21 (21.9)	
11–15	14 (17.9)	38 (48.7)	26 (33.3)	
>15	7 (11.9)	28 (47.5)	24 (40.7)	

Table 4 illustrates the association between duration of menopause and bone mineral density (BMD) among the 300 postmenopausal women. Women with shorter menopausal duration (<5 years) had the highest proportion of normal BMD (53.7%) and the lowest prevalence of osteoporosis (10.4%), whereas those with menopause duration over 15 years had the lowest normal BMD (11.9%) and highest osteoporosis prevalence (40.7%). Osteopenia was most frequently observed in the 5–10 years group (49%). The association was statistically significant ($p = 0.002$).

Table 5: Relationship between BMI and Bone Mineral Density (n = 300)

BMI Category (kg/m²)	Normal n (%)	Osteopenia n (%)	Osteoporosis n (%)	p-value
<18.5 (Underweight)	7 (17.1)	14 (34.1)	20 (48.8)	0.015
18.5–24.9 (Normal)	35 (23.6)	71 (48.0)	42 (28.4)	
25–29.9 (Overweight)	28 (38.9)	36 (50.0)	8 (11.1)	
≥30 (Obese)	15 (38.5)	16 (41.0)	8 (20.5)	

Table 5 shows the relationship between body mass index (BMI) and bone mineral density (BMD) among the 300 postmenopausal women. Osteoporosis was most prevalent among underweight women (48.8%), whereas women with normal BMI and overweight/obese categories had lower osteoporosis rates (28.4%, 11.1% and 20.5%, respectively). Normal BMD was highest in the overweight (38.9%) and obese groups (38.5%). Osteopenia was most common in women with normal BMI (48%). The association between BMI and BMD was statistically significant ($p = 0.015$).

DISCUSSION

In our cross-sectional study of 300 postmenopausal women from a rural Bangladeshi hospital setting, we identified a high prevalence of reduced bone mineral density (BMD), 45.7% had osteopenia and 26.0% had osteoporosis. This finding underscores the magnitude of skeletal health risk in this population. Similar concerns have been reported in Bangladesh: for example, Kha et al. found that approximately 40% of postmenopausal women in a north-central region had osteoporosis and a further 43.5% had osteopenia [15].

Our data demonstrated a clear age-related decline in BMD: in women aged 45-50 years, 51.9% had normal BMD, while in women >65 years only 8.8% had normal BMD and 52.9% had osteoporosis. The statistically significant association ($p < 0.001$) aligns with established evidence that advancing age is a major risk factor for bone loss and fracture risk [16]. The pattern seen in our rural Bangladeshi sample indicates that age-related bone loss may be compounded by local factors such as nutrition, limited mobility and delayed screening.

Duration since menopause was also strongly associated with reduced BMD: women menopausal for <5 years had a 53.7% prevalence of normal BMD compared to only 11.9% in those >15 yrs, while osteoporosis prevalence rose from 10.4% to 40.7% ($p = 0.002$). This supports the concept of post-menopausal estrogen deficiency accelerating bone loss over time and aligns with findings in other settings from Sayed et al. evaluated osteoporosis risk by bone mass density [17]. In the rural Bangladeshi context, women often begin menopause later and may have delayed access to preventive services; our data suggest an urgent need for early screening soon after menopause.

Our BMI–BMD relationship further reinforces the literature: underweight women (<18.5 kg/m²) had the highest osteoporosis prevalence (48.8%), whereas overweight (25-29.9 kg/m²) and obese (≥30 kg/m²) women had higher proportions of normal BMD (38.9% and 38.5% respectively) ($p = 0.015$). This is consistent with prior Bangladeshi findings by Ghani *et al*., who reported significant positive correlation between BMI and BMD among postmenopausal women in Bangladesh [18]. The protective effect of higher BMI may relate to greater mechanical loading and higher peripheral estrogen levels in adipose tissue [19-21]. In our study, undernutrition, low calcium/vitamin D intake and higher physical labour may further predispose underweight women to accelerated bone loss.

Collectively, our findings underscore three modifiable risk factors advancing age (non-modifiable but identifiable), longer menopausal duration and low BMI as key determinants of reduced BMD in Bangladeshi postmenopausal women. These results highlight the need for targeted screening and preventive interventions, especially in rural populations where access to care is often limited. The high burden of osteopenia (45.7%) indicates a large window of opportunity for preventive action before progression to osteoporosis.

Limitations of the Study

This study has some limitations. The sample size was relatively small, which may limit the generalizability of the findings. Additionally, it was conducted at a single center, so the results may not represent all postmenopausal women in Bangladesh.

CONCLUSION

In conclusion, our study reveals a substantial burden of low BMD in Bangladeshi postmenopausal women, with advancing age, prolonged menopausal duration and low BMI as significantly associated factors. These findings support the urgency of early screening (e.g., by DEXA) and implementation of prevention strategies such as weight-bearing exercise, nutritional support and lifestyle modification to mitigate osteoporosis risk and fracture burden in this vulnerable population.

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