

Age, Weight and Body Mass Index Effect on Bone Mineral Density in Postmenopausal Women

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Background: Osteoporosis is a multifactorial skeletal disease, whose mechanisms are not fully understood. It is more common in older people, especially in postmenopausal women.

Objectives: Body mass index (BMI) has been suggested as an important measurement to assess bone mineral density (BMD). Therefore, the aim of this study was to assess the effects of age, weight and BMI on BMD in postmenopausal women.

Patients and Methods: In a cross-sectional study based on BMD measurement using dual-energy X-Ray Absorptiometry (DEXA) method, 80 postmenopausal women referred to Rheumatology Clinics in Zahedan were selected; 26 participants had osteoporosis, 28 had osteopenia, and 26 had normal bone density. Weight and height were obtained to calculate BMI.

Results: The mean BMD of women older than 50 years compared to those younger than 50 years was significantly different ($P < 0.05$). The mean weight and BMI were found to be significantly lower in patients with low BMD as compared to the normal group ($P < 0.0001$). There was a negative significant association between age and low BMD only in femur neck region ($r = -0.37, P = 0.006$). In addition, a direct association was observed between weight ($r = 0.41, P = 0.002$) and BMI ($r = 0.31, P = 0.02$) with BMD at lumbar spine.

Conclusions: The findings indicated that older women with low BMI were at higher risk of low bone mass. Body weight, BMI and aging may be important predictors of BMD, but they are not the only factors affecting bone loss. Therefore, it is recommended to assess other risk factors with a larger number of patients.

Keywords: Bone Density; Body Mass Index; Osteoporosis, Postmenopausal; Achard-Thiers Syndrome

1. Background

Osteoporosis is a public health problem worldwide (1, 2) and is a common disease in the older population, especially in the postmenopausal women (2-6). The prevalence of osteoporosis in Iranian women has been reported from 6% to 34.4% in different cities and provinces (5). This disease is characterized by low bone mass and destruction of bone tissue, leading to increased fracture risk (1, 2, 6). Several studies have shown that in addition to the risk factors such as aging, lack of physical activity, smoking, premature menopause, family history, poor diet and low intake of calcium and vitamin D (3, 5, 7-12), other factors, including body weight (13-15) and BMI (1, 3, 5, 9, 11-13, 16) are also important in the risk assessment tools, which contribute to osteoporosis and osteoporotic fracture risk. Measurement of body mass index is an inexpensive and valuable technique to guide public

health policy, clinical decisions, and evaluation of nutritional status (17-19). Decreased BMD in postmenopausal women with lower BMI is more than those with higher BMI (13, 16). Changes of BMD in weight loss may be related to the role of soft tissue in disturbance with bone densitometry by DEXA. However, the relation between body mass index and higher BMD remains ambiguous (13). The importance of both BMI and aging on bone mass density has been shown in previous studies (3-6, 12). Calcium and other bone minerals are reduced by aging. As a result, bones become thinner and more fragile, leading to osteoporosis (1, 2, 17, 20). Considering to exponential rise in the number of fractures and risk factors of bone mass loss among older adults, early diagnosis and identification of the factors associated with bone loss and its complications could be effective in the management of disease and therapeutic decisions of those with risk factors of low BMD (2, 12).

Implication for health policy/practice/research/medical education:

According to the anthropometric parameters, weight and BMI are recognized as good predictors for evaluation of osteoporosis and osteoporotic fracture risk.

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2. Objectives

Since among the anthropometric parameters, weight and BMI have been recognized as good predictors for the evaluation of osteoporosis and osteoporotic fracture risk (1), in the present study, we evaluated the effect of age, weight and BMI on BMD in postmenopausal women.

3. Patients and Methods

Eighty postmenopausal women aged 35 - 79 years old referred to two Rheumatology Clinics in Zahedan were enrolled. The exclusion criteria were hyperthyroidism, diabetes mellitus, renal or liver disease, rheumatoid arthritis or a history of treatment with Levothyroxine, furosemide, heparin, phenytoin, phenobarbital, vitamin K, ranitidine, calcium carbonate and vitamin D3 and corticosteroids, alcohol consumption and smoking. The participants were referred to the bone densitometry center. Bone Mineral Density (BMD) was measured using Dual Energy X-ray Absorptiometry method (DEXA) (GE-Lunar Radiation Corporation, DPX MD + 73457 models, Madison, WI, USA) at femur neck and the second to fourth lumbar spine. Osteoporosis and osteopenia were assessed based on t-scores from BMD measurements as defined by the World Health Organization (WHO): t-score < -2.5 was considered as osteoporosis; $-1 \geq$ t-score > -2.5 as osteopenia, and those with t-scores > -1 were considered as normal (21).

Participants were divided into three groups based on BMD, 26 with osteoporosis, 28 with osteopenia and 26 with normal bone density (as control group). The height and weight of patients were measured at the time of the DXA scans with a stadiometer and a clinical scale with a precision of 0.5 cm and 100 g, respectively. Participants were dressed in light clothes without wearing shoes. Body mass index (BMI) was calculated as the weight in kilograms divided by height in meters squared ($\text{weight (kg)} / [\text{height (m)}]^2$) (17, 22). BMI was categorized based on the guidelines reported by centers for disease control (CDC) (23) as follows; equal or below 18.5 was considered as underweight, 18.5 to 24.9 as normal and $\geq 25 \text{ kg/m}^2$ as overweight and obese. The ethics committee of the Zahedan University of Medical Sciences approved the study, and informed consent was orally obtained from all patients and healthy individuals.

3.1. Statistical Analysis

Data was analyzed using statistical package for social sciences (SPSS) software, version 18.0. All data were normally distributed and expressed as mean \pm SD. One-way analysis of variance (ANOVA) and Tukey test were used for comparison between the three groups. Independent sample t-test and Chi-square test were also used. The correlations between the variables were calculated

by Pearson correlation test. P value < 0.05 was considered significant.

4. Results

The study population included 80 postmenopausal women; the mean age was 54.8 ± 8.1 years. The mean body weight was 71.4 ± 13.6 kg, and the mean BMI was $29.1 \pm 5.9 \text{ kg/m}^2$. There was a significant difference between the mean age in patients with osteoporosis and control group ($P < 0.05$). The mean weight and BMI were significantly lower in patients with osteoporosis and osteopenia compared to the control group ($P < 0.0001$). However, the mean weight and BMI values of the two groups did not differ significantly. The demographic data is shown in Table 1. Subjects' distribution based on age and BMI, are summarized in Table 2.

Compared with the normal group, 27.3% and 31.8% of women younger than 50 years, and 34.5% and 36.2% of those aged 50 years or above had osteoporosis and osteopenia, respectively. The frequency of osteoporosis and osteopenia were 47.6% and 28.6% in women with normal BMI, and 27.1% and 37.3% in those with overweight and obese. None of the studied individuals were underweight. DEXA scan results are shown in Table 3 based on the t-score values at the femoral neck and lumbar spinal region regarding age and BMI. The findings revealed that the mean t-score values of women older than 50 years were significantly different at both femoral neck and lumbar spine ($P < 0.05$) compared to those younger than 50 years. In addition, the mean BMD in overweight women was higher compared to normal weight women (although the values did not differ significantly ($P > 0.05$)). Table 4 describes the correlation coefficients between the variables in the studied populations. There was a negative significant association between age and low BMD only in femur neck region ($r = -0.37$, $P = 0.006$). Moreover, a direct association was found between weight ($r = 0.41$, $P = 0.002$) and BMI ($r = 0.31$, $P = 0.02$) at lumbar spine region, while such a significant correlation was not seen at the femoral neck region.

Table 1. Demographic Characteristics of the Studied Population ^a

Variables	Osteoporosis (n = 26)	Osteopenia (n = 28)	Normal (n = 26)
Age, y	58 ± 8.4^b	53.7 ± 7.2	52.7 ± 8
Weight, kg	63 ± 10.2^c	69 ± 10.4^c	82 ± 12.4
Height, cm	154.7 ± 5.2	157.2 ± 5.5	157.8 ± 8.3
Body Mass index, kg/m^2	26.2 ± 3.6^c	27.9 ± 4^c	33.5 ± 7.1

^a Values are presented in mean \pm SD.

^b $P < 0.05$ vs. normal group.

^c $P < 0.0001$ vs. normal group.

Table 2. Distribution of Patients Based on Age and Body Mass Index^a

Osteoporosis Variable	Osteopenia	Normal	No. (%)	P value
Age, y				0.35
< 50	6 (27.3)	7 (31.8)	9 (40.9)	
≥ 50	20 (34.5)	21 (36.2)	17 (29.3)	
Body Mass Index, kg/m²				0.17
Normal	10 (47.6)	6 (28.6)	5 (23.8%)	
Overweight and obese	16 (27.1)	22 (37.3)	21 (35.6)	

^aData are presented in No. (%).

Table 3. Comparison Between Mean t-Score Values in Postmenopausal Women With Bone Mineral Density Regarding Age and Body Mass Index

Variables	Femoral Neck	Lumbar Spine
Age, y		
< 50 (n = 13)	-1.3 ± 0.4 (-3 to -0.3)	-1.9 ± 0.9 (-3.4 to -0.3)
≥ 50 (n = 41)	-1.9 ± 1 (-3.7 to -0.2)	-2.43 ± 1.25 (-5.2 to -0.4)
P value	0.045	0.032
Body Mass Index		
Normal weight (n = 16)	-2 ± 0.9 (-3.1 to -0.7)	-2.68 ± 1.2 (-4.3 to -1)
Overweight and obese (n = 38)	-1.69 ± 1 (-3.7 to -0.2)	-2.1 ± 1.18 (-5.2 to -0.3)
P value	Not significant	Not significant

Table 4. Correlation Between Bone Mineral Density and the Variables in the Studied Population

Variables	Femur Neck	Lumbar Spine
Age, y	r = -0.37 P = 0.006	r = 0.25 P ^a = 0.070
Weight, kg	r = 0.152 P ^a = 0.273	r = 0.41 P = 0.002
BMI, kg/m²	r = 0.209 P ^a = 0.128	r = 0.315 P = 0.020

^a Not significant.

5. Discussion

We investigated three factors including age, weight and body mass index, which may affect bone loss in postmenopausal women. Although, the effects of these factors on bone are as yet uncertain, some studies have

shown that aging and menopause are the two major factors likely to be associated with increasing risk of bone tissue destruction (1-3, 5, 8, 11, 12, 20). At the present study, bone mineral density levels also decreased with aging. An inverse correlation between age and BMD at the femoral neck in the present study, suggests that advancing age is associated with lower BMD. This fact is consistent with the results of Chanprasertyothin et al. (24) and Douchi et al. (25) studies. A positive significant correlation between age and BMD at both lumbar spine and femoral neck (16, 26) and a direct correlation between age and lumbar spine BMD were also observed in recent studies (27, 28). Despite the fact, Lofman et al. (29), Saravi et al. (4), and Mazess et al. (26) reported no effect of age on BMD. Low body mass index has been described as a predictor for the evaluation of both osteoporosis and increased fracture risk in the Black et al. (16) and van der Voort et al. studies (9). In our study, mean weight and BMI were also found to be significantly lower in patients with osteoporosis and osteopenia as compared to the normal group. However, the mean weight and BMI values of the two groups of patients did not differ significantly. Other studies have also shown an association between body weight (14, 15) and BMI (1, 11, 22, 30-33) with BMD. But, Saravi et al. (4) reported no significant effect of BMI on BMD. Furthermore, the results showed that 76.2% of patients with osteoporosis and osteopenia had normal BMI, and 64.4% were overweight which was approximately similar to the study conducted by Fawzy et al. (1). However, it has been suggested that postmenopausal women with lower BMI have more bone loss than those with higher BMI. Although in this study obese women had higher BMD than those with normal weight, it was not significantly different ($P > 0.05$). Albala et al. (34) also reported similar findings that obese women after menopause have higher bone mass than normal weight age-matched women, especially at lumbar spine and femoral neck.

Moreover, in some studies as shown in the present study, a positive significant correlation was found between body weight and BMI with BMD at the lumbar spine, but not at the femoral neck, (3, 4). A positive correlation between BMI and BMD at the femoral neck of postmenopausal women was seen by Bayat et al. (12) and Steinschneider et al. (13). Increased BMD in obese women may be due to the role of soft tissue in interfering with BMD determination by DEXA, (1, 13) which decreases the accuracy of BMD measurements (35). As shown in our study, low BMD has been reported with both aging and low body weight in some studies (3-5, 12). Other similar studies found a significant correlation between osteopenia and osteoporosis with aging and lower BMI (4, 12). Despite numerous reports on the association between aging and BMI with bone mass, the exact mechanisms are not fully identified yet; however, some studies suggested that humoral factors related to body fat mass, in particu-

lar low ovarian estrogen production in postmenopausal women may affect lumbar spine BMD and bone loss (25). The findings indicated that older women with low BMI were at higher risk of low bone mass. Body weight, BMI and aging might be important predictors of BMD, but they are not the only factors affecting bone loss. Thus, it is recommended to assess other risk factors with a larger number of patients.

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Authors' Contribution

Drafting and preparing the manuscript: Farzaneh Montazerifar and Mansour Karajibani; performing statistical analysis: Farzaneh Montazerifar; data collection: Sara Alamian; conducting the study: Farzaneh Montazerifar, Sara Alamian, Mahnaz Sandughie and Zahra Zakeri; cooperation in statistical analysis: Ali Reza Dashipour.

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