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Original article

Muscle mass is a strong correlation factor of total hip BMD among Korean premenopausal women

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Abstract

Objectives: This study was to investigate mean Z-score of BMD of Korean premenopausal women and also to investigate the relationship between BMD and body composition, such as skeletal muscle (SM) mass, body fat mass, and abdominal adiposity among healthy Korean premenopausal women in their forties.
Methods: A total of 2711 premenopausal women in her forties (40−49 years) who had taken dual energy X-ray absorptiometry (DXA) for BMD screening and body composition analyser (InBody J10®) from 2012 to 2013 at health promotion center of Ewha Womans university Mokdong hospital were analyzed retrospectively. Demographic data such as body mass index (BMI), waist circumference (WC), hip circumference (HC), waist hip ratio (WHR), SM mass, body fat mass, and serum lipid profile were included in this study. The Pearson's correlation coefficient (CC) was used to identify co-efficiency between BMD and other parameters.
Results: The mean age was 44.2 ± 4.44 (years) and mean BMI was 22.43 ± 2.99 (kg/m^2). Mean Z-score of BMD-lumbar 1−4 (BMD-L) and BMD-femur total hip (BMD-F) was 0.33 ± 1.14 and −0.19 ± 0.85. Mean of BMD-L and BMD-F were 1.18 ± 0.16 (g/cm^2) and 0.96 ± 0.12 (g/cm^2). Skeletal muscle mass showed a strong significant correlation coefficient (CC) only with BMD-F (CC = 0.13, p-value = 4.78×10^{-11}). However serum lipid profile, body fat mass, and WHR did not show significant CC with mean Z-score of BMD-F and BMD-L.
Conclusions: Skeletal muscle mass measured by body composition analyzer of BIA method is a strong correlation factor for BMD especially of hip bone among healthy Korean premenopausal women in their forties.
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Keywords: Bone; Hip; Menopause; Skeletal muscle

1. Introduction

Osteopenia and osteoporosis are much more common in postmenopausal women than in premenopausal women. However maintaining optimal bone mineral density (BMD) levels during the premenopausal years is important for reducing the risk of osteoporosis and fractures during the postmenopausal years [1,2]. The peak bone mass (PBM), which is defined as the amount of bony tissue present at the end of the skeletal maturation [3], is a well known determinant of osteoporotic fracture risk. The greater their peak bone mass, the lower their risk for osteoporosis later in life. The importance of obtaining high PBM is emphasizing in these days because the mean life expectancy is more increasing. It is well known that the PBM usually obtained until in one's early thirties and thereafter demineralization process is continued. Main factors affecting the PBM are genetic factors such as age and race [4]. However, non genetic factors such as nutrition,

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physical activity, and behavioral factor including smoking also affect the PBM. We can increase the PBM by improving the non-genetic factors, therefore continuous exploration about the way to increase PBM by changing the non-genetic factors is important for improving bony health [5]. Among these, physical activity especially regular weight-bearing exercise which can increase muscle mass is the best way to exercise for the healthy bone. High impact weight bearing exercise is effective on increase of hip BMD and strength [6]. Recent study in premenopausal women also confirmed the impact exercise can improve the BMD [7].

Evidence of the inter-relationship between muscle and bone metabolism is increasing, and the significance of sarcopenia, the age-related loss of skeletal muscle (SM) mass and function, is also more important [8−10]. Although there are no standard diagnosis criteria, diagnosis is based on low muscle mass, low muscle strength, and/or low physical performance. Sarcopenia and low SM mass increase the risk of physical limitation and subsequent disability; therefore, recent articles report that this condition increases the risk of comorbid conditions [11,12]. For example, sarcopenia is reported to correlate highly with fragility and increases the risk of falling in the elderly, which is an important risk factor for disability and mortality [13,14]. Moreover, the loss of SM mass, in particular of its strength, is important based on the evidence that SM mass predicts future mortality in middle-aged, as well as older, adults [14]. What age is reported to have peak SM mass? In terms of total lean body mass, it is reported to begin to decrease early in the third decade of life and shows a sharp decline at 45 years of age and older [15−17]. The peak SM index occurs in Korean women in their thirties and forties. In Korean females, appendicular skeletal mass (ASM), BMD, and PBM reach peak levels in the 40−49-year-old age group, and then these levels decrease [18,19]. Therefore, this study aimed to investigate a mean Z-score of the BMD in the lumbar spine L 1−4 (BMD-L) and the femur total hip (BMD-F) in healthy premenopausal women in their forties, as this age was revealed to have peak SM mass. We also aimed to find a relationship between BMD and body composition, such as SM mass, body fat mass, and abdominal adiposity, among healthy Korean women in their forties whose SM index was known to be at the peak level.

2. Materials and methods

This was a retrospective study that analyzed a total of 2711 premenopausal women, aged 40−50 years, who had a dual-energy X-ray (DXA, GE-Lunar Prodigy advance, Lunar software, version 11.20, Madison, WI, USA) at both the lumbar spine and the total hip, from 2012 to 2013 at the Health Promotion Center of Ewha Womans University, Mokdong Hospital. Women who were current smokers and women who drank more than 3 units of alcohol per week were excluded from this study. This study also excluded women who had thyroid disease, rheumatic arthritis, hepatic or renal dysfunction, or malignancy or who were taking medications that could affect BMD. We used demographic data, such as height, weight, BMI, waist circumference (WC), hip circumference (HC), waist-hip ratio (WHR), and serum lipid profile (including total cholesterol, low density lipoprotein [LDL], high-density lipoprotein [HDL], and triglyceride [TG] levels). A body composition analyzer (InBody J10®, Biospace, Seoul, Korea) was used to measure SM mass and total fat mass. All continuous data are presented as mean ± standard deviation. Statistical analyses were performed using R software, version 3.1, and differences were considered significant if $p < 0.05$. The relationship between BMD, Z-score of BMD-L (L1−L4), BMD-F (femur total hip), and other parameters was analyzed. The Pearson's correlation coefficient (CC) was used to identify the coefficiency between the Z-score of BMD and other parameters. The CC was expressed using conditioning plots-coplots. This study was approved by the Institutional Review Board of EUMC (No. EUMC 2016-03-006).

3. Results

The mean age was 44.20 ± 1.02 years. The mean height, weight, and BMI were 162.82 ± 5.06 cm, 55.28 ± 8.24 kg, and 22.43 ± 2.99 kg/m^2, respectively. The mean BMD-L and BMD-F were 1.18 ± 0.16 g/cm^2 and 0.96 ± 0.12 g/cm^2, respectively. The mean Z-score of BMD-L and BMD-F were 0.33 ± 1.14 and −0.19 ± 0.85, respectively. The mean SM mass and mean body fat mass were 37.17 ± 3.80 kg and 18.12 ± 5.54 kg, respectively. The mean WC and HC were 73.90 ± 8.02 cm and 92.38 ± 5.96 cm, respectively. The mean WHR was 0.80 ± 0.06. The serum lipid profile, including total cholesterol, HDL, LDL, and TG levels, was within the normal limit and did not show a significant CC. In addition, total body fat mass, abdominal obesity, and WHR did not show a significant CC (Table 1). Only the SM mass showed a strong CC with BMD-F (CC = 0.13, $p = 4.78 \times 10^{-11}$). However, SM mass and BMD-L showed only a weak positive correlation (Fig. 1).

Table 1
Correlation of variables with BMD Femur z-score of Korean premenopausal women in their forties.

Variables	Values (n = 2711)	CC	p
Age (y)	44.20 ± 3.02	0.002	0.301
BMI (kg/m^2)	22.43 ± 2.99	0.024	0.206
T-Cholesterol (mg/dl)	88.82 ± 63.23	−0.031	0.097
LDL-C (mg/dl)	115.58 ± 29.7	−0.022	0.241
HDL-C (mg/dl)	60.45 ± 12.86	−0.017	0.376
TG (mg/dl)	106.38 ± 68.74	0.003	0.891
Skeletal muscle mass (kg)	37.17 ± 3.8	0.126	4.781×10^{-11}
Body fat mass (kg)	18.12 ± 5.54	−0.007	0.705
WH ratio	0.8 ± 0.06	−0.010	0.581

Data are mean ± SD. CC, correlation coefficient; BMI, body mass index; TC, total cholesterol; LDL-C, low density lipoprotein-cholesterol; HDL-C, high density lipoproteincholesterol; TG, triglyceride; WH ratio, waist-hip ratio.

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