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Relationship between body composition and age, menopause and its effects on bone mineral density at segmental regions in Central Southern Chinese postmenopausal elderly women with and without osteoporosis

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ABSTRACT

We aimed at evaluating the relationship between lean mass and fat mass with age, menopausal age (MA) and years since menopause (YSM) and their effects on bone mineral density (BMD) at segmental regions in postmenopausal elderly women with and without osteoporosis. After using a dual-energy X-ray absorptiometry (DXA) methodology to measure body composition and BMD at posteroanterior spine and hip in 244 postmenopausal elderly non-osteoporotic (Non-OP) women (65.5 ± 4.3 years) and 298 postmenopausal elderly osteoporotic (OP) women (67.1 ± 4.4 years), we found that in postmenopausal elderly Non-OP women, there was no correlation between lean mass with age, MA, and YSM, as well as no correlation between fat mass with age (all, $p > 0.05$); leg fat (LF) mass ($r = 0.187$; $p < 0.01$), whole body fat (WF) mass ($r = 0.151$; $p < 0.05$), and trunk fat (TRF) mass ($r = 0.141$; $p < 0.05$) were positively correlated with MA; LF ($r = -0.131$; $p < 0.05$) and WF ($r = -0.127$; $p < 0.05$) were negatively associated with YSM; WF and whole body lean (WL) mass were the most important body composition components influencing BMD at the third lumbar spine (L3), total first to fourth lumbar spine (L1–4) and hip, respectively; TRF was the most significant determinant of BMD at both L2 and L4. In postmenopausal elderly OP women, there was no relationship between body composition with MA ($p > 0.05$); Trunk lean (TRL) mass ($r = -0.183$; $p < 0.05$), leg lean (LL) mass ($r = -0.136$; $p < 0.01$), and WL mass ($r = -0.162$; $p < 0.01$) were negatively correlated with age; TRL mass ($r = -0.132$; $p < 0.05$), LL mass ($r = -0.152$; $p < 0.01$), WL mass ($r = -0.170$; $p < 0.01$) were also negative with YSM; WF was the most important factor influencing BMD at lumbar spine and hip. These data suggest in postmenopausal elderly Non-OP women, fat mass (TRF, LF, and WF) was more related with MA; WF and WL mass were the most important body composition components influencing BMD at L1–4 and hip, respectively; in postmenopausal elderly OP women, body composition was not correlated with MA; lean mass (TRL, LL, and WL) was more age-related negatively; WF mass was the most significant factor affecting BMD at lumbar spine and hip.

1. Introduction

Body composition is mainly constituted by two components: lean mass and fat mass. There are several factors influencing body composition. Aging and menopause are the two important ones. Changes in body composition with aging and menopause, especially bone mass loss, have been associated with increased morbidity and mortality which predisposes to falls and OP fractures. The decrease in lean mass was more menopause-related, while the shift toward upper body fat distribution and overall adiposity were more age-related (Douchi et al., 2002). In elderly OP women, with aging and the prolongation of YSM, accompanied by changes of lifestyles and patterns of physical activities, the anthropometric indexes change more than those of Non-OP women; besides, degree of physical exercises naturally differs with segmental regions. So it is plausible that effects of aging and menopausal status on body composition cause differences between postmenopausal elderly women with and without osteoporosis and also deposit differences in various segmental regions.

Osteoporosis, a multifactorial disease, is commonly observed in postmenopausal women, especial in the elderly. Osteoporosis has become a serious public and worldwide health problem in the postmenopausal elderly women. Many factors affect BMD. WT is perhaps the best-known determinant of BMD and low WT should be regarded as an important risk factor for osteoporosis (Reid, 2002; Guney et al., 2003; Radak, 2004; Schöffl et al., 2008). Several studies have examined the relationship between body composition with BMD measurements, although the individual role of each compo-

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nent remains controversial. Some researchers have been reported WL has the closest positive association with BMD in postmenopausal women (Sahin et al., 2003), while others have reported that WF has the closest relationship with BMD (Cui et al., 2007), and yet others have shown that WF and WL are equally associated with BMD (Lim et al., 2004). Actually, the impacts of lean mass and fat mass on BMD were regional difference in postmenopausal women (Liu-Ambrose et al., 2006; Cui et al., 2007). Investigation for Non-OP women indicated only WL was correlated with whole body BMD, but for OP women, WL and WF were correlated with whole body BMD (Gnudi et al., 2007). So it is reasonable to simultaneously examine relationship between whole body and regional lean mass and fat mass with BMD at regional sites in postmenopausal elderly women with and without osteoporosis.

Therefore, we used DXA methodology to measure both body composition and BMD at posteroanterior spine and hip in healthy postmenopausal elderly women with and without osteoporosis and analyzed the relationship between body composition with age, MA, YSM, and various regional BMD.

2. Subjects and methods

2.1. Subjects

Between January and October 2008, a total of 542 healthy postmenopausal elderly women, age ranging from 60 to 76 years (66.4 ± 4.5 years), MA from 40 to 67 years (49.5 ± 3.9 years), and YSM from 1 to 31 years (median 16.7 years) were enrolled in this study. The participants, who were all from a Key Projects of the National Science & Technology Pillar Program of China during the Eleventh Five-Year Plan Period-Prevention and Interventions of Elderly Osteoporotic Fracture, were residents of Changsha-capital city of Hunan Province in Central South China. The subjects were screened with a detailed questionnaire and history and physical examinations. Subjects with conditions known to affect bone, lean tissue, or fat tissue metabolism were excluded from this study, such as diseases of liver, kidney, thyroid and parathyroid, diabetes, menopause and oligomenorrhea before being 40 years, hyperprolactinemia, ovary excision, rheumatoid arthritis, ankylosing spondylitis, malabsorption syndrome, malignant tumors, blood diseases, as well as previous pathological fractures. Also excluded were subjects who had been previously, recently, or presently taking drugs that could affect bone, lean tissue, or fat tissue metabolism, such as glucocorticoids, estrogen, thyroid hormone, fluoride agents, bisphosphonates, calcitonin, thiazide diuretics, vitamin D, calcium-containing drugs, barbiturates, and antiepileptic drugs. Postmenopausal women had experienced natural menopause. Menopause was defined clinically as the absence of menstrual cycles for at least 1 year. Based on the *T*-score of BMD, we divided the population into Non-OP group and OP group. There were 244 women (65.5 ± 4.3 years) without osteoporosis (*T*-score ≤ -2.5) and 298 women (67.1 ± 4.4 years) with osteoporosis (*T*-score > -2.5). All participating volunteers were provided informed consent and the study was approved by appropriate institutional research ethics committee.

2.2. Anthropometric measurements

Height (TH, cm) and body weight (WT, kg) of subjects were measured under fasting conditions and wearing only underwear. The precision error was 0.5 cm and 0.5 kg, respectively. Body mass index (BMI) was calculated as weight (kg) per squared height (m^2).

2.3. Body composition and BMD measurements

Lean and fat mass of trunk, leg, whole body, and including regional percentage of fat mass, percentage of WL and WF, ratio of LF mass to WF mass (LF/WF ratio) and ratio of TRF mass to WF mass (TRF mass/WF mass ratio) were measured by DXA (GE-Lunar Prodigy Advance, USA). BMD at posteroanterior spine including the first lumbar spine (L1), L2, L3, L4, and the total first to fourth lumbar spine (L1–4) and left hip including femoral neck (FN), femoral greater trochanter (FT), intertrochanteric area (FI) and total femoral (TF) were also measured by the same equipment (DXA). All results were evaluated by the same experienced investigator. Quality control phantom scan was obtained everyday for 2 years with the coefficient of variation of 0.33%.

The trunk region was delineated by an upper horizontal border below the chin, vertical borders lateral to the ribs, and a lower border formed by oblique lines passing through the hip joints. The leg region was defined as tissue below the oblique line passing through the hip joint.

2.4. Statistical analysis

The descriptive data for numerical variables are expressed as mean ± S.D. The correlation between body composition with age, MA, YSM, and BMD were assessed using Pearson's correlation analysis. Partial correlation analysis was performed to study the correlation between the body composition and BMD when controlling WT. The strength of correlation between the two variables was assessed by Pearson's correlation coefficient, partial correlation coefficient. Intergroup comparisons were made by Student's *t*-test. Multiple stepwise regression method was used to identify the determinants of regional BMD among age, MA, YSM, BMI, whole body and regional lean mass, fat mass and percentage of fat. WT was not included as a controlling variable, since WF and WL are closely related to WT, and its inclusion might lead to misinterpretations to results. The difference was considered statistically significant at $p < 0.05$. All calculations were performed using SPSS V13.0 for Windows Software (SPSS, Chicago, IL, USA).

3. Results

Table 1 presents the clinical characteristics of postmenopausal elderly Non-OP and OP women. The OP women were older, longer YSM, shorter, thinner, and had lower BMD at all measured sites. They also had lower whole body and regional lean mass and fat mass amount, lower fat percentage of whole and region and TRF/WF ratio, but higher percentage of WL and LF/WF ratio than Non-OP group. However, the percentage of LF mass did not differ between the two groups.

Table 2 shows that in Non-OP group, there was no correlation between lean mass with age, MA, and YSM, as well as no correlation between fat mass with age (all, $p > 0.05$); LF ($r = 0.187$; $p < 0.01$), percentage of LF ($r = 0.171$; $p < 0.01$), and WF ($r = 0.151$; $p < 0.05$), TRF ($r = 0.141$; $p < 0.05$), percentage of WF ($r = 0.143$; $p < 0.05$) were positively correlated with MA; though LF ($r = -0.131$; $p < 0.05$) and WF ($r = -0.127$; $p < 0.05$) were also negatively associated with YSM, LF and WF was more related with MA. In OP group, there was no correlation between lean mass and fat mass with MA ($p > 0.05$); WF ($r = -0.124$; $p < 0.05$), TRL ($r = -0.183$; $p < 0.05$), LL ($r = -0.136$; $p < 0.01$), WL ($r = -0.162$; $p < 0.01$) and TRF ($r = -0.141$; $p < 0.01$) were all negative correlated with age; TRL ($r = -0.132$; $p < 0.05$), LL ($r = -0.152$; $p < 0.01$), and WL ($r = -0.170$; $p < 0.01$) were also negative with YSM. However, TRF/WF ratio and LF/WF ratio were not correlated with age, MA, and YSM ($p > 0.05$) (Table 2).

Pearson's correlation analysis revealed (Table 3) that in the Non-OP group, BMD at all measured sites were positively correlated with body composition ($p < 0.01$) except BMD of FT with percentage of TRF, LF, and WF ($p > 0.05$). In OP group, BMD at all bone sites were all positively correlated with body composition