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Original Article

The correlation between bone mineral density/trabecular bone score and body mass index, height, and weight

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Abstract

This study investigated the correlation between bone mineral density (BMD)/trabecular bone score (TBS) and body mass index (BMI), height and weight in Korean adults.

We enrolled 2555 female participants in their 20s–80s and 1631 male participants in their 20s–70s. Participants with history of previous vertebral surgeries or current vertebral diseases were excluded. Female and male participants were divided into osteoporosis group (n = 136 and n = 31, respectively), osteopenia group (n = 822 and n = 460, respectively), and normal group (n = 1596 and n = 1140, respectively) based on their BMD T-score.

Dual-energy X-ray absorptiometry image analysis and linear regression analysis were conducted on each participant in each group to determine the p-value and the correlation between BMD T-score/TBS T-score and BMI, weight and height.

We found a significant correlation between BMI and TBS in both male and female participants. In the male participants, the correlation coefficient increased progressively from the normal group to the osteoporosis group. In the female group, we observed a significant positive correlation between height and TBS, and in the male group a significant negative correlation between weight and TBS was observed.

BMI and weight are closely correlated to body fat content. BMD was positively correlated to BMI and weight, while TBS was negatively correlated to BMI and weight. Therefore, although BMI causes an increase in BMD, it appears to be negatively affecting bone quality.

Keywords: Bone mineral density (BMD); Trabecular bone score (TBS); Body mass index (BMI); Body fat contents; Osteoporosis; Korean

1. Introduction

Osteoporosis is a chronic skeletal disease characterized by a reduction in bone density that increases fracture risk. In fact, the most common complication of osteoporosis is bone fracture [1,2], and world widely, it is estimated that there are 9 million cases of osteoporosis-related fractures reported every year [3]. Currently, osteoporosis is diagnosed using dual-energy X-ray absorptiometry (DXA) which measures bone mineral density (BMD) [1]. However, many studies have claimed that BMD has limited value as an independent predictor of fracture risk [4–7]. The most likely explanation for this is that fracture risk is not only influenced by the amount of bone mineral as measured by BMD, but also by the 3D microarchitecture of the bone tissue [8]. In order to overcome the limitations of BMD, the trabecular bone score (TBS) was developed to determine the bone's microarchitecture [9–11].

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TBS is a texture parameter that quantifies the changes in pixel gray-level in DXA images [10,11]. A high TBS indicates that the trabecular bone microarchitecture has high connectivity, greater number of trabeculae and low trabecular spacing (TbSp), and therefore high resistance to fracture. On the other hand, a low TBS indicates that the bone microarchitecture is prone to fracture [11,12]. Since the importance of TBS has been clinically recognized, many studies have been conducted and are ongoing with the aim of investigating this parameter. Several retrospective cross-sectional studies have reported that TBS could discern fracture in patients with similar effectiveness as BMD and some studies also reported that better results were observed when TBS and BMD were used together [12–16]. In addition, it was confirmed that TBS could predict fractures of the lumbar spine (LS) as effectively as areal BMD (aBMD) [17–19]. A cohort study, which conducted experiments on female subjects above 50 years of age for an average of 4.7 years in Manitoba, Canada, reported that individuals with low TBS were prone to fracture regardless of the aBMD score [18]. At present, ethnic differences in TBS are being evaluated with one study aimed at investigating differences in TBS between Caucasians and African Americans [20] and another study between European Caucasian males and females [21].

Most of the studies on TBS so far have solely been conducted on Caucasian subjects. The few studies conducted on Asian subjects [22–24] were limited by the fact that they enrolled only male participants or post-menstrual women. In addition, majority of the studies merely emphasize on age and fracture. As of now, there is no study that highlights the relationship between TBS/BMD and BMI, height and weight in Korean population, which is one of the most rapidly aging population in Asia.

TBS and BMD differ in units, but they are converted into T-scores, which allows reliable comparison. This study was conducted on 4186 male and female participants of all ages divided into three groups (osteoporosis, osteopenia, and normal groups) and the changes in TBS and BMD, which was later converted into T-score according to body mass index (BMI), height, and weight, were investigated. The goal of this study was to evaluate the correlation between TBS and physiological variables including BMI, height and weight, and to identify whether these correlations differ from those between BMD and the physiological variables stated previously.

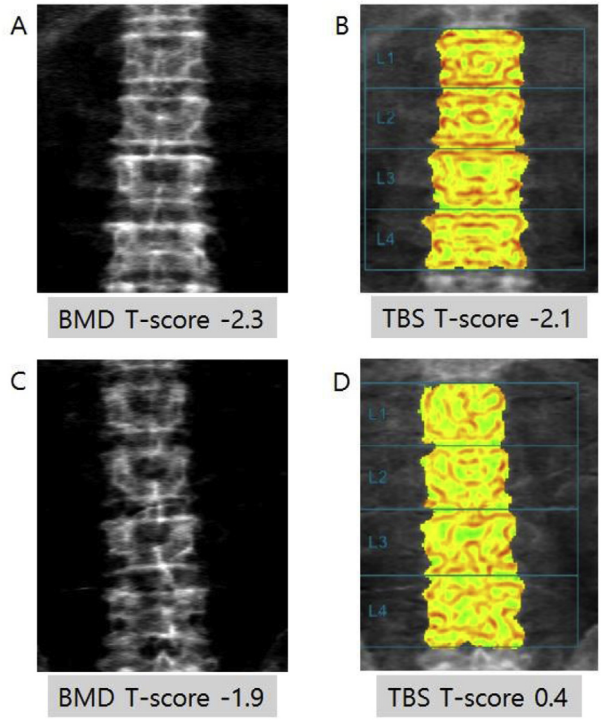

Fig. 1. Images of a DXA analysis in two 70-year-old Korean women. It was observed that two participants had similar BMD but different TBS.

2. Methods

2.1. Subjects

This study was conducted on 4186 subjects (2555 females and 1631 males) who had DXA (Hologic, Inc., Walthan, MA, USA) images taken at Dongguk University Hospital between August 2012 and July 2015. The coefficients of variation (CV) for these measurements were <1.5%. We enrolled the subjects from their health examinations results. Bone density was quantified based on T-score and used to categorize the subjects

Table 1
Subjects characteristics.

	Total number	Variables	Average	Median	Minimum	Maximum	Standard deviation
Female	2555	Age (y)	44.33	41	20	84	11.24
		BMI (kg/m^2)	22.25	21.63	15.03	44.14	3.41
		Height (cm)	159.49	159.6	140.9	178	5.62
		Weight (kg)	56.58	55	39	113	8.92
		BMD T-score	−0.23	−0.3	−4.22	3.15	1.1
		TBS T-score	0.26	0.4	−3.8	3	1.02
Male	1631	Age (y)	40.08	38	25	77	6.16
		BMI (kg/m^2)	24.43	24.25	15.38	38.53	3.06
		Height (cm)	172.85	173	151	190.5	5.59
		Weight (kg)	73.07	72.9	45	118	10.31
		BMD T-score	0.007	0.0	−3.97	2.97	1.028
		TBS T-score	0.601	0.6	−2.4	3	0.65

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