Journal of Clinical Densitometry, vol. 10, no. 3, 285−288, 2007

1094-6950/07/10:285−288/$32.00
DOI: 10.1016/j.jocd.2007.03.100

Original Article

Is BMD Sufficient to Explain Different Fracture Rates in Sweden and Turkey?

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Abstract

Osteoporosis and consequent fractures have become an important health problem all over the World. However, there are quite different fracture rates among different populations. In this study, our aim was to obtain the bone mineral density (BMD) values at calcaneus in a healthy Turkish population and compare them with Swedish population data. BMD was measured at the calcaneus using a dual X-ray and laser Calscan (Demetech AB, Stockholm, Sweden) bone densitometer. The total number of subjects was 951 consisting of 639 women and 312 men and age ranged from 15 to 79 yr. Mean BMD value for healthy young women (20−39 yr old) was 0.411 ± 0.058 g/cm^2 and for healthy young men was 0.504 ± 0.068 g/cm^2. BMD values tended to decrease with age in both genders. In comparison between the Turkish and Swedish population data, the Turkish population has about 1 standard deviation lower BMD values than the Swedish population in both genders, for all ages. Considering that Swedes have high fracture rates and Turks have the lowest fracture rates in Europe, the opposite difference in BMD values in the calcaneus seems interesting. Further research is needed to explain the difference in fracture rates among different populations.

Key Words: Bone mineral density; DXL; fractures; reference data.

Introduction

There are 2 major bone properties that affect the probability of osteoporotic fractures. These are low bone mineral density (BMD) and micro-architectural deterioration. However, the micro-architectural status cannot be adequately measured in vivo, therefore BMD is still a key measure to define osteoporosis *(1)*. As well as providing diagnostic information, low BMD is widely recognized as a major risk factor for fractures *(2)*. However, there are differences in fracture rates among different populations. The Swedish population has the highest hip fracture rates in Europe, whereas the Turkish population has the lowest. According to the estimated 10-yr probability of hip fracture, lifetime risk at the age of 50 yr varied from 1% in women from Turkey to 28.5% in women from Sweden. Therefore, whereas Swedish women have been categorized in a very high-risk group, Turkish women have been ranked among the low-risk group countries *(3)*.

The peripheral dual-energy X-ray absorptiometry (DXA) method developed by Swanpalmer and Kullenberg *(4)* is called the dual X-ray and laser (DXL) technique. This technique uses 2 X-ray energies in combination with laser measurement of the thickness of the object. The measurement of the thickness of the heel makes it possible to more accurately determine the amount of bone mineral, lean, and adipose tissue. In this way, errors of the traditional DXA technology are reduced *(5,6)*.

In this study, our aim was to obtain the BMD values at the calcaneus using a DXL Calscan bone densitometer in a healthy Turkish population and compare them with a Swedish population database.

Received 01/29/07; Revised 03/12/07; Accepted 03/27/07.
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Materials and Method

The total number of the healthy Turkish subjects was 951 consisting of 639 women and 312 men and age ranged from 15 to 79 yr. The demographic features of the studied subjects are shown in Table 1. Differences in age, weight, and height between the 2 populations were all significant ($p < 0.01$) for both women and men. All participants were given a questionnaire which was previously used for the Swedish population *(7)* for reporting medical history, medication use, fracture history, smoking and alcohol habits, and menopausal status. The candidates were recruited from business companies, textile factories, and universities in Istanbul. Exclusion criteria that were applied during the data analysis were history of fracture, malabsorption syndrome, lactose intolerance, bulimia, diabetes mellitus, hyperparathyroidism, hyperthyroidism, the usage of anti-osteoporotic agents (biphosphonates, calcitonine, estrogen, selective estrogen receptor modulator (SERM), and flour), corticosteroids, and chemotherapy, premature menopause (before the age of 45 yr), and extended bed rest. Every participant in the study signed an informed-consent form.

BMD was measured at the nondominant foot using DXL Calscan (Demetech AB, Stockholm, Sweden). This device uses fan-beam X-rays at 35 and 68 kV. The heel thickness was measured with a triangular laser technology during the BMD measurement.

The measurements of the subjects were completed within 3 mo. The DXL Calscan device was checked by weekly measurements of hydroxyapatite slabs in different concentrations incorporated in a solid, water-based, human-like phantom (Computerized Imaging Reference Systems, Inc., USA). These weekly measurements also give the accuracy of the device, the same phantom had previously been measured during the study of the Swedish population. The in vitro precision of the device was determined by these phantom measurements. In vivo precision was assessed by duplicate measurements of 17 healthy individuals, with reposition of the foot between the measurements.

The short-term in vivo precision of DXL Calscan, expressed as coefficient of variation, was 1.4% and the in vitro precision from weekly measurements on an anthropometric bone phantom was found to be 0.6%. The accuracy of the device was better than 2% (standard error of estimate) measured as difference between actual and measured hydroxyapatite content.

Results

After exclusion criteria were applied, 639 women and 312 men were included in the study. The mean age of women was 42.8 ± 14.4 yr, whereas it was 42.4 ± 14.6 yr for men.

Peak bone density at the calcaneus was reached in the 30−39 yr age group in women. However, it was reached earlier in the 20−29 yr age group in men. Mean BMD value for healthy Turkish young women (20−39 yr old) was 0.411 ± 0.058 g/cm^2 and for healthy Turkish young men 0.504 ± 0.068 g/cm^2. BMD values tended to be decreased with age in both genders (*see* Figs. 1 and 2).

In this reference population, among the postmenopausal women 12% were osteoporotic and 47% of them osteopenic according to the WHO criteria *(8)*. BMD cutoff limits measured with the DXL Calscan for Turkish women were found to be for osteopenia between the values of 0.353 and 0.266 g/cm^2 whereas osteoporosis was found below the value of 0.266 g/cm^2.

The differences in body mass index (BMI) between the 2 populations were small. The BMI for Turkish women and men was 25.9 and 26.0 kg/m^2, respectively and for Swedish women and men 24.5 and 25.8 kg/m^2, respectively.

The age-dependent BMD values in 10-yr bands for both genders, in Turkish and Swedish populations are shown in Table 2. Turkish subjects' BMD values were found to be about 1 standard deviation (SD) lower than those of the Swedish subjects, for all ages and in both genders. The BMD values of the 2 populations are compared in Figs. 1 and 2.

Discussion

This study presents BMD values of a healthy Turkish population and compares them with a Swedish population using a DXL Calscan device. Differences in fracture risk among different populations do not necessarily follow BMD differences *(9)*. Although DXA is a kind of gold standard technique in determining BMD, the study by Salminen et al. *(10)* showed that there was a fairly good correlation between BMD measurement at the calcaneus with DXL which has

Table 1
Demographic Features of the Turkish and Swedish Study Population

	Turks	Swedes	Turks	Swedes
	Women		Men	
Number	639	993	312	459
Mean age (±SD)	42.8 ± 14.4	48.2 ± 15.2	42.4 ± 14.6	47.0 ± 15.2
Weight (kg), mean (±SD)	65.8 ± 12.8	67.3 ± 11.1	77.1 ± 12.6	82.8 ± 12.0
Height (cm), mean (±SD)	159.3 ± 13.7	165.6 ± 6.3	172.3 ± 12.7	179.1 ± 6.8

Abbr: SD, standard deviation.