Original Article

Geographic Differences in Bone Mineral Density of Mexican Women


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Abstract. The aim of this study was to generate standard curves for normal spinal and femoral neck bone mineral density (BMD) in Mexican women using dual-energy X-ray absorptiometry (DXA), to analyze geographic differences and to compare these with ‘Hispanic’ reference data to determine its applicability. This was a cross-sectional study of 4,460 urban, clinically normal, Mexican women, aged 20–90 years, from 10 different cities in Mexico (5 in the north, 4 in the center and 1 in the southeast) with densitometry centers. Women with suspected medical conditions or who had used drugs affecting bone metabolism, were excluded. Lumbar spine BMD was significantly higher (1.089 ± 0.18 g/cm²) in women from the northern part of Mexico, with intermediate values in the center (1.065 ± 0.17 g/cm²) and lower values (1.013 ± 0.19 g/cm²) in the southeast (p < 0.0001). Similarly, femoral neck BMD was significantly higher in women from the north (0.895 ± 0.14 g/cm²), intermediate in the center (0.864 ± 0.14 g/cm²) and lower (0.844 ± 0.14 g/cm²) in the southeast part of Mexico (p < 0.0001). Northern Mexican women tend to be taller and heavier than women from the center and, even more, than those from the southeast of Mexico (p < 0.0001). However, these differences in BMD remained significant after adjustment for weight (p < 0.0001). A significant loss (p < 0.0001) in BMD was observed from 40 to 69 years of age at the lumbar spine and up to the eighth decade at the femoral neck. Higher and lower lumbar spine values, as compared with the ‘Hispanic’ population, were observed in Mexican mestizo women from the northern and southeastern regions, respectively. In conclusion, there are geographic differences in weight and height of Mexican women, and in BMD despite adjustment for weight.

Keywords: Bone mineral density (BMD); Dual-energy X-ray absorptiometry (DXA); Femoral neck; Hispanic; Lumbar spine; Mexican women

Introduction

Low bone mass is currently recognized as the most important predictor of fracture risk. The current relative fracture risk increases 1.5 to 2.5 times for each standard deviation (SD) the bone mineral density (BMD) declines from the mean young normal BMD [1]. Peak bone mass and the rate of bone loss in adulthood determine the BMD in later life and are influenced by environmental, dietary, genetic, gender and racial factors.

It has been well recognized that there are gender and racial/ethnic differences in BMD. Women have approximately 8–12% lower femur BMD than men of the same race or ethnic groups. Black people have 8–14% higher BMD than whites of the same gender [2], and Caucasians have higher BMD than Japanese Asians.

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Nevertheless, US-born Japanese-American and immigrant Japanese-American women have significantly higher BMD than native Japanese women, suggesting a strong influence of changes in lifestyle and diet [4]. Other authors have also shown differences among ethnic groups [5,6].

Caucasian white women in the United States seem to have a 2-fold greater incidence rate of hip and vertebral fracture than ‘Hispanics’, an ambiguous term used to designate Latin American immigrants from Mexico, Central and South American countries, the Caribbean and even Spain or Portugal, often regardless of their ethnic background [2,7]. Hip BMD in this group seems to be lower than that in blacks and higher or equal to that in white Caucasians in the United States [8]. Differences in body size may to some extent explain the differences, since most ethnic differences in BMD are reduced or eliminated after adjustment for weight [9,10].

The aim of this study was: (1) to obtain standard curves for normal BMD in a large sample of Mexican population and to analyze geographic differences within our country, related to differences in ethnicity [11,12] and nutrition [13,14]; and (2) to compare them with the ‘Hispanic’ reference values in current Lunar DPX bone densitometers (Lunar, Madison, WI) in order to determine the applicability of the reference values.

Subjects and Methods

Subjects:

The study population consisted of 4460 Mexican women, aged 20–90 years, from 10 different cities in Mexico: five in northern Mexico (Mexicali, Monterrey, Obregon, Hermosillo and Durango), four in the central zone (Guadalajara, Leon, Mexico City and Puebla) and one in the southeast (Merida). All women were clinically healthy, and had been referred by a physician to a bone densitometry center as part of a routine examination or attended of their own accord as they were invited to participate in this study. All the young women (20–39 years old) – 140 women from the north (Mexicali), 148 from the center (Puebla) and 133 from the southeast (Merida) – were invited to participate in this study.

Healthy women from 20 to 90 years old were included. The medical records of the subjects in the bone densitometry centers were carefully analyzed in the search for exclusion criteria. These included suspected conditions affecting BMD such as chronic renal failure, endocrine disorders, chronic hepatic and metabolic bone diseases, malignancies, early menopause or oophorectomy (under 40 years), rheumatoid arthritis, nephrolithiasis, a history of a pathologic fracture, prolonged bed rest or alcohol abuse. Present or previous use of glucocorticoids, anticonvulsants, heparin, thyroxine or any drug approved or experimentally used to treat osteoporosis was also an exclusion criterion. Menopausal women were considered to be those with a natural occurring menopause; women with an oophorectomy or hysterectomy before 50 years of age were excluded for the comparison between premenopausal and postmenopausal women.

Methods

Bone Densitometry. All women had a measurement of BMD of the lumbar spine and proximal femur by DXA (Lunar DPX; Lunar, Madison, WI).

To assess the quality control of the bone densitometers in each of the centers, standard Lunar daily quality control was performed throughout the study. The intraobserver coefficient of variation was determined measuring BMD five times on five subjects as well as six times on a phantom (a piece of milled aluminum with four steps of known density provided by the manufacturer) on all instruments. To evaluate the interobserver variability (in vivo) of measurement of BMD, one subject was measured three times, once in each of the three areas: north (Mexicali), center (Puebla) and southeast (Merida).

Statistical Analysis. All reported values are means ± standard deviation (SD). Due to clear differences in height, weight and BMD, the entire population was divided in three geographical regions: north, center and southeast. In order to investigate any difference in mean BMD amongst age groups (per decade) and quartiles (Q) of body mass index (BMI; Q1 = BMI 15.0 – 23.3, Q2 = 23.4 – 25.8, Q3 = 25.9 – 29.0, Q4 = 29.1 – 56.0 kg/m²) analysis of variance was applied. Weight adjustments were determined by regression equations using weight as a dependent variable, following procedures carried out by Lunar (R. B. Mazess and H. S. Barden, personal communication), and were applied for weights between 35 and 70 kg. The weight adjustment for the spine BMD was 0.004 g/cm² for each kilogram of weight above or below the mean (65 kg). Data for women over 70 kg suggest that an additional weight adjustment is not necessary beyond that already applied for 70 kg; therefore, subjects heavier than 70 kg received the same adjustment as a 70 kg subject. Femur adjustments were applied for weights between 35 and 100 kg. The weight adjustment per kilogram for femoral neck BMD is 0.003 g/cm² for each kilogram of weight above or below the mean (65 kg).

Young adult reference values were calculated separately in the three geographical regions in subjects between 20 and 39 years old (young population). Means and SD for weight, height, BMI and lumbar spine and femoral neck BMD (weight-adjusted and unadjusted) were determined.

Analysis of variance (ANOVA) and Student’s t-test for independent samples were used to determine differences between the three regions separately and by pairs (north vs center, north vs south and center vs south), respectively. To calculate the degree of correlation between BMD (lumbar spine and femoral neck)