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Bone mineral density in Brazilian men 50 years and older

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Abstract

Bone mineral density (BMD) in the lumbar spine (LSBMD), femoral neck (FNBMD) and whole body (WBBMD) and whole body tissue composition were evaluated in 288 Brazilian men 50 years and older, 80% white and 20% Mulattoes. Age was inversely correlated with WBBMD (r = -0.20) and FNBMD (r = -0.21) but not with LSBMD (r = 0.03). Body mass index and weight showed a strong positive correlation with WBBMD (r = 0.48 and 0.54), LSBMD (r = 0.37 and 0.45) and FNBMD (r = 0.42 and 0.48). Correlation with height was positive but weaker. No significant bone loss at the lumbar spine level was observed as the population aged. FNBMD and WBBMD decreased significantly only in the last decade (age 70-79) studied. BMD was higher for Brazilian men as compared to Brazilian women at all sites. No significant differences were observed between Brazilian and the US/European male population for BMD in the femoral neck. BMD measured by dual-energy X-ray absorptiometry in South American men is reported here for the first time. A decrease in FNBMD was detected only later in life, with a pattern similar to that described for the US/European male population.

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Introduction

Low bone mass is the most important predictor of fragility fracture. Other risk factors such as low body weight and a positive maternal history of fracture may be predictive of fragility fracture but they are not as objectively quantifiable as bone mass measurements. Bone mineral density (BMD) has been measured with good precision for the purpose of identifying asymptomatic individuals at risk for fracture but factors such as ethnic variability and environmental diversity preclude the use of a single reference data base (1). Bone measurements may vary among people of different racial background living in specific geographic areas with differences in climate, exposure to sunlight and dietary habits (2-6). A contribution by the genetic potential to variability in bone mass may be observed comparing measurements in people of African origin and Caucasians. Its well known that, even when matched for age and weight, blacks attain a higher peak bone mass, have higher bone density and fewer osteoporotic fractures than whites (7,8). Environmental factors may explain the lower bone densities found in Japan-born immigrants when compared to siblings of Japanese immigrants born in the United States (9). These data show the necessity to establish reference data for bone mass measure-

ments and also patterns of bone loss for each particular population in order to identify pathologic deviations and indicate therapeutic interventions.

The epidemiology of osteoporosis in South America is incomplete since it has been studied in only a few areas and only in women. Available data have been summarized by Mautalen and Pumarino (10). Although it has been established that bone mass for white women at the time of menopause in São Paulo (Brazil) is very similar to values for white women in the US (11) there are no bone mass measurement studies in the normal male population. This would not be a surprise since osteoporosis research has been focused on the group at highest risk of osteoporotic fracture, i.e., white women. Only in recent years has it been recognized that fractures are common and osteoporosis in men is also a public health problem (12-14).

A large study conducted in the US, the Third National Health and Nutrition Examination Survey (NHANES III), estimated that 1-4% of men have osteoporosis and 15-33% have osteopenia based on World Health Organization female cutoffs for BMD at the femoral neck level (15).

A later pattern of bone loss and also a lesser loss of cortical bone in healthy men as compared to healthy women have been well documented (16,17). The incidence of fractures due to minimal-to-moderate trauma also occurs later in life in men (18,19).

Table 1 - Body size and bone mineral density (BMD) of 288 healthy men, aged 50 years and more.

Characteristics	Mean	SD	Median	Minimum	Maximum
Age	62.5	7.9	61.0	50	79
Body size					
Weight (kg)	73.0	12.5	71.6	42.1	116.5
Height (m)	1.65	6.5	1.65	1.45	1.84
BMI (kg/m^2)	26.6	3.9	26.2	15.5	41.8
BMD (g/cm^2)					
Lumbar spine (L_2-L_4)	1.169	0.191	1.163	0.713	1.988
Femoral neck	0.916	0.146	0.918	0.538	1.393
Total	1.145	0.104	1.149	0.819	1.394
Bone mineral content (g)	2,736.1	424.5	2,740.0	1,351.0	4,364.0

The objective of this study was to obtain normal reference data for vertebral and proximal femur bone density in men 50 years and older living in an area of southern Brazil and to observe the pattern of bone loss with age. Comparisons with female Brazilian and US/European male populations were also made.

Patients and Methods

We recruited 357 healthy male subjects 50 years and older, all residents of São Paulo city (southwestern Brazil) from among husbands whose wives were sent by their primary care physicians for a bone densitometry and we also advertised in newspapers. This cross-sectional study was part of a larger study designed to determine the relationship between body composition and bone mass in older men. All subjects were submitted to a medical interview including a food and beverage intake questionnaire, smoking habits and medication use. Written informed consent was obtained from all subjects. We measured weight (kg) with a standardized balance-beam scale and height (m) with a stadiometer and calculated the body mass index (BMI) as the ratio of weight (kg) to height (m^2).

BMD in the anteroposterior lumbar spine L_2-L_4, femoral neck and whole body and whole body soft tissue composition were measured with a Lunar dual-energy X-ray absorptiometer (DXA) (3.6z software; Lunar Corp., Madison, WI, USA). We report bone content in grams and BMD in g/cm^2. We excluded any subjects whose whole body was not fully visible within the scan region and those who had >40% body fat.

The coefficients of variation for DXA measures were 1.5% for lumbar spine and femoral neck BMDs and 0.6% for whole body BMD.

After application of the exclusion criteria the number of participants was reduced to

288 males, 79.86% of them white and 20.14% Mulatto. There were no Orientals in our sample.

Statistical analysis

The Kruskal-Wallis test was used to compare BMDs among different decades of life. Pearson's correlation coefficients were calculated to analyze the association between bone mass/bone density variables and body size measurements. The Student *t*-test was used to examine possible differences between Brazilian and US/European male populations for the measured variables and also between Brazilian female (11) and male populations. The effective P value for observations to be considered statistically significant was 0.05. Data were analyzed using the SPSS statistical software system.

Results

The characteristics of the 288 men are shown in Table 1. Their mean age was 62.5 years, 79.86% were white and 20.14% were Mulattoes. Their mean BMI was 26.6 kg/m^2, mean weight 73 kg, and mean height 1.65 m.

A correlation matrix is provided in Table 2, which indicated a negative association between BMD and age at all skeletal sites except the lumbar spine. These associations were significant for the femoral neck (P<0.001) and whole body (P = 0.001) but not for the spine. Height associations were weaker and less consistent. BMI and weight were significantly correlated with BMDs at all sites showing similar Pearson's coefficients. When subjects were stratified by decade (Table 3) significant decrements in weight and height were observed only in the eighth decade (age 70-79). These decrements kept BMI unchanged with age.

Body size comparisons between Brazilian male and female (11) populations are shown in Table 4. Women had a significant increase in BMI with age due to decreasing

Table 2 - Correlations between body size and bone mass variables (N = 288 men).

r = Pearson's correlation coefficient; BMI = body mass index; WBBMC = whole body bone mineral content; WBBMD = whole body bone mineral density; LSBMD = lumbar spine bone mineral density; FNBMD = femoral neck bone mineral density.

Variables	WBBMC	WBBMD	LSBMD	FNBMD
Age (r)	-0.19	-0.20	0.03	-0.21
P	(0.001)	(0.001)	(0.631)	(<0.001)
Weight (r)	0.72	0.54	0.45	0.48
P	(<0.001)	(<0.001)	(<0.001)	(<0.001)
Height (r)	0.57	0.26	0.25	0.24
P	(<0.001)	(<0.001)	(<0.001)	(<0.001)
BMI (r)	0.52	0.48	0.37	0.42
P	(<0.001)	(<0.001)	(<0.001)	(<0.001)

Table 3 - Clinical and demographic characteristics of 288 healthy Brazilian men stratified by decade.

P<0.05 for a x c, b x c, d x f, and e x f (Kruskal-Wallis test with correction). BMI, Body mass index.

Age (years)	N	Weight (kg)	Height (m)	BMI (kg/m^2)
50-59	122	74.2 ± 13.4^a	1.66 ± 6.2^d	26.7 ± 4.2^g
60-69	106	73.8 ± 11.3^b	1.65 ± 7.0^e	26.8 ± 3.7^h
70-79	60	69.2 ± 12.0^c	1.62 ± 5.8^f	26.3 ± 4.1^i

Table 4 - Comparison between Brazilian male (M) and female (F)* populations for weight, height and body mass index (BMI) stratified by decade.

Data were analyzed statistically by the Student *t*-test. *Brazilian female population from Ref. 11.

Age (years)	N	Weight (kg)	Height (m)	BMI (kg/m^2)
50-59	M (122)	74.2 ± 13.4^a	1.66 ± 0.1^c	26.7 ± 4.2^e
	F (138)	64.0 ± 8.1^b	1.58 ± 0.1^d	25.5 ± 3.1^f
60-69	M (106)	73.8 ± 11.3^g	1.65 ± 0.1^i	26.8 ± 3.7^k
	F (61)	63.4 ± 8.1^h	1.55 ± 0.1^j	26.4 ± 3.5^l
70-79	M (60)	69.2 ± 12.0^m	1.62 ± 0.1^o	26.3 ± 4.1^q
	F (18)	64.1 ± 7.7^n	1.54 ± 0.1^p	27.0 ± 3.1^r

a x b: P = 0.009 g x h: P<0.001 m x n: P<0.001
c x d: P = 0.494 i x j: P<0.001 o x p: P<0.001
e x f: P = 0.506 k x l: P = 0.094 q x r: P<0.0019

height and increasing weight. These changes led to a significantly higher female BMI than in males in the eighth decade (P<0.001). A cross-calibration between equipment used by us and those used in the female study was performed before the beginning of the present study in order to allow both centers to participate in a multicenter trial already published elsewhere (20).

Table 5 - Mean bone mineral density of lumbar spine, femoral neck and whole body of 288 healthy Brazilian men 50 years and older.

P<0.05 for d x f, e x f, g x i, and h x i (Kruskal-Wallis test with correction).

Age (years)	N	Spine (g/cm^2)	Neck (g/cm^2)	Whole body (g/cm^2)
50-59	122	1.157 ± 0.20^a	0.939 ± 0.15^d	1.160 ± 0.17^g
60-69	106	1.187 ± 0.17^b	0.922 ± 0.16^e	1.149 ± 0.10^h
70-79	60	1.171 ± 0.20^c	0.862 ± 0.12^f	1.114 ± 0.10^i

Table 6 - Comparison of Brazilian male (M) and female (F)* populations for lumbar spine and femoral neck bone mineral densities stratified by decade.

Data were analyzed statistically by the Student *t*-test. P<0.0001 for a x b, c x d, e x f, g x h, and i x j. P<0.0007 for k x l. *Brazilian female population from Ref. 11.

Age (years)	N	Spine (g/cm^2)	Femur (g/cm^2)
50-59	M (122)	1.157 ± 0.20^a	0.939 ± 0.16^g
	F (138)	1.010 ± 0.14^b	0.830 ± 0.10^h
60-69	M (106)	1.187 ± 0.17^c	0.922 ± 0.13^i
	F (61)	0.940 ± 0.14^d	0.770 ± 0.11^j
70-79	M (60)	1.171 ± 0.20^e	0.862 ± 0.12^k
	F (18)	0.950 ± 0.16^f	0.750 ± 0.10^l

Table 7 - Comparison of Brazilian and US/European* male populations for lumbar spine and femoral neck bone mineral densities (g/cm^2) stratified by decade.

Data were analyzed statistically by the Student *t*-test. No statistical differences were detected between measurements except c x d (P = 0.02). *Lunar reference data from Ref. 21.

Country	Site	50-59 years	60-69 years	70-79 years
Brazil	Spine	1.157 ± 0.20^a (N = 122)	1.187 ± 0.17^c (N = 106)	1.171 ± 0.20^e (N = 54)
US/Europe		1.145 ± 0.240^b (N = 250)	1.157 ± 0.24^d (N = 400)	1.173 ± 0.24^f (N = 330)
Brazil	Neck	0.939 ± 0.16^g (N = 122)	0.922 ± 0.13^i (N = 106)	0.862 ± 0.12^k (N = 54)
US/Europe		0.956 ± 0.26^h (N = 319)	0.909 ± 0.26^j (N = 428)	0.876 ± 0.26^l (N = 344)

No significant bone loss was observed at the lumbar spine level as the study population aged (Table 5). Artifacts such as osteophytes or extravertebral calcification, which are common in older men, may have influenced lumbar spine BMD results. Femoral neck and whole body BMDs did not change significantly between the sixth decade (age 50-59) and the seventh decade (age 60-69). When these two decades were compared with the last decade (age 70-79) BMD values showed a significant decrease, disclosing a later pattern of bone loss in the mainly predominant cortical bone areas. Brazilian women had lower BMDs at all sites and also an earlier pattern of bone loss when compared to men (Table 6).

No significant differences were observed between Brazilian and US/European (21) older male populations for BMD at all skeletal sites except for lumbar spine in the seventh decade (Table 7). Neither population showed a decrease in bone mass at the lumbar spine level with age. At the femoral neck level, bone density decreased linearly with age for all subjects.

Discussion

The present results show normative data for BMD and the pattern of bone loss for Brazilian men 50 years and older living in São Paulo city (southwestern Brazil).

Brazil is a large country with a wide variety of environmental conditions. The Brazilian male population shows ethnic multiplicity and is characterized by an interracial mixing rarely seen in other countries. Taking into account these factors the database obtained in our study may not be representative of the entire Brazilian male population and therefore our normative data should be used only for a population sharing the same genetic potential and living under similar environmental conditions. One limitation

of our study was the recruitment of volunteers. The study sample was not population based but recruited from husbands whose wives were admitted for bone densitometry or through newspaper advertisements. It is possible that this may introduce a selection bias focusing on the wealthier and better educated part of the population or alternatively on those who through life style or living conditions are more prone to osteoporosis.

To our knowledge, this is the first study of BMD in a large South American male population using DXA measurements. Before our study Pumarino et al. (22) published BMD data for the normal male population of Santiago (Chile). Unfortunately, the determinations were performed with a different type of equipment (Norland 2000) using a gadolinium-153 source. The different calibration of the equipment and doubts involving the analysis of values from different scales prevented a comparison. In the present study body size (weight and BMI) was strongly correlated with BMD at the spine, femoral neck and whole body levels. BMD decrements by age were observed at all skeletal sites, except the spine. The lack of association between spinal BMD and age has been observed in other studies in men using bone absorptiometry (22-25). This may reflect degenerative changes of the spine due to spondylosis deformans or vascular calcifications, although one study (26) demonstrated stability of L_2-L_4 BMD with age in men after radiographic exclusion of osteophytes. A recent study has used lumbar spine BMD successfully to correlate bone loss with vertebral body size in a small male population (27). Trabecular bone loss with aging has been evidenced by the technique of quantitative computed tomography (QCT) in the male spine (28,29). Probably the use of lateral QCT and DXA measurements may provide a more accurate assessment of spinal bone mass changes in men (30).

Significant weight loss was associated with significant decrements in whole body and femoral neck BMDs in the eighth decade. Weight has been correlated with bone mass variations showing that heavier men have greater BMD and that weight loss is associated with bone loss with aging (31,32). Mazess et al. (26) found a low but also significant correlation of lumbar spine and femoral neck BMDs with body weight in males. It should be taken into account, however, that BMD is influenced by skeletal size since it is not corrected for variations in the third dimension. Since body weight and skeletal size are related this may explain some of the relations described. Longitudinal studies are needed to confirm our results.

Some controversy still remains over the continuation and pattern of bone loss in the very elderly population. Although some studies suggest that cortical bone loss may cease in old age (33,34), our cross-sectional study suggests that cortical bone loss, which predominates at femoral neck and whole body sites, may continue in old males. A cross-sectional study may have some limitations due to a possible cohort effect, but the same pattern of bone loss was also observed in the longitudinal Framingham Osteoporosis Study (35).

In the present study BMD at the lumbar spine and femoral neck level was higher for men than for women in all decades. Vertebral BMD continued to decrease with age in the sample of women used for comparison (11) but not for men. BMD at the femoral neck level decreased for both sexes with age but reduction was lesser and later for men. The Framingham Study (35) found no difference between sexes for BMD at the forearm or proximal femur level. Mazess et al. (26) found no differences in BMD at the spine, femoral neck or trochanter level when comparing men and women aged 70 years and older. Blunt et al. (36) measured BMD at the spine, hip, midshaft and ultradistal radius level in a large population of men and women aged 50-98 years. In their study mean BMD

levels decreased significantly with age at all sites except the male spine and bone loss was significantly higher in women except for the ultradistal radius. Differences among cross-sectional studies may be elucidated in future prospective studies.

The similar values for BMD at the lumbar spine and femoral neck level between Brazilian and US male populations allow the use of the same reference data for both. An exception was the lumbar spine BMD in the seventh decade (ages 60-69). This may be due to osteophytes or to an artifact effect as discussed earlier.

In the present study we cannot exclude cohort effects such as socioeconomic status, lifetime exercise patterns or nutritional habits. A survival bias may also have occurred since we made bone measurements only in the individuals able to come to the outpatient clinic. It is possible that the total elderly male population may have lower BMD levels.

We have described BMD data for a predominantly Caucasian healthy Brazilian male population 50 years and older. Our cross-sectional data indicate that BMD levels in cortical areas decline with age in men and this occurs later in life than for women. These observations suggest that interventions directed at preserving bone mass may be helpful in elderly men. Population screening for osteoporosis in men may be considered at the beginning of the eighth decade when there is a significant bone loss in the femoral neck, probably followed by a rapid increase in age-related fractures (37).

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