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Original Article

A Pilot Study of Body Composition and Bone Mineral Density in Healthy Men From Argentina

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Abstract

A precise assessment of bone mineral density (BMD) and body composition can be performed using dual-energy X-ray absorptiometry (DXA). Values of body composition for males would be useful to evaluate the occurrence of alterations in body composition in a number of diseases. The objectives of this study were to establish BMD and body composition values in healthy men and to analyze age-related changes. BMD and body composition of total body and subareas were determined in 116 healthy men (aged 20–79 yr) using DXA. Comparison between 20–29- and 70–79-yr-old men showed that older subjects were shorter ($p < 0.03$), and had a higher body mass index ($p < 0.01$). Fat mass increased (+46.7%; $p < 0.001$) especially in the trunk. Lean mass (LM) decreased (−9.4%; $p < 0.05$) mainly in the arms and legs. Bone mineral content (BMC) and BMD decreased (−15.3% [$p < 0.001$], −6.3% [$p < 0.05$], respectively). Correlation was observed between BMC and LM ($r = 0.7$, $p < 0.01$). Values of BMD and body composition in healthy men were obtained. A relation was observed between bone mass and body composition, suggesting that the age-related decrease in LM may be associated to bone mass loss. Further studies should be conducted to elucidate the role of body composition in the occurrence of osteoporosis in men.

Key Words: Body composition; healthy men; reference values.

Introduction

Dual-energy X-ray absorptiometry (DXA) is 1 of the methods available to determine body composition *(1–9)*. DXA is a rapid, inexpensive, easily available, precise, noninvasive method involving low radiation exposure *(1,4–6)*. The technique basically involves the differential attenuation of transmitted photons by bone, fat, and lean tissue, at 2 energy levels *(10)*, and has been shown to correlate with other techniques such as magnetic resonance, computer tomography, neutron activation, and radioactive isotopes *(1,6,7,9)*.

DXA analysis of the total body allows a precise determination of body composition by dividing it into 3 compartments—fat mass (FM), lean mass (LM), and bone mineral content (BMC), based on which bone mineral density (BMD) can be calculated *(2,4,5,7,8,11)*.

Over the last few years, evaluation of body composition using DXA has contributed to our understanding of the physiopathology underlying a number of clinical conditions known to affect both skeletal and soft tissues, such as anorexia nervosa, overweight, Crohn's disease, celiac disease, hepatic cirrhosis, and renal and endocrine disorders *(10,12–18)*. In addition, increased attention has been paid to changes in body composition associated with bone metabolic diseases (e.g., Paget's disease, osteoporosis, and osteopetrosis) *(10,11,19,20)*.

According to a number of studies, there is a direct relation between body composition and bone mass in pre- and postmenopausal women *(11,19–30)*. Studies performed in elderly men evidenced age-related variations in muscle and FM, demonstrating the existence of a relation between muscle and FM and bone mass *(8,21–23,26–28)*.

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To our knowledge, no studies have been conducted in Argentina to establish body composition reference values in healthy men.

The aim of the present study was to establish values of body composition (FM, LM, and BMC) and total body BMD in healthy men living in Buenos Aires, Argentina, and to analyze age-related variations in these values.

Materials and Methods

Population

One hundred and sixty-one men were asked to participate in our study, which was conducted during 2004 and 2005. The subjects were relatives of patients attending the Clinicas University Hospital of Buenos Aires, hospital employees, and university students.

Only healthy men aged between 20 and 79 yr and presenting with a body mass index (BMI) between 20 and 30 kg/m^2 were included in the study. All the subjects gave their informed consent. The subjects were asked to fill out a questionnaire and those reporting to have had previous fractures, renal, liver, gastrointestinal, and/or rheumatic diseases, or have received medication known to affect bone and mineral metabolism (e.g., heparin, corticosteroids, fluorides, bisphosphonates, thyroid hormone, or vitamin D metabolites) were excluded from the study. Men with evidence of coronary disease, determined according to self-reported health history algorithms (antecedents of coronary artery bypass surgery, pacemaker, myocardial infarction, or carotid endarterectomy), and medication records (anti-angina medication), were also excluded, due to the reported association between visceral FM and the incidence of myocardial infarction *(31)*. Anthropometric parameters, that is, weight, height, and BMI, were determined using standard techniques.

Forty-five men were excluded from the study in compliance with the established exclusion criteria, 9 of them had a BMI above 30.

The protocol was approved by the Ethics Committee of the Hospital de Clínicas, and is in keeping with the Declaration of Helsinki and subsequent amendments *(32)*.

Analysis of Body Composition: Total Body and Subareas

DXA (Lunar DPX) was used to determine body composition compartments (FM, LM, and BMC) and BMD of total body and subareas, namely arms, legs, and trunk *(33)*.

The coefficients of variation obtained at our laboratory were as follows—FM: 4.8%; LM: 0.8%; and BMC: 1.0% and BMD: 0.6% *(19)*. All the measurements were performed by the same expert technician.

Statistical Analysis

The statistical analysis was performed using SPSS software (11.0, SPSS Inc., Chicago, IL). The subjects were divided into groups according to age as follows: 20–29, 30–39, 40–49, 50–59, 60–69, 70–79 yr. The data are expressed as mean ± 1 standard deviation ($X \pm SD$). Comparison between groups was performed using a nonparametric nonpaired test (Mann-Whitney). Correlation coefficients were calculated to assess the relationship among variables using Pearson's test. A value of $p < 0.05$ was considered significant.

Results

The anthropometric data corresponding to each of the decades of life are shown in Table 1. Men aged 70–79 yr were shorter ($p < 0.01$), heavier (ns), and had higher BMI ($p < 0.01$) than those aged 20–29 yr.

Values corresponding to body composition (FM, LM, and BMC) and BMD are shown in Table 2.

Comparison between total body values, corresponding to the first and last decades studied herein, showed an approx 46.2% increase in FM ($p < 0.001$), an approx 9.4% decrease in LM ($p < 0.001$), and an approx 15.2% decrease in BMC ($p < 0.001$; Fig. 1).

Analysis of the subareas showed a significant increase in FM of the trunk ($p < 0.001$) and arms ($p < 0.001$). Although an increase in FM of the legs was also observed, it failed to reach statistical significance (ns; Fig. 2). Unlike LM of the trunk (ns), LM of the arms and legs was found to decrease with age ($p < 0.001$; Fig. 3). BMC of all the studied subareas decreased with age: arms (approx 20%, $p < 0.001$), legs (approx 15.4%, $p < 0.001$), and trunk (approx 27.3%, $p < 0.001$).

Total body BMD values decreased significantly (approx 6.3%, $p < 0.001$), as did BMD values of all the subareas (arms: approx 13.1%, $p < 0.001$; legs: approx 9.5%, $p < 0.001$; and trunk: approx 6.3%, $p < 0.001$).

Significant positive correlation was observed between BMC and LM in all the studied areas: total body ($r = 0.7$, $p < 0.01$; Fig. 4), arms ($r = 0.6$, $p < 0.01$), legs ($r = 0.7$, $p < 0.01$), and trunk ($r = 0.6$, $p < 0.01$). Positive correlation was observed between FM and BMC when comparing values corresponding to the legs ($r = 0.3$, $p < 0.01$), but no correlation was found when comparing values corresponding to total body ($r = 0.1$, ns), arms ($r = 0.07$, ns), and trunk ($r = 0.02$, ns).

Table 1
Anthropometric Data Corresponding to Different Age Groups of Healthy Men From Buenos Aires

Decade of life (yr)	n	Weight (kg)	Height (m)	BMI (kg/m^2)
20–29	25	74.1 ± 0.8	1.76 ± 0.6	24.0 ± 2.1
30–39	15	75.0 ± 0.8	1.74 ± 0.5	24.8 ± 2.2
40–49	22	75.0 ± 0.9	1.74 ± 0.7	24.8 ± 2.2
50–59	16	74.8 ± 0.9	1.71 ± 0.8	25.5 ± 2.5
60–69	22	76.4 ± 0.9	1.71 ± 0.6	26.1 ± 2.4
70–79	16	75.0 ± 0.5	1.70 ± 0.5**	26.1 ± 2.0*

Abbr: BMI, body mass index.
*$p < 0.01$ (20–29 vs 70–79); **$p < 0.001$ (20–29 vs 70–79 yr).

Table 2
Body Composition of Different Age Groups of Healthy Men From Buenos Aires

	Areas/subareas	Decades of life (yr) 20–29	30–39	40–49	50–59	60–69	70–79
FM (kg)	Total body	14.3 (5.7)	19.2 (6.0)	17.3 (4.1)	19.4 (5.8)	19.7 (5.0)	20.9 (4.1)*
	Arms	1.6 (0.8)	2.5 (0.1)	2.0 (0.6)	2.3 (0.1)	2.5 (0.1)	2.4 (0.9)**
	Legs	5.2 (2.8)	6.1 (1.8)	5.3 (1.6)	5.7 (1.8)	5.4 (1.5)	5.9 (1.3)
	Trunk	6.6 (2.8)	9.6 (2.9)	9.0 (2.1)	10.2 (2.9)	10.6 (2.5)	11.3 (2.5)**
LM (kg)	Total body	56.5 (3.5)	52.7 (3.9)	54.5 (6.4)	52.3 (6.7)	53.7 (5.3)	51.2 (4.7)**
	Arms	6.9 (0.7)	6.2 (0.7)	6.5 (0.1)	5.9 (0.1)	6.6 (0.1)	5.7 (0.6)**
	Legs	19.8 (1.5)	18.3 (1.9)	18.6 (2.5)	17.7 (2.3)	17.3 (1.9)	16.7 (2.2)**
	Trunk	26.0 (1.9)	24.6 (1.7)	25.8 (3.0)	25.0 (3.1)	26.2 (2.6)	25.4 (2.5)
BMC (kg)	Total body	3.3 (0.5)	3.0 (0.4)	3.1 (0.4)	3.0 (0.5)	3.0 (0.4)	2.8 (0.3)**
	Arms	0.5 (0.06)	0.4 (0.05)	0.4 (0.07)	0.4 (0.07)	0.4 (0.07)	0.4 (0.04)**
	Legs	1.3 (0.2)	1.2 (0.2)	1.2 (0.2)	1.2 (0.2)	1.2 (0.2)	1.1 (0.1)**
	Trunk	1.1 (0.2)	0.9 (0.2)	0.9 (0.2)	0.9 (0.2)	0.9 (0.2)	0.8 (0.1)**
BMD (g/cm^2)	Total body	1.253 (0.09)	1.236 (0.08)	1.238 (0.05)	1.223 (0.09)	1.222 (0.08)	1.174 (0.06)**
	Arms	1.013 (0.11)	0.945 (0.06)	0.955 (0.05)	0.945 (0.07)	0.950 (0.07)	0.880 (0.06)**
	Legs	1.391 (0.13)	1.403 (0.10)	1.399 (0.09)	1.353 (0.14)	1.351 (0.12)	1.259 (0.09)**
	Trunk	1.045 (0.09)	0.994 (0.08)	1.016 (0.06)	1.000 (0.09)	1.006 (0.08)	0.979 (0.07)**

Abbr: FM, fat mass; LM, lean mass; BMC, bone mineral content; BMD, bone mineral density; SD, standard deviation.
Note: Values are expressed as mean (SD).
*$p < 0.01$ (20–29 vs 70–79 yr); **$p < 0.001$ (20–29 vs 70–79 yr).

Discussion

To our knowledge, this is the first study to assess body composition parameters and BMD of healthy men from Buenos Aires using DXA (Table 2).

Total body peak bone mass was observed in men in the third decade of life (20–29 yr of age), and bone mass was found to decrease with age. Our results are similar to those found by Nuti et al. *(34)* in a study performed in Italy.

DXA analysis evidenced an age-related increase in FM of the trunk in men. Although it holds true that DXA analysis does not allow distinguishing between intra-abdominal and subcutaneous fat, FM determinations of the upper abdominal region using DXA and intra-abdominal FM measurements using computer tomography have been found to correlate positively. Central adiposity is an important determinant of metabolic and cardiovascular disease, and an independent marker of insulin resistance in obesity. Studies using DXA to determine FM showed a relation among fat distribution, glucose tolerance, and gallstone pathogenic factors in obesity *(10)*. No correlation was observed between FM and bone mass. However, the age-related increase in FM shown by DXA suggests that DXA may prove useful to evaluate metabolic and cardiovascular disease risk factors *(31)*. The BMI results reported in Table 1 could be influenced by the BMI exclusion criteria.

In addition, LM was found to decrease with age, predominantly in the lower limbs. This may be associated with the decrease in bone mass, as also suggested by the significant positive correlation observed between BMC and LM in all the studied areas. This finding is in agreement with other studies reported in the literature *(4,23,25,27,28,30,34,35)*.

Matsuo et al. *(35)* found body weight and LM of men to decrease with age, suggesting that these events would result

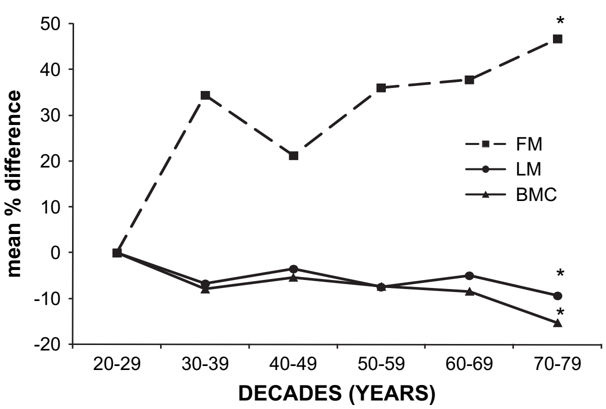

Fig. 1. Mean percentage differences in body composition of healthy men from Buenos Aires in different decades of life, expressed as a percentage. *$p < 0.001$, compared to the 20–29 yr group. FM, fat mass; LM, lean mass; BMC, bone mineral content.

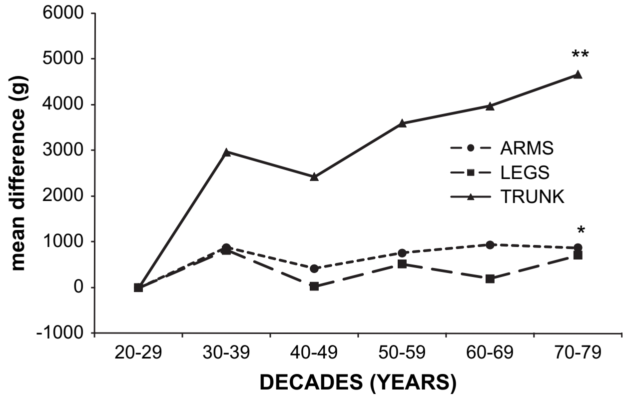

Fig. 2. Mean differences in fat mass of body subareas of healthy men from Buenos Aires in different decades of life. $**p < 0.001$, $*p < 0.01$, compared to the 20−29 yr group.

in a decrease in the muscular biomechanical strength exerted on bone. The decrease in physical activity and in protein intake observed in men throughout the decades of life, together with the diminution in testosterone levels, would account for the changes in body composition, such as the increase in FM and the decrease in LM and BMC that occur with age. The existence of a genetic association between LM and bone mass cannot be ruled out.

These results differ from body composition and bone mass findings corresponding to the Buenos Aires population of healthy women *(19)*. The female population exhibited an increase in body weight, mainly due to an increase in FM between the age of 30 and 70 yr, and no significant changes in LM. Body weight and FM contributed greatly to BMD values in women, as confirmed in other studies reported in the literature *(20,21,23,25,27−30)*. The protective role of androstenedione conversion to estrone, the main estrogen after menopause, may have implications in the association between FM and BMD.

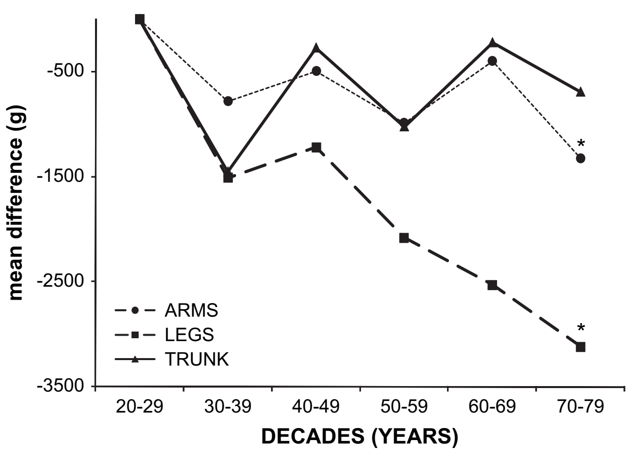

Fig. 3. Mean differences in lean mass of body subareas of healthy men from Buenos Aires in different decades of life. $*p < 0.01$, compared to the 20−29 yr group.

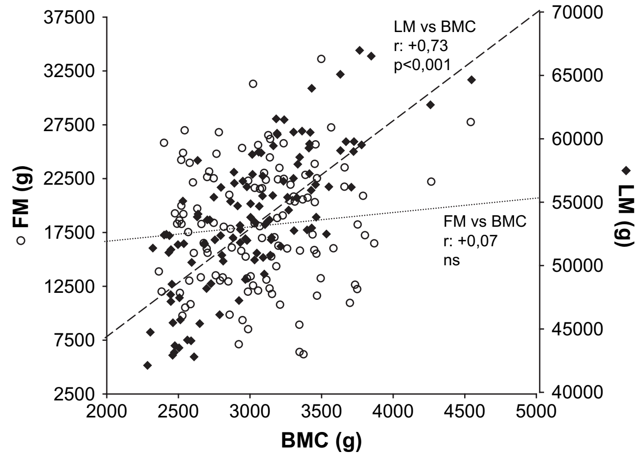

Fig. 4. Correlation between FM/LM and BMC of healthy men from Buenos Aires. FM, fat mass; LM, lean mass; BMC, bone mineral content.

The present study poses limitations, in that it is a cross-sectional study and the study sample is small. Longitudinal studies should be conducted to confirm the age-related changes observed in our study. In addition, it must be pointed out that the subjects were not randomly selected, and only men with BMI between 20 and 30 were included; therefore, the study sample may not be representative of the whole population. In addition, hormonal status, habits, dairy intake, and physical activity of the subjects were not recorded.

In conclusion, our results show a relation between bone mass and body composition in healthy men, suggesting that the age-related decrease in LM may be associated to the decrease in bone mass. In addition, an increase in FM was found to occur with age.

Establishing body composition reference values in the male population is crucial to the evaluation of pathologies potentially affecting body composition. Moreover, determining alterations in body composition in specific diseases would enable implementing measures to prevent osteoporosis-associated bone loss, and may be a useful tool to monitor treatment.

Further studies should be conducted to provide a better understanding of the mechanisms linking FM, LM, and bone mass and to elucidate the role of body composition in the occurrence of osteoporosis in men.

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