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Health and ageing: A cross-sectional study of body composition

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SUMMARY

Background & aims: The aim of this work was to provide a complete profile of body composition (BC) in healthy subjects and to investigate age and gender-related differences by dual-energy X-ray absorptiometry (DXA) and its latest developments.
Methods: Italian volunteers among blood donors were enrolled in 5 different age bands (from 18 to 70 years old) to reach the threshold of 25 males and 25 females per single band (total: 250 subjects). All non-obese subjects who satisfied selective inclusion criteria were measured for weight and height and submitted to DXA, to determine fat mass (FM), non-bone lean mass (LM), bone mineral content and density, at regional and whole-body level. Moreover, the assessment of android visceral FM was performed by a new software.
Results: A decrease in LM and increase in FM was observed with ageing, although the phenomenon was proved to be attenuated in women. The central and visceral redistribution of FM was also shown along lifetime, but women were not affected as men by this change.
Conclusions: This paper is a report on the status of healthy Italian subjects in their adulthood, to be used as a reference for future investigations on physiology, pathological human conditions, and differences between countries.

1. Introduction

The assessment of body composition (BC) is essential in the study of biology, both human and animal. In the research field, BC is increasingly considered a hot topic in the characterization of metabolic status[1,2]; nevertheless, BC clinical applications and opportunities have not been completely defined yet, thus not entirely been transferred to daily practice. Investigations on BC have involved various populations and diseases (e.g. obesity, diabetes, and endocrine diseases but also gastrointestinal, renal, and infectious diseases) as well as physiological and paraphysiological conditions such as in athletes or in growth and ageing processes.[3–6]

A gold standard technique for the assessment of human BC[7,8] is represented by dual-energy X-ray absorptiometry (DXA). DXA measurements are based on a 3-compartment model that can be simplified into fat mass (FM), non-bone lean mass (LM) and bone mineral content (BMC). This technique is able to assess the body masses (and bone mineral density–BMD) on a regional and whole-body basis. DXA is accurate, reproducible, fast, relatively inexpensive, and involves very low radiation dose to the patient. All these advantages and the predisposition of the latest DXA technologies to BC analysis make this densitometric method ideal for clinical use and longitudinal studies, in both adults and children.[9,10] Furthermore, a new software has recently been proposed to separately assess the visceral compartment of android fat by DXA, and results concerning its accuracy are very promising. Reported coefficient of determination (r^2) for regression of computed tomography (CT) on iDXA values were 0.959 for females, 0.949 for males and 0.957 combined.[11]

The development and application of all medical techniques and methods that are involved in the measurement of clinical

Abbreviations: BC, body composition; DXA, dual-energy X-ray absorptiometry; FM, fat mass; LM, lean mass; BMC, bone mineral content; BMD, bone mineral density; CT, computed tomography; BMI, body mass index; ROIs, regions of interest; SAT, subcutaneous adipose tissue; VAT, visceral adipose tissue; A/G, android/gynoid; aFMR, appendicular FM ratio; aLMR, appendicular LM ratio; FMI, fat mass index; LMI, non-bone lean mass index; VMI, visceral mass index.

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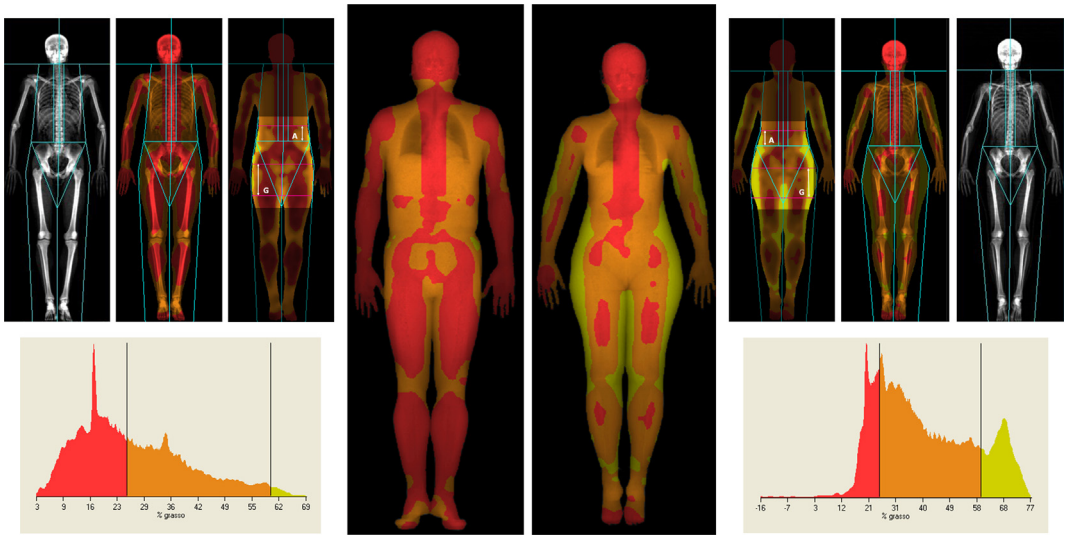

Fig. 1. Dual-energy X-ray absorptiometry (DXA) examination of body composition. The DXA scan allows to assess fat mass, non-bone lean mass, and bone mineral content and density on both whole-body and regional basis. In this picture the topography of regions of interests (ROIs) and the analysis of tissue density are enhanced, in a male (left) and female (right) sample. ROIs are automatically drawn by the software according to anatomical landmarks, and these are submitted to the corrective intervention of the imaging operator (A and G are "android" and "gynoid" regions, respectively). In the central part of the picture, the distribution of fat and lean is shown following the typical colour scale, from yellow (high fat percentage) to red (low fat percentage – lean); in the lower corners, the two histograms represent the amount of tissue mass spread by different percentage of fat content. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

parameters are based on standard reference data. BC values can be considered among the most variable to be collected and analysed, since the differences between worldwide populations and countries are remarkable.[12] However, some parameters and indexes as measured with different techniques in the analysis of BC may be proposed for collection and comparative evaluations among healthy and unhealthy populations. Today, these kinds of data on general or "normal" populations are almost completely missing or patchy.[12] Thus, efforts in the definition of a normative database should be made, even on a regional basis.

The concept of "health" is somewhat difficult to be tested, and subjects are arbitrarily considered healthy in different studies on criteria as established by authors. Although some categories of "healthy" people have been studied and analysed from a BC point of view (i.e. athletes, newborn infants, children, elderly, women in menopause, twins),[13,14] data on healthy subjects of the general population as included by homogenous and selective criteria are almost completely missing.[15–19]

The purpose of this study was to provide a complete profile of BC in healthy subjects and to investigate age and gender-related differences by the latest DXA technology.

2. Materials and methods

2.1. Study design and population

In a cross-sectional analysis of BC, we prospectively recruited subjects from 18 to 70 years old among blood donors of our hospital, in order to reach the threshold of 25 males and 25 females per 5 different age bands (A, 18–30 years old; B, 31–40 years old; C,

Table 1
Body composition, whole body data and differences by sex and age.

DXA data – total body									
Age (Group)		BMI (Kg/m^2) mean ± s.d.	FM (g) mean ± s.d.	FMI (kg/m^2)	LM (g) mean ± s.d.	LMI (kg/m^2)	BMC (g) mean ± s.d.	BMD (g/cm^3) mean ± s.d.	T-score mean ± s.d.
18–30 (A)	m	23.97 ± 2.35	17,262 ± 5459	5.48 ± 1.65	55,377 ± 5025	17.63 ± 1.48	3138 ± 335	1.259 ± 0.121	0.6 ± 1.2
	f	21.96 ± 2.43	19,005 ± 3762	7.03 ± 1.55	38,547 ± 3445	14.20 ± 1.20	2268 ± 235	1.086 ± 0.063	0.1 ± 0.6
p (sex)		0.005	NS		0.000		0.000	0.000	0.022
31–40 (B)	m	24.52 ± 2.56	18,239 ± 6439	5.6 3 ± 1.89	57,787 ± 6405	17.91 ± 1.48	3164 ± 433	1.229 ± 0.106	0.3 ± 1.0
	f	23.89 ± 3.97	22,692 ± 7735	8.53 ± 3.10	38,901 ± 3103	14.53 ± 1.26	2286 ± 167	1.098 ± 0.085	0.2 ± 0.7
p (sex)		NS	0.021		0.000		0.000	0.000	NS
41–50 (C)	m	24.81 ± 2.71	19,461 ± 6476	6.23 ± 2.09	56,357 ± 6587	17.94 ± 1.45	3142 ± 369	1.224 ± 0.082	0.3 ± 0.8
	f	23.94 ± 2.67	22,724 ± 5933	8.57 ± 2.12	38,275 ± 3069	14.45 ± 0.84	2283 ± 242	1.103 ± 0.085	0.2 ± 0.8
p (sex)		NS	0.045		0.000		0.000	0.000	NS
51–60 (D)	m	24.94 ± 2.91	21,042 ± 7068	6.75 ± 2.24	54,195 ± 5503	17.37 ± 1.65	2934 ± 324	1.160 ± 0.088	−0.4 ± 0.8
	f	23.51 ± 2.38	22,068 ± 5662	8.25 ± 1.90	38,580 ± 3878	14.45 ± 1.17	2146 ± 271	1.028 ± 0.088	−0.5 ± 0.9
p (sex)		NS	NS		0.000		0.000	0.000	NS
61–70 (E)	m	25.92 ± 2.70	23,648 ± 7111	7.73 ± 2.03	52,713 ± 5852	17.34 ± 1.29	2923 ± 421	1·148 ± 0·109	−0.5 ± 1.1
	f	24.27 ± 2.80	22,740 ± 4812	8.87 ± 1.73	37,689 ± 4470	14.69 ± 1.22	2044 ± 281	0·990 ± 0·091	−0.9 ± 0.9
p (sex)		0.039	NS		0.000		0.000	0.000	NS
p (age)	m	0.004	0.000		0.014		0.002	0.000	0.000
	f	0.001	0.021		NS		0.034	0.002	0.002

BMI, body mass index; FM, fat mass; FMI, fat mass index; LM, non-bone lean mass; LMI, non-bone lean mass index; BMC, bone mineral content; BMD, bone mineral density; NS, not statistically significant.