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Abdominal adiposity by ultrasonography: A "pocket" database for reference standard in Italian people

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ABSTRACT

Aims: To provide a reference standard database of ultrasonographic parameters of abdominal adiposity in healthy people.
Methods: Italian non-obese volunteers among blood donors were enrolled in 5 age bands (from 18 to 70 year-old) to reach the threshold of 25 males and 25 females per single band (total: 250). All subjects were measured for weight, height and waist circumference and underwent ultrasonography (US) by an expert radiologist for the assessment of several abdominal fat thicknesses (*minimum* and *maximum subcutaneous fat thickness*, *maximum preperitoneal fat thickness*, *intrabdominal fat thickness*, *aorto-mesenteric thickness*, and *mesenteric fat thickness*). In addition, US data were normalized per waist circumference.
Results: From 30s to 50s no statistically significant differences were achieved between males and females for the adiposity markers of visceral fat, while a relevant divergence was proved from 60s to 70s. During ageing a marked increase of the visceral fat compartment was observed in males, while only the preperitoneal circumference was significantly modified in females.
Conclusions: This paper reports on US parameters of abdominal adiposity of healthy Italian adults, to be used as a reference for daily clinical practice. Data could be also considered as control group for future investigations on physiology, pathological conditions, and differences between countries.

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1. Introduction

Who is "healthy"? This is the most problematic and one of the most comprehensive questions in medicine. The "healthy" condition is somewhat very hard to be determined. Although different markers of human biology may be involved in the definition of healthy status, the concept of "health" keeps and is going to keep changing. The improvement of the knowledge is basically founded on the research of a variety of parameters able to describe the whole "quality" of human body. At first, on the other side, this process needs researching and understanding of both definition and evolution of the so-called "range of normality".

Metabolism is a cornerstone of human physiology and the awareness of its importance in decoding the whole spectrum of human pathology – even those pathological entities considered in the past so far from endocrinological implications – is rapidly emerging [1]. Today, a very hot topic in characterizing the metabolic status of patients is body composition (BC) [2–4]. Although there are many tools able to investigate the BC at different levels of organization, this is mainly studied and scanned by clinically available techniques, such as anthropometry (whole-body level), bioelectrical impedance analysis (BIA, molecular level, bicompartmental model) and dual-energy X-ray absorptiometry (DXA, molecular level, tricompartmental model) [5]. However, *adipose*, *muscle* and *other depots* where lipids accumulate are primarily studied and considered, by definition, as "tissues" and "organs". Therefore, the organ-tissue level of organization for BC seems to be one of the most clinically relevant. Although BC analysis by computed tomography (CT) and magnetic resonance (MR) imaging are very attractive, these techniques remain categorically unsuitable for clinical practice (unless this analysis is not performed as secondary aim of the exam), and for large population and longitudinal studies [5]. Ultrasonography (US) is a technique with great potential in studying BC, with the capability to directly measure visceral adipose tissue (VAT) and subcutaneous adipose tissue (SAT) thicknesses at different axial sections of the abdomen; this peculiarity allows US to overcome some limits of anthropometry and conventional DXA and BIA machines. US is accurate, reproducible, and fast especially in the analysis of abdominal adiposity. It offers a regional, easy, and close-at-hand evaluation of the subcutaneous and visceral fat compartments. This should be also taken into consideration when clinical routine examinations are performed or to evaluate patients with specific metabolic diseases before and after treatments [6,24].

Different studies tried to set the rules for US assessment of adiposity, determining parameters and investigating limits and strengths [6–9]. US was also used in several clinical studies to scan different populations and their body fat distribution. However, to our knowledge, no one considered to study the BC of individuals free from disorders, with selective inclusion criteria to explore and to assess the range of the "healthy" status.

Our purpose was to establish normal ranges of abdominal adiposity in a healthy Italian population, and to diligently provide values for a reference standard database of US parameters on a national-basis.

2. Methods

2.1. Study design and population

In a period from June to March, we prospectively recruited subjects from 18 to 70 years old among blood donors of our hospital, in order to reach 25 males and 25 females per 5 different age bands (A, 18–30 years old; B, 31–40 years old; C, 41–50 years old; D, 51–60 years old; E, 61–70 years old; total recruitment: 250 subjects). All participants were Caucasians, living in Italy.

The inclusion criteria were fitness for blood donation, normal glycemic and lipid profiles, normal hepatic and renal function, the absence of relevant past or present diseases, stable weight in the last year, and body mass index (BMI) between 18 and 30 kg/m^2. The anamnesis of patients was collected also to exclude aberrant habits (i.e. smokers > 20 cigarettes/die, alcoholism, etc.). As well, other conditions that might induce a iatrogenic variation in the metabolic status determined the exclusion from the study. The assumption of drugs potentially impacting with changes in BC (e.g. thyroid, steroids, and estro-progestinic) was also screened. Furthermore, pregnant women and subjects with external and/or internal devices were excluded from the study. The study was approved by our institution review board and conducted according to the Declaration of Helsinki. All participants signed an informed consent before enrolment.

Height and weight of patients were measured barefoot, with subjects wearing only underwear and a cloth gown, to the nearest 0.1 cm and 0.1 kg respectively, using a mechanical balance with altimeter (Seca 711, Seca GmBH & Co Kg, Hamburg, Germany). BMI was calculated as weight/area (kg/m^2). Waist circumference (WC) was measured at the midpoint between the lowest rib bone on the sides and the iliac crest, using a flexible plastic measuring tape to the nearest 0.1 cm, with the subject wearing only underwear and standing, at the end of a normal expiration.

On the same day, patients were submitted to US examination.

2.2. Ultrasonography – technique

The distribution pattern of abdominal fat was examined by measuring several abdominal fat thicknesses and parameters (Fig. 1), according to the most validated methods in literature, as revisited by Vlachos et al. in 2007, and subsequently by our research team in 2011 [6,7]; a conventional ultrasonographic equipment was used (Technos MPX, Esaote, Genoa, Italy) and all measurements were performed with subjects in a supine position with arms at sides, at the end of a normal expiration. An expert radiologist, whose precision had been previously tested [6], carried out the scans.

Maximum preperitoneal fat thickness (MaxPFT) measurement was performed right below the xiphoid process in the epigastric region, on the xiphoumbilical line, as the major distance between the anterior surface of the peritoneum covering the liver (left lobe) and the posterior surface of linea alba (b – Fig. 1).

Minimum subcutaneous fat thickness (MinSFT) was measured in the same anatomic region as the maximum preperitoneal