Editorial

Body composition imaging

The assessment of body composition (BC) consists on the quantification and the study of the distribution of body elements at different levels (1). In this special issue, we will review what are the perspectives in the study of BC.

The first notions on the influence that the distribution of adipose tissue might have on the incidence of metabolic diseases were introduced in the 40's. In individuals that accumulated fat centrally, in the intra-abdominal and upper thoracic deposits, a close association with insulin resistance and a cluster of metabolic diseases was reported, whereas in individuals with a predominantly subcutaneous accumulation of the fat, in the femoral-gluteal region, the incidence of metabolic diseases, insulin resistance and dyslipidemia was significantly lower. These findings lead to the hypothesis that the accumulation of fat in specific locations could have a role on the association of adiposity with cardiometabolic risk. Out of the different adipose tissues, the visceral adipose tissue (VAT)—which is located around the organs, inside the abdomen and thorax—has been recognized as the one presenting a higher association with clinical and laboratory parameters characteristic of cardiovascular disease and metabolic syndrome. A number of studies have demonstrated that VAT has a metabolic activity, secrete inflammatory markers into the portal circulation, some with vasoactive properties that have a contributory effect on the development of cardiometabolic risk (2), whereas the subcutaneous adipose tissue (SAT) has been hypothesized to have different roles, from protective to more recently being associated to the development of insulin resistance, especially at abdominal level (3). The presence of lipids in other locations, such as the liver, skeletal muscle, bone marrow, have been associated with insulin resistance and adverse metabolic phenotypes, independently of total adiposity. These important associations have made the evaluation and quantification of specific adipose tissue compartments in the body of special importance. Several techniques are available to assess BC at each level of its complexity: atomic, molecular, cellular, organ-tissue and whole body (4). Whole-body, molecular, and organ tissue levels are the most investigated areas as a result of the availability of anthropometric methods and to the improved performance of the different available imaging techniques (5).

In this special issue, we will evaluate in depth what is the clinical impact of the study of BC, and review the methods to assess it. BC analysis was limited to research settings or selective clinical studies for a long time, due to the lack of available, acceptable, or accurate assessment tools other than the anthropometric measurements. Waist and hip circumferences, waist-to-hip ratio and body mass index (BMI) are the most common indexes used in clinical practice for the study of BC. These anthropometric data are easy to obtain and also cost-effective but their accuracy and reproducibility are limited, and they show poor or no correlation with VAT and SAT measurements obtained with the current gold standard imaging methods (6-8).

At the molecular level of assessment, bioelectrical impedance analysis (BIA), as a non-imaging technique, is commonly used, because of its improved accuracy and new technical features. Sarcopenia is defined as a syndrome characterized by progressive and generalized loss of skeletal muscle mass and strength by the European Working Group on Sarcopenia in Older People (EWGSOP). The decrease of muscle function (i.e., muscle strength or performance) is a requirement for the diagnosis (9). Sarcopenia is associated with many adverse outcomes. It increases morbidity and mortality, hospitalization rates, physical disability and results in loss of independence in activities of daily living (10). A dedicated article will focus on the assessment of sarcopenia (11). Today, due to the improved performance of some imaging techniques and the development of new methods, whole body, molecular, and organ tissue levels can be investigated in common clinical settings. BC clinical applications and opportunities have not been completely defined yet, and new developments are only just being transferred to every day practice (8).

Dual-energy X-ray Absorptiometry (DXA) is the reference method for BC assessment. This is the most widely used and validated imaging tool in current use. 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). Body masses and bone mineral density (BMD) can be assessed on a regional or a whole-body basis. DXA is reproducible, fast, relatively inexpensive, and involves very low radiation dose for the patient which make it ideal for clinical use and for longitudinal studies, in both adults and children (12,13). In a dedicated article, the advantages and new developments within this technique will be reviewed (14). Ultrasonography is a non-invasive, fast and relatively available and inexpensive alternative to estimate adiposity in clinical practice (15). It does not involve radiation, making it the ideal method for the evaluation of young people, and or large cohorts of patients. Conventionally, ultrasound has been assigned to the whole body and organ-tissue levels of assessment. Direct measurements of VAT and SAT thicknesses at different axial sections of the abdomen can be obtained, with good accuracy. But besides, it also allows an estimation of fat in terms of lipid content at both tissue and cellular-molecular level: it can measure adipose tissues as measurements of thickness, but it can also evaluate, in a few, intracellular fat content as variations in tissue echogenicity (16). In this issue, we will address the use of ultrasound in depth, from different perspectives: from the perspective of its possibilities in a dedicated article (17) and different population uses (for example its use in children). The gold standard techniques at organ-tissue level are Computed Tomography (CT) and Magnetic Resonance Imaging (MRI). They have excellent spatial resolution, allowing to obtain measurements on the composition of the different compartments, but also the analysis of intrinsic tissue composition (intracellular fat content). Their high cost, relatively low availability, elevated time consumption, and radiation exposure in the case of CT, have traditionally limited their use (15). In this special issue, we will analyze what are the safety standards for the assessment of BC (18) and what is the current and prospective use of advanced techniques (19).

In the field of research, BC has long been a hot topic for characterization of metabolic status (1) and investigations on BC have been focused on various population groups and diseases (e.g., obesity, diabetes, endocrine diseases, cancer) as well as physiological (growth, ageing processes) paraphysiological conditions (athletes—sports) or interventions (nutritional changes, diets) (20,21). In this special issue, two articles will explore the specific topic of BC and renal disease (22) and bone tumors (23). Two different articles will focus on the impact on health status of the presence of lipids in specific organs and how imaging can unlock their assessment: the bone marrow (24) and the liver (25). A dedicated article will focus on the evaluation of BC in the paediatric population (26). Finally, we will evaluate what are the future perspectives in the analysis of BC, with the potential use of artificial intelligence and radiomics, in a dedicated article (27).

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