European Journal of Radiology 85 (2016) 1461–1468

Contents lists available at ScienceDirect

European Journal of Radiology

journal homepage: www.elsevier.com/locate/ejrad

Body composition in clinical practice

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ARTICLE INFO

Article history:
Received 30 October 2015
Received in revised form 1 December 2015
Accepted 3 February 2016

Keywords:
Body composition
Sarcopenia
Imaging techniques
Fat mass
Total body water
Body cell mass

ABSTRACT

Nutritional status is the results of nutrients intake, absorption and utilization, able to influence physiological and pathological conditions. Nutritional status can be measured for individuals with different techniques, such as CT Body Composition, quantitative Magnetic Resonance Imaging, Ultrasound, Dual-Energy X-Ray Absorptiometry and Bioimpendance. Because obesity is becoming a worldwide epidemic, there is an increasing interest in the study of body composition to monitor conditions and delay in development of obesity-related diseases. The emergence of these evidence demonstrates the need of standard assessment of nutritional status based on body weight changes, playing an important role in several clinical setting, such as in quantitative measurement of tissues and their fluctuations in body composition, in survival rate, in pathologic condition and illnesses. Since body mass index has been shown to be an imprecise measurement of fat-free and fat mass, body cell mass and fluids, providing no information if weight changes, consequently there is the need to find a better way to evaluate body composition, in order to assess fat-free and fat mass with weight gain and loss, and during ageing. Monitoring body composition can be very useful for nutritional and medical interventional. This review is focused on the use of Body Composition in Clinical Practice.

1. Introduction

World Health Organization (WHO) defined the "nutritional status" as the condition of the body, resulting from the balance of intake, absorption, utilization of nutrient and the influence of particular physiological and pathological status [1]. Nutritional status can be measured for individuals, as required in clinical practice, or for populations, as required in research field, in order either to identify populations at nutrition impairment risk and to plan interventions. Because obesity is becoming a worldwide epidemic, there is an increasing interest in the study of body composition (BC) – overall and regional – monitoring conditions and delay of obesity-related development diseases, such as cardiovascular disease, metabolism and endocrine disorders, malignancy and others pathology [2].

Epidemiological trend of obesity in an ageing population has lead to the recognition of a new nutritional pattern, called "sarcopenic obesity" [3]. It is defined as a muscle mass index less than two standard deviation below the sex-specific reference in a young, healthy population. Sarcopenic obesity, in a simple approach, is characterized by an increased Fat Mass (FM) and a reduced Fat Free Mass (FFM) with a normal or high body weight. According to WHO criteria, obesity is defined as Body Mass Index (BMI) $\geq 30\,kg/m^2$ and central obesity with waist circumference more than 102 cm in men and 88 cm in women. Whether these criteria are appropriate for older people has been questioned [4]. Sarcopenia, defined as age-related loss in skeletal muscle mass and function, recognizes multi-factorial causes and includes endocrine function, chronic diseases, inflammation, insulin resistance and nutritional deficiencies. Recently, the term "myopenia" was suggested to indicate the presence of clinically relevant muscle wasting [5]. Taking into account the association between sarcopenia and disabilities, the term "dynapenia" has been introduced [6].

The emergence of these concepts demonstrate the limits of sensitivity of standard clinical assessment of nutritional status based on body weight changes for an early detection of FFM loss, such as the reliability of BMI to diagnose obesity and measure BF [7].

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http://dx.doi.org/10.1016/j.ejrad.2016.02.005

Malnutrition and weight loss are common and may be due to several mechanisms including cancer and host response to tumor and anticancer therapies. Besides this, deficit of energy, protein and/or other nutrients, in malnourished patients, may cause serious adverse effects on tissue/body form, composition, function and, in the and, deeply influence clinical outcomes. Changes in body composition may be detrimental to health [8,9].

This review is focused on the use of Body Composition in Clinical Practice.

2. Body composition models

According to chemical component of the body (water, protein, and mineral, and FM), three models of body composition were developed.

2.1. Two-component model

A more applicable reference approach, first introduced in 1942, had its roots in development of Albert R. Behnke. He conceived of the human body as two components, fat and “lean body mass”, each with an assumed stable density of 0.900 g/cm^3 and 1.095 g/cm^3, respectively [10–12].

2.2. Three-component model

Body can be composed by four main components: water, proteins, minerals, and glycogen. While these ones maintain, under usual conditions, stable relations each other, many factors are recognized to vary their proportions. On this way, in 1956, Siri developed his three-component model, assigning a density to a combined residual mass component (1.565 g/cm^3), reflecting the density of protein (1.34 g/cm^3) and minerals (3.00 g/cm^3).

2.3. Multi-compartment models (four or more compartments) models

Siri and Behnke recognized the importance in separating out residual mass components with analysis of bone mineral contributions, from standard X-ray films, and incorporated total body bone mineral mass with total body water. The results of this model, was compared to those obtained in healthy adults, using Cohn and Dombrowski’s in *vivo* whole body counting neutron activation as analysis reference method. In 1992 Wang et al. suggested that body composition could be divided into five levels: atomic, molecular, cellular, tissue-system and whole body. Since then, more than 30 body components had been evaluated in these five levels [13–15].

Recent technological advances highlight the opportunities to expand model applications to new subject groups and measure components such as total body protein [11].

3. Nutritional status assessment

In the recent years, researchers of European Society Parenteral Enteral Nutrition (ESPEN) have initiated a program to promote nutritional screening in hospitals [16]. Nutritional status assessment consists in measurement of food intake, anthropometric variables, chemical parameters, subjective global assessment and body composition measurements. This program is widely advertised and first introduced in hospital settings. Many further efforts were made to apply this approach. Assessment of body composition plays an important role in nutritional evaluation. The identification of prognostic factors in many diseases is relevant for the clinical management of the disease. Worldwide malnutrition is considered a more complex process than the result of over-nutrition or under-nutrition and inflammation.

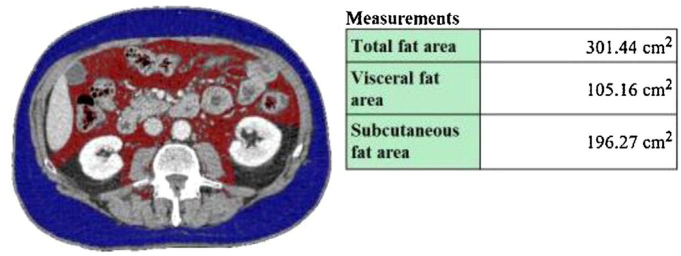

Fig. 1. Measurement of total fat area, visceral fat area and subcutaneous fat area, with CTBC, at the level of L3. (elaborated with synapse 3D).

Furthermore, the impact of inflammatory activity explains why in many “nutritional risk indexes”, proposed during the last 30 years, anthropometric data and inflammatory parameters are incorporated in predicting better: the risk of complications, bad quality of life and others conditions in comparisons with anthropometric data alone. In addition, nutritional risk screening (NRS-2002) and the MUST screening method have the same underlying principle. They assess the risk of insufficient food uptake and the size of the operative trauma/severity of disease. However, both instruments measure only weight (kg) and height (m) to calculate BMI expressed as kg/m^2. Indeed, diminution of Body Cell Mass (BCM) may result from combinations of insufficient nutrition and inflammatory activity.

Recently, Konturek et al. have been demonstrated that hospitalized patients suffering from inadequate nutritional therapy had a major risk for developing malnutrition during hospitalization, demonstrating that early patients screening for malnutrition would improve management of nutritional therapy and had a positive impact on clinical outcomes. In addition, he reported that the prevalence of malnutrition was increased in patients with hepatic, gastrointestinal disease, depression or dementia, always evidencing that the most important risk factors for malnutrition were bed rest and immobility [17].

4. Methods to assess body composition

Depending on the information needed, several methods can be used to measure BC, each with some advantages and limitations [18,19]. Changes in BC occur as part of the normal ageing processes and includes a relative increase in FM in relation to FFM [20]. Methods for analysis of BC aim to divide body mass into components on the basis of differing physical properties. Muscle mass is a part of FFM and can be quantified at five level model of body composition, with a complexity increasing from atomic to anatomic level [21].

In selecting the method, it should take into account cost (equipment and personnel), radiation exposure, time required to obtain the information and accuracy of the information obtained (Table 1). Numerous techniques for body composition analysis are currently available as listed in Table 1.

4.1. Computed tomography (CT) and CT body composition (CTBC)

CTBC presents great practical significance due to CT routinary use of CT for diagnosis and follow-up, and allows an accurate quantification of whole body composition (Fig. 1). Axial CT, using a cross-sectional images, taken around a single axis of rotation, allows to measure body components at the tissue- level using pre-established Hounsfield Units (HU).

The measurement, considered an excellent method, is made at L3 level, provides total, visceral or subcutaneous adipose (fat) area (TFA, VFA, SFA), total psoas area (TPA), visceral adipose vol-

Table 1
Pros and Cons of body composition techniques (modified from Andreoli et al.).

Technique	Pros	Cons
Body mass index	Free Fast Predictor of life expectancy	Does not give precise assessment of percentage of body fat for athletes Possible causes of error are posture (height), hydration and bowel status (weight)
Skinfold thickness measurements	Convenient Fast Portable Useful for detecting changes in percentage of body fat	Requires precise and consistent technique Not accurate for very thin or very fat people Measures only fat under the skin Not accurate estimation of present percentage of body fat Possible causes of error are age and fat compressibility
Waist–hip ratio	Fast Easy to obtain	Does not give information on body fat Possible errors due to holding breath and tape measure placement
Computed Tomography Body Composition	High accuracy Assessment of fat free mass by regional analysis Assessment of subcutaneous fat and visceral fat	X-ray exposition Can not be performed at bedside Specific software required for fat free mass assessment. Expensive
Quantitative Magnetic Resonance	Best spatial resolution and body mass composition differentiation No radiation exposure High precision	Longer image acquisition time Very expensive Need of specific software
Ultrasound	Low cost, Noninvasive Rapid procedure	Experience-related Absence of standardized procedure and measurement Artifacts
Dual-energy X-ray absorptiometry	Precise Accurate Fast Gives information on total and regional percentage of fat	Not portable Radiation exposure (even low)
Bioelectrical impedance analysis	Inexpensive Portable Fast Accurate for estimating total body water in populations if height, weight and other variables are added	Poor accuracy in detecting changes in percentage of body fat Many other variables needed Possible sources of error are dehydration, bladder status, temperature, fat asymmetry, arm position, etc.

ume (VFV) and skeletal muscle index (SMI) [22]. Moreover CTCB has been used to derive an predictive cardio-metabolic risk equation, after a large triethnic sample, according to ethnicity- and sex-specific data [23]. This type of evidence endorsed other specific research, analyzing pericardial fat, intrathoracic fat and epicardial fat, showing the potential contribution in CMR stratification [24]. Also, CT images targeted on the III lumbar vertebra, could be theoretically performed solely, since they result in similar chest. As CT has increased in clinical practice, it must be kept in mind the radiation exposure. It is estimated that 1.5%–2.0% of all cancers in the United States may be attributable to radiation from CT studies [25]. Mourtzakis et al. demonstrated that CTCB fat and free-fat tissue evaluation correlate with whole-BC [26].

4.2. Magnetic resonance imaging (MRI)

BC can be also accomplished with MRI, using a free-ionizing radiation technique. MRI, showing fat depots, can measure adipose tissue and, characterizing disease processes provide unique insight into associations between different patterns of adiposity [24]. The use of quantitative magnetic resonance (QMR) for measurement of body composition has long been established in animal studies. There are, however, only a few human studies that examine the validity of this method. These studies have consistently shown a high precision of QMR and only a small underestimation of fat mass by QMR when compared with a 4-compartment model as a reference. An underestimation of fat mass by QMR is also supported by the comparison between measured energy balance (as a difference between energy intake and energy expenditure) and energy balance predicted from changes in fat mass and FFM. Fewer calories were lost and gained as fat mass compared with the value expected from measured energy balance.

Current evidence in healthy humans has shown that QMR is a valid and precise method for non-invasive measurement of body composition. On the contrary, to standard reference methods, such as densitometry and dual X-ray absorptiometry, QMR results are independent of FFM hydration. However, despite a high accuracy and a low minimal detectable change, underestimation of fat mass by QMR is possible and limits the use of this method for quantification of energy balance [27,28].

4.3. Ultrasound (US)

Another technique, used since decades, to assess BF is ultrasound. Still now BF-US is not well known as techniques. US, based on echoes reflection, represents a two-dimensional grey-scale image, between white (strong reflections) and black (no echoes), showing borders of the skin-subcutaneous fat, fat-muscle and muscle-bone interfaces [29]. Although the US procedures can be considered relatively simple, the interpretation is more difficult and subjective. US has many advantages such as low cost, capable of measurements, noninvasive, rapid procedure, but also some limitations such as experience-related, absence of standardized procedure and measurement, artifacts. However different opinions were about US validity. Borkan et al. measured 15 sites with calipers and US. Skinfold correlated better with fat weight than did ultrasound, and they concluded that skinfolds were a better measure of subcutaneous fat than ultrasound [30]. However Fanelli and Kuczmarski suggested that US was equal to skinfolds for predicting body fat [31]. Armellini and colleagues introduced an intra-abdominal thickness US measurement, correlating data with validating US and demonstrating that US intra-abdominal thickness was the most powerful predictor of visceral adipose tissue area [32,33].

4.4. Dual-energy X-Ray absorptiometry (DXA)

Actually, a valid and precise method for measuring BC is DXA (Fig. 2), for both total and regional BC. DXA divides the body into three components: bone, lean mass and bone-free tissue, and fat. DXA, the method of choice for measuring bone mineral density, is increasingly accepted as an accurate and convenient method for measuring regional and total BC. The ability to monitor changes in BC in a person, depends on the precision. DXA systems currently available for scanning whole-body tissue composition are capable to analyze a wide range of weights including severe obese subjects (>150 kg) [34]. DXA scans can be subdivided into different body regions, i.e., trunk, arms, and legs, thus identifying and estimating both android and gynoid fat distribution. DXA is the gold standard technique for the evaluation of body composition in clinical research, although limited in clinical practice by the radiation exposure, availability and cost. DXA is a quick, noninvasive, and safe method for body composition assessment, and the radiation exposure is considered small and safe for repeated measures. Moreover, DXA measures 3 body composition compartments and can provide regional estimates of these compartments. However, the actual size of an individual presents a limitation for some DXA scans, as large persons are not able to easily fit inside the scan area. Furthermore, hydration status may affect DXA accuracy because of the programmed assumption of a constant and uniform FFM hydration.

4.5. Bioimpedance: bioelectrical impedance analysis (BIA)

Non-invasive assessment of hydration status remains a critical need in healthy and ill patients. Fluid overload is detectable as pitting edema whereas a sub-clinical increase in fluid volume without edema or mild to moderate dehydration are difficult to identify. Traditional methods to assess hydrations status (e.g., isotope dilution) are not amenable for point-of-care use, and standard clinical evaluation methods are insensitive to discriminate normal from altered hydration status for an individual. BIA is a non-invasive method that introduces a safe, radio-frequency alternating current and measures passive electrical characteristics of the body to classify the hydration status of individuals. Different BIA approaches are available: single or multiple frequency. Historically BIA assessments of hydration used regression models to predict total body water (TBW) or extracellular water (ECW) and to calculate intracellular water (ICW). This approach relied on in vitro biophysical models and assumptions of the constancy of the chemical composition of the fat-free-body; it resulted in predicted fluid volumes that were too imprecise for clinical use. Contemporary BIA methods overcome these limitations to classify (under-,normal or over hydration) and rank (more or less than before intervention) hydration status. The principal use of Bioelectrical Impedance Vector Analysis (BIVA) is the assessment of hydration status of individuals, which is helpful in the prescription of treatment [35,36]. The practical advantages and clinical value of bio-impedance measurements to identify alterations in surveillance and monitoring effects of intervention.

Numerous study show that single or multifrequency-BIA is an accurate tool to estimate body composition (FM and FFM, TBW, ECW; ICW and BCM) in healthy euvolemic adults when compared with the validity and precision of other two-compartment reference methods. In bioelectrical impedance measurements the conductance of a small alternating current through the body is measured. As the conductance is mainly determined by the amount of water, which is only present in the fat-free mass, impedance measurements allow assessment of the fat-free mass and, by difference with body weight, of BF%. The classical (total body) bioelectrical impedance method measures impedance from foot to hand.

BIA-algorithms are manufacture/device-specific whereas population or ethnic specificity are of minor importance. Anthropometric parameters play a limited role in the prediction algorithms generated for BIA. Avoidable sources of error that lead to an overestimation of FM are: touching of the things and low skin temperature. The underestimation, of FM in obese patient is low when the study population used to generate the BIA algorithm include obese people. In dehydrated, cachectic, sarcopenic, underweight or morbidly obese patients as well as in patients with edema or ascites, qualitative changes in FFM occur (e.g. increased hydration and decreased cellularity) that violate the underlying assumptions of every two-compartment method. BIA is the only non-invasive and inexpensive bedside tool that allows monitoring if hydration and body cell mass using impedance raw data (phaseangle, bioelectrical impedance vector analysis). These parameters need to be interpreted on the background of reference values that take into account age, gender and BMI of the patient. In conclusion, the great potential and clinical value of BIA is based on non-invasive monitoring of electrical properties of the tissue that relate to qualitative aspects of lean mass like cellularity and hydration. These parameters can also be used to identify cases in which the violation of the assumptions for application of a BIA-algorithm does not allow a valid prediction of FM and FFM.

Absolute measurements of impedance, reactance, resistance, capacitance and phase angle (PA) have been highly correlated to changes in the human body and have been shown to be good prognostic indicators [37]. More detailed descriptions of the principles can be found elsewhere [38,39].

4.5.1. Is BIA an accurate tool in clinical practice?

Is essential to have a precise evaluation of the role of BIA in clinical practice. Indeed it was demonstrated that BIA and PA can be used for nutritional and overall health status in cancer patients as non-invasive technique [40]. PA also showed a significant positive correlation with albumin. Besides, ECW/TBW, which is an index of edema, had a significant negative correlation with albumin and hemoglobin level, but consistently increased association with poorer nutritional status. Considering that acute inflammation or hypoalbuminemia, caused by malnutrition, is known to cause edema and that low PA indicates malnutrition [41]. PA has been negatively correlated as a prognostic factor in many conditions such as neoplastic disease, hemodialysis, chronic obstructive pulmonary disease, human immunodeficiency virus, including decompensate liver cirrhosis [42,43]. So that seems to be clear the possible impact that BIA and PA could have in daily clinical activities.

5. Rationale body composition in clinical practice

Historically, body weight has been used as macroscopic criterion for nutritional status of the catabolic patients. The availability of body composition devices—such as DXA scanners—in the clinical setting has made the use of FFM possible as a measurable outcome of anabolic treatments [44].

There is general agreement that lifestyle changes, focused on improvement dietary intake and increased daily physical activities, are the cornerstones in both preventing and treating obesity and the metabolic syndrome. Studies have shown a positive effect of exercise on BC, especially in reducing menopausal risk factors in women and enhancing treatment efficacy in older overweight

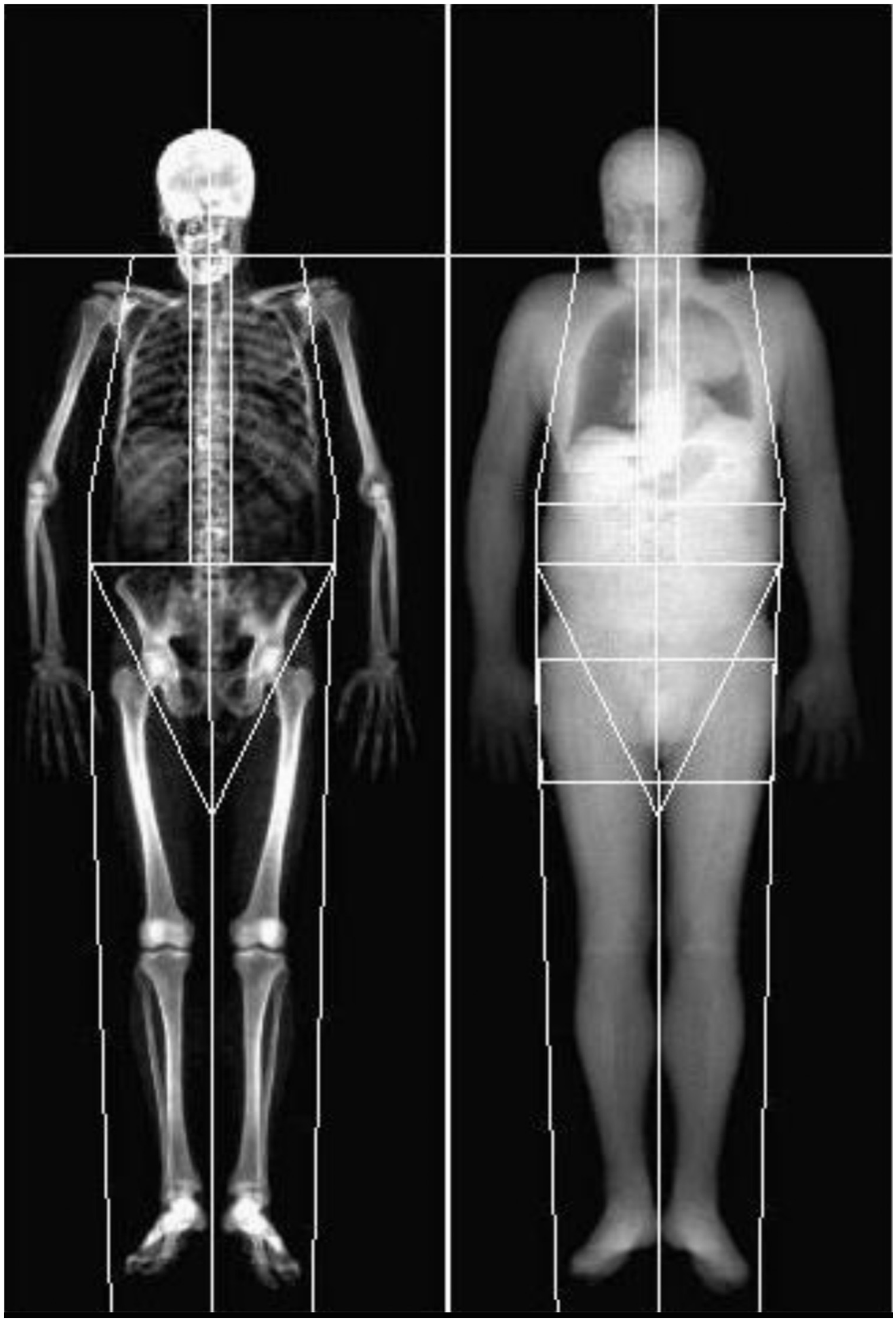

Fig. 2. Total-body composition measured by DXA with Lunar iDXA (GE healthcare).

Table 2
BMI and metabolic profile classification.

1	lean and healthy
2	lean and unhealthy (also known as thin outside, fat inside or metabolically obese but normal weight)
3	obese and unhealthy
4	obese and healthy (also coined as metabolically healthy obese or insulin-sensitive obese)

adults with type 2 diabetes mellitus [45]. Data obtained with severe weight loss and regain in lean people, weight cycling most likely has no adverse effects on fat distribution and metabolic risk in obese patients [46]. The coexistence of diminished muscle mass and increased fat mass, called 'sarcobesity', is ultimately manifested by impaired mobility and/or development of life-style related diseases. Sarcopenic obesity was first defined by Baumgartner as a muscle mass index less than two standard deviation below the

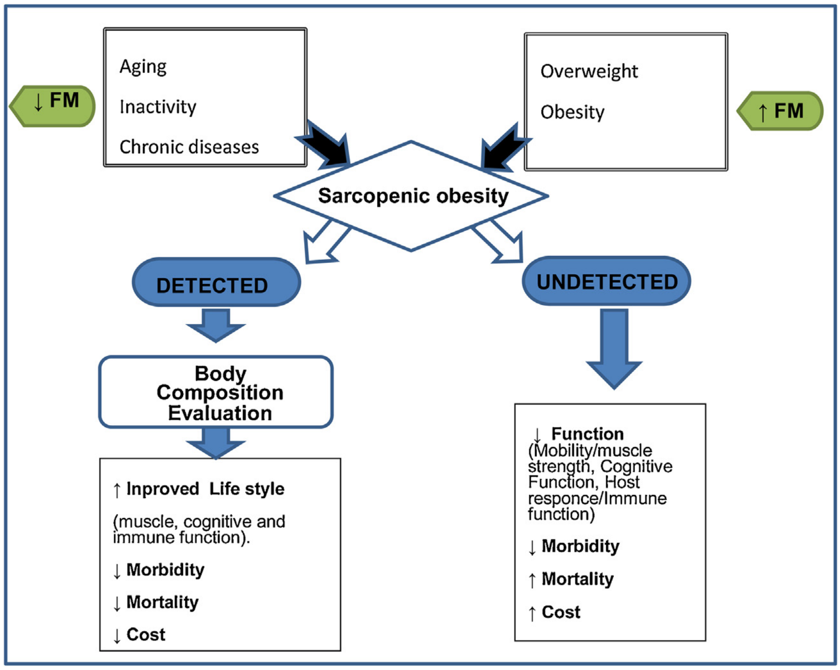

Fig. 3. Impact of body composition: a synoptic analysis [FM: Fat Mass].

Table 3
BIA Patterns (BIA assessment can provide a way to assess efficacy of interventions for weight loss and malnutrition, and to monitor pathologic changes in BC in different clinical setting) [TBW: total body water; ECW: extra cellular water; ICW: Intra cellular water; BCM: body cell mass].

ECW	TBW	ICW	BMC	Observation
Expansion (↑)	Expansion (↑)			Edema, obvious adverse consequences from the medical management
	Constant (=)			The distribution between fluid compartments may be pathologically altered
Bioelectrical impedance analysis	InexpensivePortableFastAccurate for estimating total body water in populations if height, weight and other variables are added			Poor accuracy in detecting changes in percentage of body fatMany other variables needed Possible sources of error are dehydration, bladder status, temperature, fat asymmetry, arm position, etc.
		Reduction (↓)	Reduction (↓)	Can be associated with wasting and cancer cachexia
Expansion (↑)			Reduction (↓)	Can cause body weight to remain constant, masking malnutrition

sex-specific reference for young, healthy population [47,48]. FFM loss is unequivocally associated with decreased survival, negative clinical outcome, i.e. increased rate of infections, complications, hospitalizations, lengths of hospital stay, recovery and therapy toxicity in cancer patients, which ultimately increase health care costs [49]. Therefore, the management of nutritionally at risk patients should integrate a nutritional strategy aiming at reducing the clinical and functional consequences of the disease and/or the hospital stay, in the setting of a cost-effective analysis [50]. The increased prevalence of obesity in ageing has lead to the recognition of a new nutritional entity, the "sarcopenic obesity",characterized by an increased FM and a reduced FFM with a normal or high body weight [3,49,51]. The emergence of this concept demonstrates the limits of sensitivity of standard clinical assessment of nutritional status based on body weight changes for the early detection of FFM loss.

Clinical observations show that disregarding the BMI, either normal-weight or obese individuals may present a healthy or an unhealthy metabolic profile (Table 2) [52].

Some of the main features that distinguish metabolically healthy or unhealthy phenotypes include increased VAT, ectopic fat deposition and insulin resistance in the latter phenotype, which impose on them a higher risk for metabolic and non-metabolic comorbidities than their metabolically healthy counterparts [53]. Malnutrition is a frequent manifestation of advanced cancer and it is one of the major contributor to morbidity and mortality [54]. Malnutrition is characterized by changes in cellular membrane integrity and alterations in fluid balance.

In the clinical setting, anthropometric methods are not ideal because they are time consuming and require well-trained staff. An approach in assessing body composition is to measure BCM. BCM is defined as the total mass of "oxygen-exchanging, potassium-rich, glucose oxidizing, work-performing" cells of the body. Presently, the "gold standard" for quantifying BCM is via measurement of the naturally occurring isotope ^{40}K; however, the assessment of ^{42}K as well as the measurement of the difference between ECW and TBW using multiple isotopes are also acceptable. Nonetheless, these methods are expensive, time-consuming, and not practical for use in the field.

BCM includes FFM portion of cells within muscle, viscera and the immune system and may be considered the functionally most important compartment in determining energy expenditure, protein needs, and the metabolic response to stress Volpato et al. demonstrated that BCM is a powerful predictor of mortality in older people, suggesting that decline in BCM may be involved in the pathophysiology of frailty [55].

6. Why functional body composition?

Today, BC analysis is the integrative center of body responses to internal and external factors at all biological levels in cellular and molecular physiology as well as biochemistry of intermediary metabolism. BC-analysis subdivides the crude BMI phenotype into more sharply divided phenotypes.

Functional body composition integrates body components into regulatory systems, i.e. it relates to its corresponding in vivo function and metabolic processes. Suitable application of BC-analysis is interpretation of body functions (e.g. energy expenditure, insulin sensitivity) and their disturbance in the context of body components and vice versa, such as interpretation of the meaning of individual body components in the context of their functional consequences e.g. changes in energy expenditure, insulin resistance. Since different body function and metabolic processes are differently related to individual body components, functional body composition extends the traditional view, thus, crossing as well as combining the different body composition levels. In the case of energy expenditure, FFM is its major determinant, but functional body components relate to low and high metabolic rate organs and tissues within and outside FFM. When compare with a two component model, white adipose tissue, extracellular mass and bone are considered as low metabolic rate organs [56].

7. Clinical implications of body composition assessment

Due to the lack of readily available and accurate methods to assess body composition in clinical setting, the measurement of body weight has been the most widely used method monitoring anthropometric status. BMI has been used to provide a rough estimation of nutrition status by categorizing individuals ranging from underweight to extremely obese. Although unintentional weight loss can be an indicator of malnutrition and, in some cases, disease progression, the use of body weight and BMI as clinical assessment of populations is problematic for several reasons (Table 3).

Indeed, a large proportion of obese patients with cancer are affected by sarcopenia. Like cancer, sarcopenia is known to be substantially prevalent in the elderly and the ability of malignant disease to induce muscle atrophy compounds this prevalence. Likewise, obesity is a well-known risk factor for some cancer types, such as colon cancer [57]. The simple observance of bodyweight is insufficient to detect this abnormality; in this sense, specific quantification of skeletal muscle is needed. This measurement becomes clinically available and expedient through the secondary analysis of diagnostic images. Importantly, an apparently large body weight might mask sarcopenia and men, patients aged over 65 years, and those affected by colorectal cancer seem to be especially susceptible to sarcopenia. Obese patients with sarcopenia thus have a lean mass comparable to very underweight patients or patients who are very underweight or emaciated. The prevalence of sarcopenic obesity in patients with cancer might be increasing. Our findings underscore the importance of assessment of body composition and the use of CT scans to provide powerful prognostic information and to potentially improve drug dosing. CT analysis is a well-recognized and highly precise approach for the estimation of human body composition and has a reported precision error of about 1.4% for tissue areas; furthermore, CT images are almost ubiquitously available in the health records of patients with cancer.

The variations in relative muscle mass, FFM, and in the association between these and body-surface area in obese patients could be described as extreme. Body-surface area and FFM were very poorly related even though both are related to height. This variation could be explained by the highly variable proportions of fat and lean tissue in our study population. The calculations based on our population enable us to suggest that body composition variability might introduce a variation of drug volume of distribution of up to three-times and this would pertain to any drug distributing in the lean compartment. Body-surface area is used as a conventional basis for the administration of cytotoxic chemotherapy. Our theoretical exercise of chemotherapy drug administration suggests that body composition is an important determinant of chemotherapy toxicity. As classically reported, women are more likely to have a low FFM in relation to their body-surface area and are, therefore, more prone to toxicity. If variation in toxicity can be partially explained by features of body composition, identification of clinical measures of body composition for a more refined delivery of chemotherapy dose is important [4].

8. Conclusions

Assessment of body composition, widely used during the last years, plays an important role in nutritional evaluation in clinical setting, for the quantitative measurement of tissues characteristic over time, between fluctuations in body composition equivalences in relation with survival rate, clinical conditions, illnesses, quality of life and bioelectrical impedance analysis. Since BMI has been shown to be an imprecise measurement of FFM and FM, BCM and fluids, provides no information in case of weight change occurs. Non-invasive body composition methods can now be used to monitor FFM and FM with weight gain and loss, and during ageing, such as CTCB, QMR, US, DXA, BIA, BIVA and many others. As demonstrated, several implications can be taken from BC analysis, with relevant validation in Medicine. For example, FFM loss or a low PA is related to mortality in patients with chronic diseases, cancer and elderly patients in long-stay facilities. A low FFM and an increased FM are associated with an increased hospital stay in adult. Consequently, monitoring body composition can be very useful for nutritional and medical interventional (Fig. 3).

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