

Nutritional status and body composition in individuals with overweight or obesity using usual and unusual indicators

Estado nutricional e composição corporal em indivíduos com sobrepeso ou obesidade usando indicadores usuais e não-usuais

Estado nutricional y composición corporal en personas con sobrepeso u obesidad utilizando indicadores habituales e inusuales

Received: 12/19/2020 | Reviewed: 12/26/2020 | Accept: 12/28/2020 | Published: 01/02/2021

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Abstract

Objective: the aim of this study is to explore the nutritional status in adults according to usual and non-usual components of body composition. Methods: this is a descriptive study involving a sample of 274 Brazilians adults from the south of the country. The participants had their body composition assessed by an octapolar bioimpedancimeter (InBody 520 - Biospace) and the anthropometric parameters according to the WHO standard. The data was analyzed by the descriptive and inferential statistic with the software SPSS version 22.0. Results: The participants were grouped by nutritional status and sex. There were statistical differences between the groups (both nutritional status and sex) in all the variables, except age and stature. The correlation among the variables were also significant, except for the Lean Body Mass and Body Fat Percentage (LBM vs BFP) and for the Lean-to-Fat-Ratio and Lean Body Mass (LFR vs LBM). Final considerations: The results has shown that the usual and the non-usual parameters of body composition are related (most of them) and were more strongly related in the female group.

Key words: Body composition; Nutritional status; Cardiometabolic risk; Assessment.

Resumo

Objetivo: o objetivo deste estudo foi explorar o estado nutricional em adultos de acordo com os componentes usuais e não usuais da composição corporal. Métodos: trata-se de um estudo descritivo envolvendo uma amostra de 274 brasileiros adultos do sul do país. Os participantes tiveram a composição corporal avaliada por bioimpedanciômetro octapolar (InBody 520 - Biospace) e os parâmetros antropométricos de acordo com o padrão da OMS. Os dados foram analisados pela estatística descritiva e inferencial com o software SPSS versão 22.0. Resultados: Os participantes foram agrupados por estado nutricional e sexo. Houve diferença estatística entre os grupos (estado nutricional e sexo) em todas as variáveis, exceto idade e estatura. A correlação entre as variáveis também foi significativa, exceto para a Massa Corporal Magra e Percentual de Gordura Corporal (MCM vs PGC) e para a Proporção de Gordura e Massa Corporal Magra (PG vs MCM). Considerações finais: Os resultados mostraram que os parâmetros usuais e não usuais da composição corporal estão relacionados (a maioria) e foram mais fortemente relacionados no grupo feminino.

Palavras-chave: Composição corporal; Estado nutricional; Risco cardiometabólico; Avaliação.

Resumen

Objetivo: El objetivo de este estudio es explorar más el estado nutricional en adultos según los componentes habituales y no habituales de la composición corporal. **Métodos:** se trata de un estudio descriptivo con una muestra de 274 adultos brasileños del sur del país. Se evaluó la composición corporal de los participantes con un bioimpedanciómetro octapolar (InBody 520 - Biospace) y se evaluaron los parámetros antropométricos según el estándar de la OMS. Los datos se analizaron mediante la estadística descriptiva e inferencial con el software SPSS versión 22.0. **Resultados:** Los participantes fueron agrupados por estado nutricional y sexo. Hubo diferencias estadísticas entre los grupos (tanto estado nutricional como sexo) en todas las variables, excepto edad y estatura. La correlación entre las variables también fue significativa, excepto para la Masa Corporal Magra y el Porcentaje de Grasa Corporal (MCM vs PGC) y para el Proporción de grasa a grasa y la Masa Corporal Magra (PGG vs MCM). **Consideraciones finales:** Los resultados han demostrado que los parámetros habituales y no habituales de la composición corporal están relacionados (la mayoría de ellos) y estaban más fuertemente relacionados en el grupo femenino.

Palabras clave: Composición corporal; Estado nutricional; Riesgo cardiometabólico; Evaluación.

1. Introduction

Obesity is an important independent risk factor for the more prevalent chronic noncommunicable diseases cardiovascular (Hales et al., 2020). It is also a risk factor for cardiovascular events, since it promotes atherogenesis (Rooy & Pretorius, 2014; WHO, 2015).

One number of populational studies have shown that the odds of developing cardiometabolic multimorbidity (two or more chronic diseases like type 2 diabetes, coronary heart disease, and stroke) in overweight individuals was twice as high, almost five times higher for individuals with class I obesity, and almost 15 times higher for individuals with classes II and III obesity combined (Kivimäki et al., 2017). Further concerns are added when observing that the goals to keep the obesity rates stable around the ones reported in 2005 are very rarely achieved by the countries members of the UN (World Obesity, 2020).

In addition, it is increasingly clear that profound changes in skeletal muscle metabolism can occur in obesity and can lead to an altered body composition with greater fat mass and substantial loss of muscle mass (Beals et al., 2016; Guillet et al., 2009; Murton et al., 2015; Smeuninx et al., 2017). In this sense, low or declining muscle mass appears as a negative prognostic factor associated with increased morbidity and mortality in obese patients with chronic diseases (Honda et al., 2007; Montano-Loza et al., 2016).

Changed body composition arising from obesity-related reduced skeletal muscle mass and increased visceral fat, known as 'sarcopenic obesity', aggravates insulin resistance and, thus, seems to be closely related to the onset and progression of cardiovascular disease (CVD) mediated by the abnormal metabolism of glucose and lipids (Shah et al., 2017).

Sarcopenic obesity is a chronic condition that has metabolic consequences, but also affects physical capacity, quality of life and, possibly, mortality of affected individuals. The prevention of sarcopenic obesity, rather than its treatment, is certainly the most rational choice (Polyzos & Margioris, 2018).

In view of this scenario, drastic measures must be taken to prevent further increases in CVD morbidity and mortality. Therefore, it is vital to accurately identify people at increased risk for cardiometabolic conditions (Dada et al., 2018; Diemer et al., 2019). In this sense, some authors have proposed a few potentially useful indicators to complement the assessment of nutritional status, which consists of adjusting lean body mass (LBM) and fat body mass (FBM) by height, since people with similar mass and height values may have very different body composition (VanItallie et al., 1990).

So, the usual parameters of body composition such as lean body mass (LBM) and fat body mass (FBM) and the non-usual indicators as the lean-to-fat mass ratio (LFMR), lean mass index (LMI), fat mass index (FMI) can potentially identify metabolic syndrome (MS) according to nutritional status (Dada et al., 2018).

Recent studies have reinforced the utility of such indicators for diagnose diabetes, like the Lean-to-fat mass ratio (LFMR) which was inversely associated with the incidence of diabetes in a prospective study from Baltimore-USA whose

follow up median was up to 7 years. They found that a higher absolute total lean-to-fat mass ratio over time was also related to a relatively lower risk of diabetes (Kalyani et al., 2020).

The effect of body shape has also been associated to the development of cardiovascular disease in individuals with metabolically healthy obesity (MHO). As BMI does not accurately reflect body composition it reflects a heterogeneous CVD risks within MHO individuals. Although BMI is the most widely used measure to define obesity, it does not identify fat distribution and cannot distinguish muscle from fat (Moon et al., 2017). About that fact Forbes (2000) made clear that changes in body weight invariably comprise both the lean and fat components of the body and that the relative contribution of lean and fat is, in many situations, a function of initial body fat content. Because of that, it is no longer correct to consider each component in isolation (Forbes, 2000).

The association of body composition with physical performance and functional limitation in elderly has been investigated. Sternfeld et al., (2002) have shown that a higher fat mass was associated with slower walking speed and greater likelihood of functional limitation, while higher lean mass was generally associated only with increased grip strength. A higher lean mass-to-fat mass ratio, a relative measure of body composition, was associated with faster walking speed and less limitation (Sternfeld et al., 2002). Based on evidences like that Eisner et al., (2007) have established that the Lean-to-fat ratio has substantive analytic advantages, because it is independent of body size and is not collinear with height, whereas lean mass and height are collinear (Eisner et al., 2007).

Given the above, the aim of this study is to explore more the nutritional status in adults according to usual and non-usual components of body composition.

2. Materials and Methods

This study is characterized as a descriptive research with ex post facto design and quantitative approach. The descriptive research was conducted based on a past event, using descriptive methods in which variables were explored (Thomson et al., 2005).

All participants signed a free and informed consent form that was approved by the local ethics committee of the State University of Maringá (UEM) under legal opinion 412/2008, in accordance with the Helsinki declaration.

Participants

A total of 274 individuals participated in the study (209 women and 65 men), recruited as of the publishing of the study in electronic and printed media, at the State University of Paraná/PR and at basic health units (BHUs) in Paranavaí/PR. The assessments were conducted by a multidisciplinary team (physical education, nurse, nutrition and psychology professionals).

As inclusion criteria, individuals with obesity, according to the criteria of The World Health Organization ($BMI \geq 30 \text{ Kg/m}^2$) (WHO, 2015), with waist circumference $\geq 88 \text{ cm}$ for women or $\geq 102 \text{ cm}$ for men (IDF, 2006), adults (18 to 50 years), of both sexes, living in the municipality study, in southern Brazil, with availability for evaluations.

To standardize measurements, the participants were instructed not to perform moderate or intense physical activity in the 24 hours preceding the assessments, neither ingest alcohol or caffeine-containing substances during this period. As for the exclusion criteria, no pregnant women, and patients with previous bariatric surgery, referred eating disorder, pacemakers or prostheses were included.

Collection Procedures

Body composition measurements were carried out using the bioimpedanciometry method, with the aid of an octapolar multi-frequency analyzer (InBody®, model 520 Body Composition Analyzers, South Korea), following recommendations proposed by Heyward (Heyward, 2001). The variables used were lean body mass (LBM) and fat body mass (FBM). Based on these variables, the following body composition parameters were calculated: lean mass index (LMI), fat mass index (FMI) and lean-to-fat ratio (LFR). The LMI was obtained by the division of the lean body mass by height squared [LBM (kg) / height (m)²] and the same elements were used to calculate the FMI [FBM (kg) / height (m)²] according to recommendations of Vanitallie et al (VanItallie et al., 1990). The lean-to-fat-ratio LFR [LBM (kg) / FBM (kg)] was calculated in accordance with Sternfeld et al., (2002) study, (Sternfeld et al., 2002).

Statistical Analyses

Initially, calculations of body composition indexes were performed in an Excel spreadsheet and the results were stratified into four groups according to risk and nutritional grade: overweight, obesity I, obesity II and obesity III. Then, the means and standard deviations of the characteristics between the variables were calculated. The statistical package (SPSS) (Andy Field, 2009) version 20.0 was used for statistical analysis and the Kolmogorv-Smirnov test was used to verify the normality of the data, using the Anova One-Way test for parametric samples to compare the variables between the four groups, the Post Hoc tests and later Scheffe test to verify the relationship of the four groups to the variables. Finally, the Spearman's Correlation test was used to verify the correlation of all body composition variables.

3. Results

Table 1 presents components of body composition of adults according to nutritional status and sex. The participants were categorized according to their nutritional status from overweight to obesity degree III. All the variables present significant differences ($p < 0,05$) among the groups according to the nutritional status, except for the age and height.

Table 1. Characteristics of body composition according to nutritional status in overweight and obese individuals.

General stratified by nutritional status (n = 274)					
Body Composition (n=274)	Overweight (n=38)	Obese I (n=68)	Obese II (n=70)	Obese III (n=98)	p-value
Age (years)	33.50±11.10	34.03±9.53	35.73±8.64	38.06±11.24	0.034
Height (m)	1.62±0.07	1.65±0.08	1.65±0.09	1.65±0.08	0.140
Body Mass (kg)	72.33±9.20 ^{a,b,c}	90.06±9.87 ^{a,d,e}	102.03±11.58 ^{b,d,f}	125.33±20.66 ^{c,e,f}	0.000*
Body Mass Index (kg/m ²)	27.23±1.67 ^{a,b,c}	32.84±1.37 ^{a,d,e}	37.37±1.44 ^{b,d,f}	45.83±5.71 ^{c,e,f}	0.000*
Lean Body Mass (kg)	42.02±6.01 ^{a,b,c}	48.80±8.94 ^{a,e}	50.66±7.73 ^{b,f}	57.37±10.10 ^{c,e,f}	0.000*
Fat Mass (kg)	30.31±5.37 ^{a,b,c}	41.26±4.65 ^{a,d,e}	51.37±5.98 ^{b,d,f}	67.96±11.88 ^{c,e,f}	0.000*
Body Fat Percentage	37.96±4.72 ^{a,b,c}	42.78±5.63 ^{a,d,e}	47.54±3.97 ^{b,d,f}	51.54±3.08 ^{c,e,f}	0.000*
Lean Mass Index (kg/m ²)	15.98±1.20 ^{a,b,c}	17.68±1.76 ^{a,e}	18.50±1.33 ^{b,f}	20.88±2.29 ^{c,e,f}	0.000*
Fat Mass Index (kg/m ²)	11.49±2.06 ^{a,b,c}	15.16±1.96 ^{a,d,e}	18.87±1.72 ^{b,d,f}	24.87±3.81 ^{c,e,f}	0.000*
Lean-to-Fat Ratio (kg/kg)	1.42±0.27 ^{a,b,c}	1.20±0.29 ^{a,d,e}	0.99±0.15 ^{b,d,f}	0.85±0.10 ^{c,e,f}	0.000*
Male stratified by nutritional status (n=65)					

Body Composition (n=65)	Overweight (n=4)	Obese I (n=20)	Obese II (n=15)	Obese III (n=26)	p-value
Age (years)	41.50±11.03	31.45±9.51	32.80±9.43	37.73±7.34	0.038
Height (m)	1.75±0.05	1.74±0.05	1.70±0.10	1.74±0.07	0.221
Body Mass (kg)	88.28±7.29 ^c	99.24±7.56 ^e	107.89±12.87 ^f	144.45±23.34 ^{c,e,f}	0.000*
Body Mass Index (kg/m ²)	28.95±1.11 ^{b,c}	32.69±1.34 ^{d,e}	37.78±1.57 ^{b,d,f}	47.85±7.33 ^{c,e,f}	0.000*
Lean Body Mass (kg)	55.45±3.64 ^c	59.84±5.40 ^e	55.80±8.55 ^f	69.53±8.59 ^{c,e,f}	0.000*
Fat Mass (kg)	32.83±6.85 ^{b,c}	39.40±5.33 ^{d,e}	52.09±7.23 ^{b,d,f}	74.93±15.98 ^{c,e,f}	0.000*
Body Fat Percentage	33.15±5.94 ^{b,c}	36.01±4.30 ^{d,e}	45.71±5.28 ^{b,d}	48.78±3.40 ^{c,e}	0.000*
Lean Mass Index (kg/m ²)	18.21±0.93 ^c	19.71±1.28 ^e	19.28±1.54 ^f	22.85±2.23 ^{c,e,f}	0.000*
Fat Mass Index (kg/m ²)	10.74±1.97 ^c	12.98±1.58 ^{d,e}	18.12±2.06 ^{d,f}	24.64±5.16 ^{c,e,f}	0.000*
Lean-to-Fat Ratio (kg/kg)	1.76±0.49 ^{b,c}	1.55±0.28 ^{d,e}	1.08±0.19 ^{b,d,f}	0.95±0.12 ^{c,e,f}	0.000*
Female stratified by nutritional status (n=209)					
Body Composition (n=209)	Overweight (n=34)	Obese I (n=48)	Obese II (n=55)	Obese III (n=72)	p-value
Age (years)	32.56±10.89	35.10±9.44	36.53±8.33	38.18±12.39	0.070
Height (m)	1.60±0.06	1.62±0.06	1.64±0.08	1.62±10.06	0.116
Body Mass (kg)	70.46±7.46 ^{a,b,c}	86.23±8.06 ^{a,d,e}	100.43±10.78 ^{b,d,f}	118.43±14.45 ^{c,e,f}	0.000*
Body Mass Index (kg/m ²)	27.03±1.61 ^{a,b,c}	32.90±1.38 ^{a,d,e}	37.36±1.42 ^{b,d,f}	45.10±4.86 ^{c,e,f}	0.000*
Lean Body Mass (kg)	40.44±3.86 ^{a,b,c}	44.20±5.36 ^{a,d,e}	49.25±6.93 ^{b,d}	52.98±16.29 ^{c,e}	0.000*
Fat Mass (kg)	30.02±5.22 ^{a,b,c}	42.03±4.15 ^{a,d,e}	51.17±5.65 ^{b,d,f}	65.44±8.87 ^{c,e,f}	0.000*
Body Fat Percentage	38.53±4.31 ^{a,b,c}	45.60±3.16 ^{a,d,e}	48.04±3.42 ^{b,d,f}	52.54±2.24 ^{c,e,f}	0.000*
Lean Mass Index (kg/m ²)	15.71±0.93 ^{b,c}	16.84±1.13 ^{d,e}	18.29±1.20 ^{b,d,f}	20.16±1.86 ^{c,e,f}	0.000*
Fat Mass Index (kg/m ²)	11.69±2.07 ^{a,b,c}	16.06±1.27 ^{a,d,e}	19.07±1.57 ^{b,d,f}	24.95±3.22 ^{c,e,f}	0.000*
Lean-to-Fat Ratio (kg/kg)	1.37±0.21 ^{a,b,c}	1.06±0.13 ^{a,e}	0.97±0.13 ^{b,f}	0.81±0.07 ^{c,e,f}	0.000*

Data Source: these data were generated by the researchers involved with this study.

*p-value <0.05 Anova one-way test. Post-Hoc test of Scheffe: ^aOverweight x Obese I; ^bOverweight x Obese II; ^cOverweight x Obese III; ^dObese I x Obese II; ^eObese I x Obese III; ^fObese II x Obese III

Source: Authors.

Table 2 shows correlations between usual body composition parameters (BMI, LBM, LFR), unusual parameters (LMI, FMI and LFR) components among the adults participating in the study. The correlations presented were high and significant with a few exceptions. They showed that the usual parameters are associated with the non-usual indicators and that may permit new associations and further developments in this field.

Table 2. Correlation Spearman general (n=274) between usual components (BMI, LBM, FBM – absolute and relative), unusual components (LFR, LMI and FMI).

Body Mass Index	Lean Body Mass (kg)	Fat Body (kg)	Body Fat Percentage	Lean Mass Index	Fat Mass Index (kg/m ²)	Lean-to-Fat Ratio (kg/kg)
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	(kg/m ²)				(kg/m ²)			
Body Mass Index (kg/m ²)	1	r= 0.623** p=0.000	r= 0.946** p=0.000	r= 0.714** p=0.000	r= 0.830** p=0.000	r= 0.957** p=0.000	r= -0.651** p=0.000	
Lean Body Mass (kg)	r= 0.623** p=0.000	1	r= 0.668** p=0.000	r= 0.049 p=0.421	r= 0.865** p=0.000	r= 0.432** p=0.000	r= -0.001 p=0.987	
Fat Body (kg) *	r= 0.946** p=0.000	r= 0.668** p=0.000	1	r= 0.744** p=0.000	r= 0.750** p=0.000	r= 0.938** p=0.000	r= -0.701** p=0.000	
Body Fat Percentage	r= 0.714** p=0.000	r= 0.049 p=0.421	r= 0.744** p=0.000	1	r= 0.270** p=0.000	r= 0.862** p=0.000	r= -0.968** p=0.000	
Lean Mass Index (kg/m ²)*	r= 0.830** p=0.000	r= 0.865** p=0.000	r= 0.750** p=0.000	r= 0.270** p=0.000	1	r= 0.669** p=0.000	r= -0.194** p=0.000	
Fat Mass Index (kg/m ²)	r= 0.957** p=0.000	r= 0.432** p=0.000	r= 0.938** p=0.000	r= 0.862** p=0.000	r= 0.669** p=0.000	1	r= -0.809** p=0.000	
Lean-to-Fat Ratio (kg/kg)	r= -0.651** p=0.000	r= -0.001 p=0.987	r= -0.701** p=0.000	r= -0.968** p=0.000	r= -0.194** p=0.000	r= -0.809** p=0.000	1	

Data Source: these data were generated by the researchers involved with this study.

** p < 0.05.

Source: Authors.

4. Discussion

The aim of the present study was to present and correlate the nutritional status in adults according to usual and non-usual components of body composition. In this aspect, the findings indicate that an increased nutritional status (overweight degree) promotes changes in usual and unusual body composition parameters.

The body mass index (BMI) is the most widely used weight status measure in epidemiology, clinical care and clinical nutrition because its simplicity (the calculation includes body weight in kilograms divided by the square of an individual's height in meters (kg / m²) (Vanavanan et al., 2018). However, BMI does not give information about the relative proportions of fat and lean body mass (Merli et al., 2019).

There are a limited number of studies exploring the association between the BMI and body composition profile in larger samples. One study which did that is from USA whose sample involved 4.984 subjects from who the measurements included the BMI and the % body fat measured by DEXA. They found that the BMI value to predict the % body fat indicating obesity was 24,9 and 24,1 for men and women over 60 years old, respectively. The conclusion of that study is that traditional measures poorly identify obesity in the elderly. In older adults, BMI may be a suboptimal marker for adiposity (Batsis et al., 2016).

In this sense the concept of the “obesity paradox” arises - the unexpected association between higher body mass index (BMI) and lower mortality – has now been described in multiple cardiovascular disease (CVD) states (Srikanthan et al., 2016). However, it is necessary to consider that in most studies that describe the “obesity paradox” in CVD groups, BMI has been applied to measure obesity. However, BMI is highly correlated with fat and muscle mass and, therefore, may not reflect variations in the level of fat and muscle mass. Thus, the balance of fat muscle mass may be the key to understanding the

pathophysiology underlying the "obesity paradox" (Romero-Corral et al., 2008; Srikanthan et al., 2016; Srikanthan & Horwich, 2012).

Therefore, it is important to observe body composition in addition to BMI, and this study indicates that, as nutritional status increases, the changes in body composition values are observed. Body composition is highly variable among individuals with the same BMI (Lee et al., 2018). For example, among the factors that can alter body composition is the use of medications, such as metformin, for the treatment of diabetes mellitus (Aghili et al., 2014). This is particularly important because fat mass and lean body mass may act differently on health outcomes including mortality (Lee et al., 2018). Lean body mass (mainly skeletal muscles mass) has a protective role, whereas fat mass is detrimental (Medina-Inojosa et al., 2018; Wannamethee & Atkins, 2015). Therefore, understanding the different contributions of lean body mass and fat mass to BMI may provide new insights on the obesity paradox and deliver important clinical and public health messages about healthy body composition beyond BMI (Lee et al., 2018).

A longitudinal cohort study showed that a higher percentage of total lean body mass over time was associated with a lower risk of developing diabetes in men, even after taking race into account. In addition, an absolute total of lean mass over time has also been linked to a relatively lower risk of diabetes in men (Kalyani et al., 2020).

A study that analyzed the body composition of patients after bariatric surgery showed that patients who lose more weight appear to have accelerated losses of lean and fat mass. These differential rates of tissue loss are modestly correlated; in addition, few patients after bariatric surgery retain lean body mass over time (Zalesin et al., 2010).

In patients with Chronic Obstructive Pulmonary Disease (COPD), abnormal body composition was associated with an increased risk of functional limitation, with greater severity among women. Studies on abnormalities in body composition may represent an important area for screening and preventive intervention in COPD (Eisner et al., 2007).

In addition, unusual body composition markers (LMI, FMI and LFR) differed between the four groups. However, direct measurement of lean body mass and other unusual body measurements are difficult to perform in large epidemiological studies because they require expensive and sophisticated technologies. Therefore, little is known about the influence of body composition on mortality. A limited number of studies used unusual body composition measures to assess mortality, (Auyeung et al., 2010; Cesari et al., 2009; Newman et al., 2006; Padwal et al., 2016; Rolland et al., 2014; Toss et al., 2012) but these studies had a relatively small sample size, short follow-up period, restricted study population and potential study biases. In addition, the association of lean body mass and fat mass with specific cause mortality is largely unknown (Lee et al., 2018).

A meta-analysis carried out in 2013 showed that obesity (BMI ≥ 30) was associated with higher mortality from all causes in relation to normal weight (BMI 18.5-24.9), but overweight (BMI 25-29, 9) was associated with lower mortality from all causes (Flegal et al., 2013). On the other hand, another meta-analysis carried out in 2016 showed that the increased risk of all-cause mortality among overweight people was largely due to confusion from smoking and the reverse causation of the underlying disease and frailty at older ages (Di Angelantonio et al., 2016).

In this scenario and trying to make clear what really matter in terms of cardiometabolic risk analyzes. Poggiogalle et al. have shown 4 phenotypes according with the contribution of the adipose tissue and the muscle mass. Based on that concept they were able to show greater impairment of insulin sensitivity and glycaemic control in the group with high adiposity and low muscle mass, or in order words, with the higher load (adiposity) and the smaller capacity (muscle mass) (Poggiogalle et al., 2020).

5. Final Considerations

With these results, it was possible to verify that, according to the nutritional status changes are observed in the usual and unusual components of body composition in the studied population. That can be important, especially when applied to the

population with overweight or obesity. Based on that, other studies may evaluate the utility of the unusual components of body composition as diagnostic tool for different conditions and in a variety of population groups. The use of indicators like the Lean-to-Fat Ratio may add information not observed when the traditional parameters of body composition were applied isolated. Further studies are necessary to check that possibility and should be done including risk related parameters like blood glucose, lipids and hormones.

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