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# Body Composition Profile and Nutritional Status of Adolescents with Overweight or Obesity Using Usual and Unusual Indicators

# Perfil de composición corporal y estado nutricional de adolescentes con sobrepeso u obesidad mediante indicadores habituales e inusuales

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**Abstract.** In recent decades, overweight and obesity in childhood and adolescence have been one of the most important challenges in public health. The objective of this cross-sectional study was to further explore the body composition and nutritional status of adolescents with overweight or obesity using usual and unusual indicators. Participants were 90 adolescents between 10 and 18 years of age belonging to a multiprofessional obesity treatment program, who were evaluated with multifrequency bioelectrical impedance to determine their nutritional status as overweight, with obesity or with severe obesity and body composition. Analysis of variance, correlation, and linear regression adjusted for confounding variables were used to analyze the data. There were significant differences between the three groups according to their BMI in lean and fat mass as the usual indicators ($p<0.05$). The same was observed for lean and fat mass indexes, and for lean-to-fat ratio ($p<0.01$) which are unusual indicators. Additionally, positive and significant correlations were observed between usual and unusual variables ($r = 0.5$ to $0.89$; $p<0.05$). At the same time, lean and fat mass mainly tended to increase with a higher BMI in adolescents ($p<0.05$). It is concluded that the comparison and associations between the usual and unusual variables provided important findings on the evaluation of adolescents with overweight, obesity, or severe obesity. It should be considered that this study was cross-sectional and did not indicate cause-effect between the variables.
**Keywords:** Body composition; nutritional condition; cardiometabolic risk; Evaluation; young teenagers

**Resumen.** En las últimas décadas, el sobrepeso y la obesidad en la infancia y la adolescencia han sido uno de los desafíos más importantes en salud pública. El objetivo de este estudio transversal fue explorar más a fondo la composición corporal y el estado nutricional de adolescentes con sobrepeso u obesidad utilizando indicadores habituales e inusuales. Los participantes fueron 90 adolescentes entre 10 y 18 años pertenecientes a un programa multiprofesional de tratamiento de la obesidad, quienes fueron evaluados con impedancia bioeléctrica multifrecuencia para determinar su estado nutricional como sobrepeso, con obesidad o con obesidad severa y composición corporal. Para analizar los datos se utilizaron análisis de varianza, correlación y regresión lineal ajustados por variables de confusión. Hubo diferencias significativas entre los tres grupos según su IMC en masa magra y grasa como indicadores habituales ($p<0,05$). Lo mismo se observó para los índices de masa magra y grasa, y para la relación magro-grasa ($p<0,01$), que son indicadores inusuales. Además, se observaron correlaciones positivas y significativas entre variables habituales e inusuales ($r = 0,5$ a $0,89$; $p<0,05$). Al mismo tiempo, la masa magra y grasa tendió principalmente a aumentar con un IMC más alto en los adolescentes ($p<0,05$). Se concluye que la comparación y asociaciones entre las variables habituales e inusuales proporcionaron hallazgos importantes en la evaluación de adolescentes con sobrepeso, obesidad u obesidad severa. Se debe considerar que este estudio fue transversal y no indicó causa-efecto entre las variables.
**Palabras clave:** Composición corporal; condición nutricional; riesgo cardiometabólico; Evaluación; jóvenes adolescentes

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## Introduction

Food, active life and self-care are dimensions of healthy lifestyle habits that, developed early on, contribute to a good quality of life, both physically and mentally, in adolescent students. In this sense, the environment in which people live in general influences the formation of habits. Based on this, a person attends an educational establishment, such as school, for an average of twelve years of their life, so it is in this scenario that the child can acquire and consolidate healthy lifestyle habits that allow them to maintain optimal physical and mental health (Hallal et al., 2006; Torres et al., 2019; Yang et al., 2022).

It is important to consider that health and well-being in adulthood have their origin in childhood behavior and lifestyles (Escalante et al., 2011). An adequate level of regular physical activity in adults reduces the risk of hypertension, coronary heart disease, stroke, diabetes, breast and colon cancer, depression and falls, improves bone and functional health, is a determinant of energy expenditure and therefore essential for caloric balance and weight control. On the other hand, it is highly necessary to reach the recommended levels of physical activity due to its beneficial effects on health and as a prevention of Chronic Non-Communicable Diseases (NCDs) (WHO, 2020).

Currently, numerous scientific studies confirm that the regular practice of physical activity (PA) brings significant benefits to health, both physiologically, mentally and socially, being considered one of the essential habits for the adoption of an active and healthy lifestyle (R. H. Bim et al., 2022; Ricardo Henrique Bim et al., 2021; Binder et al., 2014; G. Westphal et al., 2021).

In turn, decreased PA is associated with excess weight due to poor nutrition and decreased cardiovascular status in young people and adults. Therefore, the World Health Organization (WHO) started to recommend at least 60 minutes daily of moderate-vigorous aerobic and strength training, at least 3 days a week in children and adolescents aged 5 to 17 years. Between 150-300 min, moderate aerobic, or at least 75-150 min vigorous aerobic, and at least 2 days a week moderate muscle work in adults that reduces the potential for NCDs (Bull et al., 2020; WHO, 2020). Zapata-Lamana et al., (2015) argue that more physical exercise improves physical condition, makes body composition healthier and reduces cardiovascular risk.

For more than three decades, overweight and obesity in childhood and adolescence have been considered one of the most relevant public health challenges in developed countries (Di Cesare et al., 2019; Escrivá et al., 2021; Lobstein et al., 2015). Whereas on a global level, active and healthy lifestyles are a topic taken lightly, as 34 of the 36 OECD countries have BMI indexes >25/<30, which translates into being overweight. This in turn is reflected in the fact that 1 in 4 people are obese. Accurate measurement and evaluation of anthropometric parameters are essential to detect nutritional status that requires some sort of prevention or treatment (Christinelli et al., 2021; Cole et al., 2000), as well as the assessment of weight and height, and their relationship through BMI, continue to be measures of easy application and diagnosis, despite the controversial sensitivity of the latter (Borba De Amorim et al., 2008; Domínguez-Reyes et al., 2017; Greice Westphal et al., 2020).

There are also other anthropometric indicators such as waist circumference, which is considered a simple and inexpensive measurement, that offers relevant information on the distribution of abdominal fat in adults (Campos et al., 2015). The waist/height ratio is considered a tool to predict cardiovascular risk and its use is comparable with both BMI and waist circumference (Padrón Martínez et al., 2016). Another useful, simple, and inexpensive indicator to assess body fat distribution and disease risk is the waist-to-hip ratio, which is used as a clinical indicator for weight loss interventions (Arias-Téllez et al., 2018). The waist-to-height ratio is considered a tool to predict cardiovascular risk and its use is comparable with both BMI and waist circumference (Guedes et al., 2017). Regarding neck circumference, it is considered a simple clinical tool for the detection of obesity; it correlates significantly with adiposity indices and can reliably identify people with general and abdominal obesity (Arias-Téllez et al., 2018).

The association of body composition with physical performance and functional limitations, such as oxygen consumption, has been extensively investigated (Guedes et al., 2017; Vásquez Gómez et al., 2018). On the other hand, Sternfeld et al., (2002), have shown that higher fat mass was associated with slower walking speed and greater likelihood of functional limitation, whereas higher lean mass was generally associated only with higher strength of grip. A higher ratio of lean mass to fat mass, a relative measure of body composition, was associated with faster walking speed and fewer limitations. Based on evidence such as that of Eisner et al., (2007) it has been established that the lean-fat ratio has substantive analytical advantages because it is independent of body size and is not collinear with height, while the lean mass and height are collinear. For all these reasons and rationales, the aim of this study was to explore the nutritional status of overweight or obese adolescents using common and unusual indicators.

## Methods

This was a cross-sectional study that included adolescents enrolled in a Multi pro-fessional Obesity Treatment Program (MOTP) in Maringá, Brazil. This research is an extract from a larger study aimed at verifying the effectiveness of a multi professional obesity treatment program in Brazilian children and adolescents. All study procedures strictly followed the requirements established in resolution 466/2012 of the Brazilian National Health Council.

This research was approved by the local ethics committee and contains the Brazilian Registry of Clinical Trials (REBEC). The present study is also in line with the ethical standards established in the 1964 Declaration of Helsinki and subsequent amendments. Interventional studies involving animals or humans, and other studies that re-quire ethical approval, must list the authority that provided approval and the corresponding ethical approval code.

### *Participants*

Initially, 468 participants who saw advertisements through television, radio and so-cial networks were recruited. Sequentially, lectures were given on the risks and devel-op-ment of childhood obesity. Participants were invited to enroll in the study and those who met the eligibility criteria and showed interest and availability to participate in the pro-gram were included.

After screening for eligibility, 90 children and adolescents of both sexes were included and made up the sample of this study. To be eligible for this study, participants must meet the following inclusion criteria:

• Age between 10 and 18 years;
• Have a diagnosis of being overweight, obese or severely obese according to the cut-off points established by Cole et al., (2000);
• Have the signature of the legal guardian of the participant to participate in the evaluations of this study;
• Do not present any genetic or endocrine dysfunction;
• Do not consume alcoholic beverages, glucocorticoids, psychotropic or other sub-stances that may impair appetite regulation;
• Do not use diuretics.

Participants who did not complete all assessments or who did not follow the specific recommendations for each assessment were excluded from the analysis.

### *Anthropometric Assessments and Body Composition*

Body mass, body composition and Body Mass Index (BMI) were obtained by mul-tifrequency bioelectrical impedance with an 8-point tactile electrode (InBody®, model

520 Body Composition Analyzers, South Korea) following the recommendations proposed by Heyward, (2001). Height was determined to the nearest 0.1 cm with a wall-mounted stadiometer (Sanny). BMI was calculated by dividing weight (in kilograms) by height (in meters squared).

The variables used were Lean Body Mass (LBM) and Fat Body Mass (FBM). From these variables, the following body composition parameters were calculated: Lean Mass Index (LMI), Fat Mass Index (FMI), and Lean-to-Fat Ratio (LFR). The LBI [LBM(kg)/height(m)²] and FBI [FBM(kg)/height(m)²] calculations were used, according to the recommendations proposed by VanItallie et al., (1990) and LFR [LBM (kg) / FBM (kg)] proposed by Sternfeld et al., (2002).

### *Statistical Analysis*

Data analysis was performed with STATA v.14 software, using a descriptive and in-ferential statistical approach. Initially, the normality of the data was verified by means of the Kolmogorov Smirnov test and by the values of asymmetry and kurtosis. Levene's test was used to verify data homogeneity. The mean and standard deviation (SD) were used to characterize the results that showed a normal distribution pattern. Subsequently, the Anova One-Way statistical analysis was performed and when the difference between the three experimental groups (overweight, obesity and severe obesity) was detected, the Tuk-ey test was used as post-hoc. Subsequently, the Pearson correlation between the compo-nents of usual and unusual body composition was applied.

Correlations were interpreted according to the Hopkins classification (Hopkins et al., 2009) <0.1 [trivi-al], >0.1 to <0.3 [little], 0.3 to 0.5 [moderate], 0.5 to 0.7 [high], 0.7 to 0.9 [very high] and 0.9 to 1.0 [almost perfect]. Finally, to associate the usual variables of lean mass, fat mass and BMI, linear regression models were generated with the beta coefficient and three mod-els adjusted for confounding variables (model 1 unadjusted; model 2 adjusted by gender and age; and model 3 adjusted by model 2 plus estimated energy expenditure) with their respective confidence intervals (CI 95%). A significance of 5% was stipulated for all analyzes performed in the present study.

## Results

Table 1. shows the components of the body composition of adolescents with overweight, obesity or severe obesity according to the nutritional classification. There was differences in age at the overall and female groups but not at the male group. Most importantly there were no differences in height among the among the sex groups which is important for the comparison intended. One important finding is the absence of differences Lean Body Mass and Lean Mass Index between males and females across the BMI categories. Consequently, the Lean-to-Fat mass ratio has a significative ($p<0,01$) and inverse relationship with the BMI. These findings indicate that an increased nutritional status (overweight degree) promotes changes in usual and unusual body composition parameters.

Table 1.
Characteristics of body composition according to nutritional status in overweight, obese and obese several in adolescents.

| Overall stratified by nutritional status (n = 90) | | | | |
|---|---|---|---|---|
| Body Composition (n=90) | Overweight (n=23) | Obese (n=28) | Severe obesity(n=38) | p-Value |
| Age (years) | 16±1$^{b}$ | 14.34±1.70 | 14.47±2.40$^{b}$ | .004 |
| Height (m) | 1.67±0.09 | 1.67±0.09 | 1.68±0.10 | .892 |
| Body Mass (kg)* | 75.07±9.43$^{a,b}$ | 86.27±10.66$^{a,c}$ | 106.64±15.97$^{b,c}$ | .000 |
| Body Mass Index (kg/m$^2$)* | 26.95±1.23$^{a,b}$ | 30.78±1.36$^{a,c}$ | 37.79±4.52$^{b,c}$ | .000 |
| Lean Body Mass (kg)* | 45.10±8.86 | 47.64±8.70 | 52.05±12.94 | .043 |
| Fat Body Mass (kg) * | 29.97±4.49$^{a,b}$ | 38.63±4.73$^{a,c}$ | 54.60±10.30$^{b,c}$ | .000 |
| Body Fat Percentage | 35.26±6.04$^{a,b}$ | 41.50±4.97$^{a,c}$ | 47.65±5.27$^{b,c}$ | .000 |
| Lean Mass Index (kg/m$^2$)* | 16.09±1.51$^{b}$ | 16.91±1.57 | 18.28±3.38$^{b}$ | .004 |
| Fat Mass Index (kg/m$^2$) | 10.85±1.73$^{a,b}$ | 13.87±1.66$^{a,c}$ | 19.43±4.26$^{b,c}$ | .000 |
| Lean-to-Fat Ratio (kg/kg) | 1.54±0.41$^{b}$ | 1.25±0.25 | 0.98±0.25$^{b}$ | .000 |
| Male Adolescents (n=36) | | | | |
| Body Composition (n=36) | Overweight (n=5) | Obese (n=12) | Severe obesity (n=19) | p-Value |
| Age (years) | 15.60±1.34 | 15.05±1.65 | 15.36±2.47 | .634 |
| Height (m) | 1.81±0.02 | 1.72±0.10 | 1.74±0.10 | .169 |
| Body Mass (kg)* | 88.16±4.64$^{b}$ | 90.63±11.34$^{c}$ | 113.02±15.26$^{b,c}$ | .000 |
| Body Mass Index (kg/m$^2$)* | 26.83±1.45$^{b}$ | 30.55±1.51$^{c}$ | 37.17±3.05$^{b,c}$ | .000 |
| Lean Body Mass (kg)* | 59.80±6.51 | 52.89±9.19 | 59.58±10.86 | .224 |
| Fat Body Mass (kg) * | 28.36±3.49$^{b}$ | 37.73±4.53$^{c}$ | 53.44±7.32$^{b,c}$ | .000 |
| Body Fat Percentage | 27.94±4.79$^{a,b}$ | 38.16±4.66$^{a,c}$ | 45.04±5.91$^{b,c}$ | .000 |
| Lean Mass Index (kg/m$^2$)* | 18.18±1.76 | 17.77±1.73 | 19.47±1.71 | .060 |
| Fat Mass Index (kg/m$^2$) | 8.65±1.26$^{a,b}$ | 12.78±1.40$^{a,c}$ | 17.71±2.64$^{b,c}$ | .000 |
| Lean-to-Fat Ratio (kg/kg) | 2.15±0.45$^{a,b}$ | 1.41±0.26$^{a,c}$ | 1.12±0.20$^{b,c}$ | .000 |
| Female Adolescents (n=54) | | | | |
| Body Composition (n=54) | Overweight (n=18) | Obese (n=17) | Severe obesity (n=19) | p-Value |
| Age (years) | 16.11±1.02$^{b}$ | 14.59±1.77 | 14.75±2,33$^{b}$ | .004 |
| Height (m) | 1.63±0.06 | 1.64±0.07 | 1.62±0.05 | .651 |
| Body Mass (kg)* | 71.44±6.76$^{b}$ | 83.20±9.28$^{c}$ | 101.30±15.75$^{b,c}$ | .000 |
| Body Mass Index (kg/m$^2$)* | 26.98±1.20$^{a,b}$ | 30.95±1.27$^{a,c}$ | 38.59±5,64$^{b,c}$ | .000 |
| Lean Body Mass (kg)* | 41.02±3.22 | 43.94±6.26 | 45.32±11.68 | .259 |
| Fat Body Mass (kg) * | 30.42±4.72$^{a,b}$ | 39.26±4.90$^{a,c}$ | 55.98±12.85$^{b,c}$ | .000 |
| Body Fat Percentage | 37.29±4.65$^{a,b}$ | 43.85±3.75$^{a,c}$ | 50.12±3.38$^{b,c}$ | .000 |
| Lean Mass Index (kg/m$^2$)* | 15.51±0.77 | 16.31±1.16 | 17.28±4.29 | .923 |
| Fat Mass Index (kg/m$^2$) | 11.46±1.29$^{a,b}$ | 14.64±1.41$^{a,c}$ | 21.35±4.84$^{b,c}$ | .000 |
| Lean-to-Fat Ratio (kg/kg) | 1.37±0.19$^{a,b}$ | 1.13±0.16$^{a,c}$ | 0.85±0.23$^{b,c}$ | .000 |

Note. *p-value <0.005 Anova one-way test. Post-Hoc test the Tukey: [a]Overweight x Obese I; [b]Overweight x Obese Several; [c]Obese Several x Obese.

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Table 2 shows the correlations between the usual (BMI, LBM, FBM) and unusual (LMI, IMF and LFR) body composition parameters among the adolescents participating in the study. The coefficient of correlation shows that BMI is more strongly associated with fat mass and derived index than with lean mass.

Table 2.
Pearson's Correlation between usual components (BMI, LBM, FBM – absolute and relative), unusual components (LFR, LMI and FMI) in adolescents with overweight, obese and obese several.

| | Body Mass Index (kg/m²) | Lean Body Mass (kg) | Fat Body Mass(kg) | Body Fat Percentage | Lean Mass Index (kg/m²) | Fat Mass Index (kg/m²) | Lean-to-Fat Ratio (kg/kg) |
|---|---|---|---|---|---|---|---|
| Body Mass Index (kg/m²) | 1 | r= .352 p= .001 | r= .912 p= .000 | r= .723 p= .000 | r= .504 p= .000 | r= .876 p= .000 | r= -.414 p= .000 |
| Lean Body Mass (kg) | r= .352 p= .001 | 1 | r= .238 p= .024 | r= -.186 p= .079 | r= .867 p= .000 | r= .086 p= .420 | r= .515 p= .000 |
| Fat Body Mass (kg) * | r= .912 p= .000 | r= .238 p= .024 | 1 | r= .767 p= .000 | r= .233 p= .027 | r= .909 p=.000 | r= -.630 p= .000 |
| Body Fat Percentage | r= .723 p= .000 | r= -.186 p= .079 | r= .767 p= .000 | 1 | r= -.005 p=.966 | r= .833 p=.000 | r= -.601 p= .000 |
| Lean Mass Index (kg/m²)* | r= .504 p= .000 | r= .867 p= .000 | r= .233 p= .027 | r= -.005 p= .966 | 1 | r= .037 p= .729 | r= -.557 p= .000 |
| Fat Mass Index (kg/m²) | r= .876 p= .000 | r= .086 p= .420 | r= .909 p= .000 | r= .833 p= .000 | r= .037 p= .729 | 1 | r= -.775 p= .000 |
| Lean-to-Fat Ratio (kg/kg) | r= -.414 p=.000 | r= .515 p= .00 | r= -.630 p= .000 | r= -.601 p= .000 | r= -.557 p= .000 | r= -.775 p= .000 | 1 |

*Note*. * p < 0.005.

Still looking for the associating body composition with BMI, the results of a linear regression (Table 3) showed that adolescents with higher BMI were more likely to have more lean mass, but in model 3, when the association was adjusted for a greater number of confounding variables (gender, age and estimated energy expenditure), it decreased. In turn, adolescents with a higher BMI were more likely to have a high fat mass. That is, with an increase in BMI of 1 kg/m2, lean mass increased by 0.77 kg in model 1 (unadjusted), but, on the contrary, with an increase of 1 kg/m2 in BMI, lean mass decreased by 0, 44 kg in model 3 (adjusted by gender, age and estimated energy expenditure). For its part, the percentage of fat mass had constant increases (from 0.91 to 1.03%) when the BMI increased by 1 kg/m2 (models 1 to 3) (Table 3).

Table 3.
Association between body composition and BMI.

| Body Composition | Models | β | F | R² | Interval of confidance (95%) | p-value |
|---|---|---|---|---|---|---|
| Lean mass | Model 1 | 077 | (1, 89) 16.1 | .14 | .39; 1.15 | <.001 |
| | Model 2 | .6 | (3, 87) 46.3 | .6 | .34; .87 | <.001 |
| | Model 3 | -.44 | (4, 86) 62.1 | .73 | -.82; -.05 | .026 |
| Fat Mass | Model 1 | .91 | (1, 89) 93 | .51 | .72; 1.1 | <.001 |
| | Model 2 | .97 | (3, 87) 65.7 | .68 | .82; 1.13 | <.001 |
| | Model 3 | .03 | (4, 86) 48.9 | .68 | .76; 1.31 | <.001 |

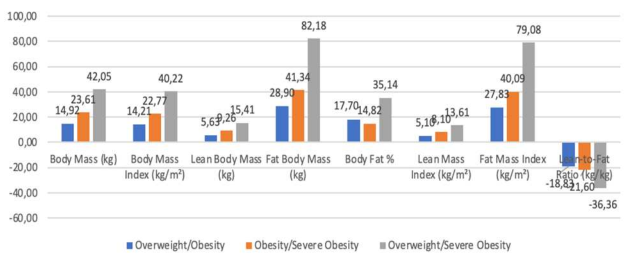


Figure 1. *Percentual differences between cathegories: Overweight/Obesity; Obesity/Severer Obesity and Overweight/Severe Obesity.*

## Discussion

The importance of this issue is related to finds from studies that showed that BMI and body mass may represent very heterogenous body composition profiles. That is more evident with the aging process characterized by an increase in body fat and the decline of lean mass.

It becomes clear from a study conducted by Bibiloni et al. (2013) that adolescents can be misclassified on the basis of their BMI. These authors have found that 58.2% of overweight adolescents were normal-fat and that is more prevalent among girls (73.4%) than boys (43.9%). That shows how important the process of identification of adolescents in normal-weight and overweight with excess body fat is, not only because they may have an increased risk of adiposity-related comorbid conditions, but also because of the psychosocial complications derived from body fatness (Bibiloni et al. 2013).

Regarding to methods to improve the value of the information provided by body composition assessments, since the last century there are proposals like the one made bu VanItale et al. (1990) who proposed the use of height-normalized indices for FFM and BFM to avoid the ambiguities frequently generated when these components are reported as percentages of body weight and/or by absolute weigh. These authors showed that with this index the accuracy about the lean body mass and the fat body mass could be importantly improved. They also presented cut-off points to make easier this application on the clinic and epidemiological application (VanItalie et al., 1990).

More recently, other authors presented conceptual and metodological basis for advance in the use of body composition in the risk prediction. Siervo et al. (2014) and Prado et al. (2014) have explored the concept of load-capacity in an inovative way to make the effects of adiposity and lean mass aditive and interative. To express that clearer they present the sarcopenic obesity phenotype in which there is the simultaneous presence of excess adiposity (obesity) and low skeletal muscle mass (sarcopenia). It is known that they are both independently associated with an increased risk for cardiometabolic disorders and physical disability (Siervo et al., 2015; Prado et al., 2014).

Therefore, a high metabolic load represented by obesity and low metabolic capacity conferred by low muscle mass reduces the capacity for physical activity and impairs glucose homeostasis, elevating chronic disease risk.

In this scenario, Prado et al. (2014) brings information about the prevalence of the high adiposity- low muscle (HA-LM) phenotype which was 10.3% in women and 15.2% in men. Whereas the prevalence of all subclasses of HA-LM in obese women and men was 14.7% and 22.9%, respectively. That brings relevant information about the impact of this profile on the health and economy for the next decades.

It is important to add that many health complications associated with overweight and obesity are improved with weight loss. However, negative consequences (such as loss of muscle mass and bone density) are also associated with weight loss and are detrimental for older adults, which results in a precaution to recommend intentional weight loss in this population. Specificaly, when caloric restriction is applied it results in reductions in both fat and lean tissue, with lean mass loss ranging from 14% to 23% of total weight lost. Considering that the change in lean-to-fat mass ratio (LFM) served as an important outcome in intervention programs (Beavers et al., 2011).

That was shown in a study that explore physiological and molecular markers to assess the effects of alternate-day fasting (ADF) in healthy, non-obese humans. In that study, they found the fat-to-lean ratio was significantly improved upon ADF by -6.3% percentage points (Stekovic et al., 2019).

Our data reinforce the importance of this unusual body composition parameter since the load represented by adiposity is higher than the capacity expressed by the lean body mass and that is not routinely used for the assessment of people with overweight or obesity and that could be potentially applied both at the risk prediction as well as in studies on effectiveness of multidisciplinary intervention programs for that population.

The data presented by Christinelli et al., (2021) in a study involving 274 Brazilian adults with overweight or obesity also reinforce the utility and practicality of the LFM ratio which has an average of 1,42 in the overweight group compared to 0,85 in the severe obese class III group once more reveling the increasing risk for cardiometabolic diseases and disability in that population.

These results are relevant since another study with a young Brazilian population between the ages of 18 and 39 years including a total of 3,111 adults (958 men and 2,153 women) evaluated using bioimpedance presented high average values for percentual body fat (%BF) for males and females. These values are over the traditional cut-off point used to classify obesity by adiposity which are 25% for males and 35% for females. Whereas in this study the average %BF was 26,7 for males and 35,9 for females (Branco et al. 2018).

Our study about the body composition profile of adolescents with different nutritional status using usual and unusual indicators highlight the importance of these parameters for a more comprehensive understanding of these groups both for the advances in risk stratification as well as in the assessments of the effectiveness of the multidisciplinary intervention for obesity treatment and that represents a real challenge issue since even the simple measures like the circumferences are rarely applied in the health services. Despite of that, the literature has offered new tools that can be explored to improve the services and promote important gains for the health sector and the economy.

Finally, is important to recognize that our study has limitations like the reduced sample size and the cross-sectional design which preclude causality information. It should be also considered that the body composition parameters presented require further testing in longitudinal studies to confirm their discriminatory capacity as diagnostic tools in stratified medicine approaches.

## Conclusions

Based on the results obtained, it was possible to verify that there were mostly differences between the three evaluated groups of overweight, obesity and severe obesity, in the usual and unusual indicators. In addition, that the usual indicators were positively and significantly associated with most of the unusual indicators, and, in addition, the association models showed that, mainly, lean mass and fat mass increased when BMI values were higher in adolescents.

These results should be taken into consideration, although with caution, since it was a cross-sectional study and cause-effect relationships between the variables cannot be assumed. However, these findings are important when trying to assess the overweight or obese adolescent population as they can bring light on the load capacity approach which is still to be explored with this population.

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