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# Comparison of body mass index, the bioimpedance electric and waist circumference in childhood obesity classification

## Abstract

**Objective:** Comparison between BMI methods, PC and BIA in Childhood obesity classification.

**Methods:** Or type of study design it was a Observational Cross-sectional study. Our sample consisted of 95 students from the 4th year of the 1st cycle of basic education of Carvalhal Schools, da Costa, of Gandra, Montes da Costa and gravel pits, the Ermesinde parish. Data were collected on gender, age, weight, height, PC and BIA. In the treatment of the data was used as a statistical tool, the application SPSS (Statistical Package for Social Sciences) version 17.0 for Microsoft Windows®.

**Results:** We found that normal weight was 53 students, 30 were overweight and 12 were obese, according to the cut-off points defined by Cole. According to the body fat percentage, it was found that 53 students they had a normal body fat percentage, 17 had excess fat and 25 had obesity.

According to the cut-off points defined by Brown, 23 students had a PC between the 75th and 95th percentiles, which corresponds to overweight students and 23 had a higher percentile PC 95, or obesity.

**Conclusion:** In this study it was observed that the three methods showed the BIA be the method that detected a higher number of children with obesity. Among the three methods used in this study, there was a statistically significant difference (p = 0.016).

**Keywords:** childhood obesity, body mass index, overweight

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**Abbreviations:** BMI, body mass index; MRI, magnetic resonance; CAT, computed axial tomography; WHO, world health organization.

## Introduction

Childhood is a period of rapid development and growth, characterized by major changes, particularly with regard to body composition. Considering that this is closely related to the nutritional and health status, the review takes on added importance in this period of life. There are currently many and varied methods for assessing body composition, which are based on different physical principles and models, and to characterize the overall body composition and undifferentiated form or in a specific manner differentiate the various body compartments.[1] The body composition can be measured by simple methods such as anthropometry or by more sophisticated measurements such as underwater weighing, plethysmography, the bioimpedance Electric (BIA) absorptiometry X - X Dual Frequency (DEXA), Magnetic Resonance (MRI), Computed Axial tomography (CAT), among others.[2] Despite the DEXA method is considered a gold standard for the evaluation of body composition, it may have some limitations, including the cost, only be possible to use in small studies and complexity of the method.[3] The Body Mass Index (BMI) is a less expensive, simple and reproducible method to assess obesity, but its use has many drawbacks, including the fact that not distinguish fat mass, lean mass, or bone.[4] Therefore the use of BMI remains under discussion due to underestimate excess fat in children.[5] Another disadvantage relates to the fact that the relationship between BMI and the body fat percentage is not the same between different ethnic groups, since a given BMI may not correspond to the same degree of fatness among different populations.[6] There is evidence suggesting that Asians have lower BMI but higher percentage of body fat than Caucasians, therefore, the International Obesity Task Force (IOTF), International Association for The Study of Obesity (IASO) and the World Health Organization (WHO) They proposed a new criterion to define overweight and obesity in these regions based on their risk factors and morbidity. Currently, to set the Child obesity have been used different references. In the United States use the curves produced by the Centers for Disease Control and Prevention (CDC) in 2000, also used in Canada and Australia. England developed curves (UK90) based on extensive research data carried out between 1978-90, at about 30,000 individuals.

Against all this the IOTF, a global expertise network, concluded that the definition of obesity in children and adolescents should be consistent with the definition of obesity in adults, and ideally should use data representative of the world's population.[6,7] Subsequently, data was collected from six countries between 1963 and 1993, and the percentile curves were developed (with specific cutting bridges for age and gender) passing the BMI 25 kg/m$^2$ and 30 kg/m$^2$ at the age of 18 years (reflecting the settings recommended by WHO for obesity and overweight in adults).[7,8] The evaluation of waist circumference

(PC) is in increasing recognition as a useful index to characterize the body fat and disease risk.[9] However, the use of the PC is not yet common practice in studies of anthropometric measurements in children. BIA is a low cost technique, simple, low variability between observers and between measurements, portable, quick to perform, allowing the monitoring of the subjects and repetition of evaluations.[10] The National Institute of Health Technology Assessment Conference Statement found that BIA is a technique more accurate than BMI and may be more sensitive the skinfold measurement on estimated fat mass.[11,12]

One of the serious complications associated with obesity relates to the effects of insulin resistance that are associated with the fat mass and its location.[13] Studies have shown that the distribution of body fat is a more reliable indicator than BMI for risk factors, diseases and mortality. And particularly, the increase of visceral or abdominal fat is more strongly associated with risk of cardiovascular and metabolic diseases, and chronic pathologies. Thus, more sensitive methods to individual differences in abdominal fat may be more useful than BMI to identify risk factors associated with obesity. The PC is a convenient method to measure abdominal fat because it does not relate to the height, has a good correlation with BMI and total body fat, is associated with risk factors for cardiovascular disease independent of BMI.[13,14] Body weight and BMI do not reflect or body composition or fat distribution. Obesity should be defined as a condition in which there is excess body fat. The co-morbidities are the result of excess fat and not overweight. Currently, adipose tissue has been considered a new endocrine organ that actively synthesize a wide variety of potent bioactive signaling molecules with autocrine functions, paracrine and endocrine. There are differences in the specific site of secretion of some of the molecules produced by adipose tissue that may help explain the large pathogenicity of intra-abdominal fat, however, in general its synthesis appears to be proportional to the total number of adipocytes. Based on all this, it can be argued that efforts should be in order to determine body fat and develop population patterns that allow the comparison between individuals.[15] In recent decades, childhood obesity has reached epidemic proportions in the Western world, and Portugal is the European country with the highest prevalence of this disease, this reaching 31.5% of children aged 7 to 9 years, of which 11.3% refers if obesity.[16]

## Materials and methods population

This was a observational study with the designed cross-sectional.

Data were collected on gender, age, weight, height, PC and BIA.

For the evaluation of the leg-to-leg bioimpedance, we used a Model Tanita® TBF - 300, with sensitivity 0.1% for the percentage of body fat. To determine the height, it used a Portable DRY Stadiometer with sensitivity 0.1cm. For these children measurements had to be barefoot and wearing minimal clothing.

In the evaluation of the PC, we used a flexible tape and non-distensible, with a sensitivity of 0.1 cm. The PC was recorded as the midpoint between the lower limit of the costal margin and the iliac crest.

were calculated and compares the BMI of each student, with the cutoff points of Cole et al.[8] The above classification of body fat according to the cut-off points defined by McCarthy et al.,[4] and for the classification of the PC we used the cutoffs of Moreno et al.[17]

### Statistical analysis

a. In the treatment of the data was used as a statistical tool, the application SPSS (Statistical Package for Social Sciences) version 17.0 for Microsoft Windows®.

b. Descriptive statistical analysis consisted of calculating the average and standard deviation for the cardinal presentation variables and frequencies for nominal variables.

c. The Kolmogorov-Smirnov test was used to determine the normality of the distribution of the different variables. To compare the variables appealed to the Friedman test.

### Target population

The sample consisted of 95 students from the 4th year of the 1st cycle of basic education of Carvalhal Schools, da Costa, of Gandra, Montes da Costa and gravel pits, the Ermesinde parish. These children were part of an Intervention Project to Reduce Childhood Obesity, carried out in the same parish, lasting four years, which began in 2005 and ended in 2009.

## Results

### Sample characterization

Of the 95 students in the study, 56 were female and 39 male.

Figure 1 shows that 53 students were normal weight (34 girls and 19 boys), 30 (14 girls and 16 boys) were overweight and 12 (8 girls and 4 boys) were obese, according to the cutting points defined by Cole et al.[8] Classifying the sample in view of the percentage of body fat, it appears that 53 students (34 girls and 19 boys) had a normal body fat percentage, 17 (7 girls and 10 boys) had excess fat and 25 (15 girls and 10 boys) had obesity (Figure 2–4).

| | Age | BMI | WC | BIA |
|---|---|---|---|---|
| **Girls** | | | | |
| Mean | **9.01** | **18.68** | **64.38** | **25.28** |
| minimum | **8.50** | **12,35** | **50.00** | **5.00** |
| maximum | **9.50** | **26.65** | **85.00** | **39.00** |
| Std. Deviation | **0.36** | **3.21** | **8.50** | **7.00** |
| **Boys** | | | | |
| Mean | **9.18** | **19.49** | **66.91** | **23.54** |
| mininum | **8.50** | **14,35** | **56.00** | **11,90** |
| maximum | **10.00** | **33,60** | **95.00** | **55.90** |
| Std. Deviation | **0.45** | **3.79** | **9.19** | **8.99** |

**Figure 1** Sample gender distribution according to the BMI according to Cole et al.[8]

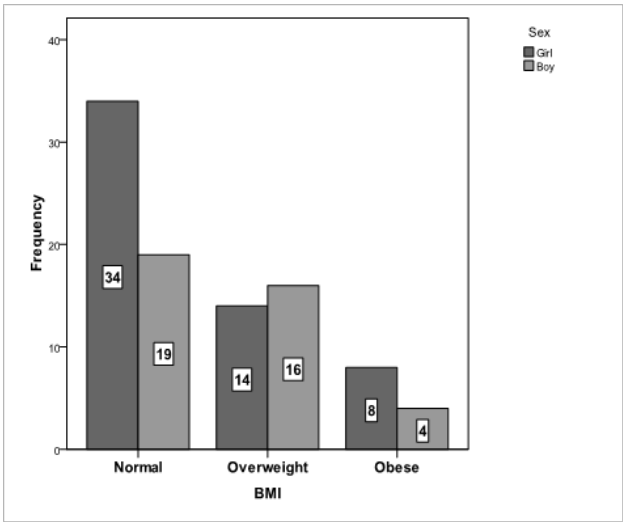


**Figure 2** Distribution of the sample according to the percentage of body fat according to McCarthy et al.[4]

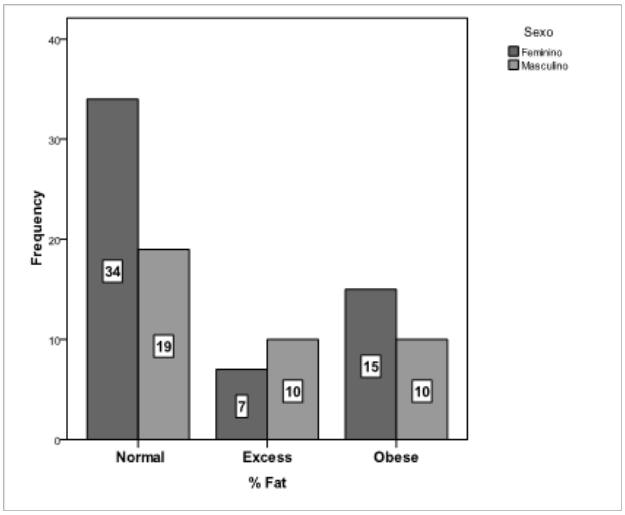


**Figure 3** The sample distribution according percentile PC defined by Moreno et al.[17]

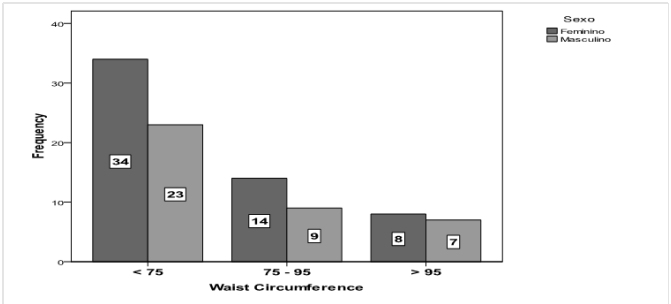


**Figure 4** Comparison sex among the three methods under study.

According to the cut-off points defined by Brown et al.,[17] students (14 girls and 9 boys) presented a pc between the 75th and 95th percentiles, which corresponds to overweight and 23 students (8 girls and 7 men) were greater PC than the 95th percentile, ie obesity. The number of normal weight students is greater according to the PC, the prevalence of overweight is greater according to BMI and obesity proved to be higher according to the BIA.

The application of the Friedman's test to compare the three methods, there was a statistically significant difference ($p = 0.016$). The number of normal weight students is the second largest PC, the prevalence of overweight is greater by BMI and obesity proved higher according to the BIA. The application of the Friedman's test to compare the three methods, there was a statistically significant difference ($p = 0.016$).

## Discussion

According to carried out bibliographical research, it was found that few of research using these three methods to perform the analysis of body composition. In this study, it was observed that BMI and PC underestimated the number of children with respect to the BIA obesity. In this sample we detected a prevalence of obesity and overweight of 44% which is slightly higher than that found by Padez et al.[16] In this study we observed that the method of BMI and BIA the percentage of children overweight and obesity is 44%. While the PC we have 39% of children with overweight and obesity. However, comparing the Obesity and overweight figures for BMI and BIA method we have differences. The BMI identified 30 children with overweight and 12 were obese, while the BIA found 17 overweight and 25 with obesity. In a study of 2152 children of County Hall Ferreira - Portugal, it was found that the similarity of this study BMI underestimates the percentage of obese children compared to the BIA (BMI - 14.2% vs. BIA - 25.4%). However, specifically comparing the BMI and the PC, the last detected a larger number of children with obesity, which is in accordance with the study by Hubert M et al.[3] In this study in Lile (France) in two primary schools, with 122 students from 3rd to 5th year, the following parameters were evaluated: BMI, PC and relationship Height/Waist (AC). The observed data suggested that the PC provides a diagnosis that is equivalent to BMI and higher than AC. However, when compared with BMI or AC, PC is more consistent discrimination of obese and non-obese. The DEXA is considered the reference method for the assessment of body composition in children, being precise and sensitive. Hosking et al.,[13] compared DEXA and BIA evaluation of the body composition of children aged 9 years old. They concluded that the BIA is a high correlation medium and small differences from the DEXA. In addition it is a simple, faster and more economical method is therefore used in epidemiological studies of large scale. Limitations of this study can include the fact that we have not compared all three methods with the DEXA method, however due to the sample size that would not be economically viable.

## Conclusion

In this study there was a statistically significant difference between the methods used ($p = 0.016$).

The BIA was the method that detected a higher number of children with obesity.

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## Conflicts of interest

The author declares that there is no conflict of interest.

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