Transversal Study Describing the Applicability of the Conicity Index in the Age Group of Children

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Abstract

The excess body mass predominantly in the abdominal region of the body, favors the emergence of several diseases among them are dyslipidemias and cardiovascular disorders. In this context, the conicity index (CI) is a viable alternative to indicate abdominal obesity. The objective of this study was to verify if the body mass index (BMI) and the CI have some correlation, and if the children's CI can be inserted in the cutoff range, using its original formula. This was an analytical and descriptive quantitative methodology with a cross-sectional design. Children of both sexes between 9 and 11 years of age participated in this study. Waist circumference-WC (m), height (m) and body mass index (kg) were used as variables for the CI and BMI calculation. After the collection of these variables, the tabulation was performed, and later SAS® Studio statistical software was used to perform the statistical analyzes. Sixty-six children (27 males and 39 females) were evaluated. It was observed that the CI and BMI data do not correlate with each other. However, the values obtained by calculating the 95% confidence interval of the mean of the children are contained in the range 1,00 and 1,73.

Keywords: adiposity; abdominal obesity; children;

1. Introduction

In Brazil, overweight and obesity in children have increased significantly in recent times [1]. For the World Health Organization (WHO), the number of overweight or obese children will increase to 70 million by 2025 ([2]; [3]).

Obesity is defined as too much body fat accumulation in adipose tissue [4], favoring health damage such as depression, dyslipidemia, cardiovascular disease, venous stasis, cancer [5]; [6]; [3], reduced autonomic nervous system functioning on the heart [7] changes in metabolism, respiratory changes, as well as damage to the locomotor system such as arthritis and arthrosis [8], [9].

It is known that fat concentration, especially in the abdominal region of the body (android), is a determining factor for the development of several diseases, especially cardiovascular diseases, dyslipidemia, type 2 diabetes mellitus, as well as changes in renal mechanism. due to the compressor effect [10], [11].

In this context, anthropometric tools are used to assess the body composition of children, as early

identification of overweight or obesity is of paramount importance to prevent future injuries [12].
There are several methods for assessing body composition in children, and currently the Body Mass Index (BMI) is one of the most used to classify obesity, however, this index represents the global mass [13]. In addition to BMI there is another form of analysis, namely waist circumference (WC), which is closely related to visceral adiposity that is of great concern [14], [15], [16].

In the 1990s, the Conicity Index (CI) was developed by Rodolfo Valdez, which represents an indicator of abdominal obesity, and is considered as a great alternative to assess the propensity or not of cardiovascular risks in adults, children and adolescents. makes use of WC [17];[18];[19];[20];[21].

For obtaining CI require routine body measurements such as body mass, height and WC. Its calculation still makes use of a fixed constant 0,109, which results from the root of the ratio between 4π (derived from the deduction of the circumference of a cylinder circle) and the average adult human density of 1050 kg / m^3 [22]. The value when obtained by the calculation can be evaluated by the cutoff point 1,00 to 1,73 (dimensionless value) and values close to 1,73 represent a high indication of potential cardiovascular risks, although when close to 1,00 presents low risk [23].

The standard calculation of the CI makes use of the average density of the adult human being, in this context it can be predicted that its use in the infant age group induces errors in the classification of abdominal obesity.

2. Objective

The aim of this study was to verify whether BMI and CI have any correlation, and whether children's CI may be inserted into the cutoff range using their original adult formula.

3. Material and Methods

3.1 Method

It was a quantitative analytical and descriptive research with cross-sectional design.

3.2 Inclusion criteria and Sample

It was considered as inclusion criteria, male and female children aged 9, 10 and 11 years. It was analyzed 66 children (27 male and 39 female) aged 9 to 11 years.

3.3 Ethical aspects

This study was submitted to the Ethics Committee for Research involving Human Beings and had its approval number (Certificate of Presentation for Ethical Appraisal - CAAE) n°. CAEE 80105217.2.0000.8114, which was approved by Opinion n°. 2442602.

3.4 Procedure

The children were invited through a newsletter delivered to some schools in a municipality in the interior of the state of São Paulo in March 2017, so that their parents and/or guardians could accept and leave a telephone number for later contact to clarify this study.

3.5 Anthropometric variables

In the first phase of the study were collected: CI, BMI, WC and height, for this we used an inelastic tape measure, with extension of 2 meters of millimeter scale, in order to measure the WC in an upright position, becoming tape at the smallest circumference between the ribs and the iliac ridges. To obtain height and body mass, a Welmy Led® anthropometric digital scale with a capacity of up to 200 kg was used, and the children remained in light clothes and without shoes, and in an upright posture to obtain better data.

3.6 Body mass index (BMI) calculation

For the second phase of the study, the objective was to calculate the children's BMI using Equation (1) below:

$$BMI = \frac{BM}{H} \tag{1}$$

where,

BMI – body mass index (kg);
H – height (m).

3.7 Conicity Index (CI) Calculation

For the third phase of the study, CI was calculated and the following variables were used: WC, body mass, height and constant 0.109 applying them in the following mathematical equation: Equation (2) proposed by Valdez (1991):

$$CI = \frac{WC}{0.109\sqrt{\frac{BMI}{H}}} \tag{2}$$

where,

WC – waist circumference [m];
BMI – body mass index (kg);
H – height (m).

3.7 Statistical analysis

After collecting these variables, the data were tabulated using the Excel spreadsheet and, subsequently, the SAS® Studio statistical software was used to perform the statistical analysis of the collected data.

4. Results

Seeking to achieve the intended objectives and based on the proposed methodology, 66 children were evaluated, being 27 boys (40.91%) and 39 girls (59.09%). Initially, the descriptive measures of the variables under analysis were calculated to summarize and describe the data, as shown in Tables 1 and 2 below.

Table 1 used the general data without considering the gender class and age of the individuals in the sample, since an exploratory analysis of the data is considered of paramount importance given a collective approach to the phenomenon under study.

With these results we seek to survey a series of statistics of the same nature, enabling a global view of measures of centrality and dispersion in the variables under analysis, as well as the organization and description for the collected data set. The mode, median and average for the 66 children in the sample highlight that the data are well distributed in each of the 5 variables considered, as highlighted in Table 1.

Table 1. Descriptive statistics of: body mass, height, WC, BMI and CI.

Variable	Minimum	Maximum	Standard deviation	Fashion	Median	Average	95% Confidence Interval for Average
Body mass index (kg)	24,80	55,80	8,27	33,10	39,80	39,34	(37,31; 41,37)
Height (m)	1,28	1,63	0,07	1,37	1,40	1,41	(1,39; 1,43)
WC (m)	53	86	9,29	58	64	66,54	(64,26; 68,82)
BMI	13,81	25,82	3,11	17,63	18,66	19,46	(18,69; 20,22)
CI	1,03	1,46	0,08	1,04	1,14	1,16	(1,14; 1,18)

Legend: BMI: body mass index; CI: conicity index.

Subsequently, in order to seek relationships between genders and ages, as well as to verify the behavior of the phenomenon within these classes, descriptive statistics of data with gender and age separation was performed, as shown in Table 2

Table 2. Descriptive statistics of the data with selection of gender and age

Age	Sex	N	Variables	Minimum	Maximum	Standard deviation	Fashion	Median	Average	95% Confidence Interval for Average
9	F	16	Body mass index (kg)	26	53,90	8,13	-	37,35	37,71	(33,38; 42,05)
			Height (m)	1,32	1,49	0,05	1,32	1,38	1,39	(1,36; 1,42)
			WC (m)	58	82	8,29	58	61,50	65,93	(61,51; 70,35)
			BMI	13,85	24,60	3,45	-	18,36	19,38	(17,54; 21,22)
			CI	1,07	1,28	0,06	-	1,17	1,16	(1,13; 1,20)
	M	12	Body mass index (kg)	27,80	53,30	9,06	27,80	39,15	39,31	(33,55; 45,07)
			Height (m)	1,28	1,47	0,06	1,33	1,37	1,38	(1,34; 1,42)
			WC (m)	54	82	9,56	59	67,50	68	(61,92; 74,07)
			BMI	15,71	25	3,38	15,71	20,77	20,34	(18,19; 22,49)
			CI	1,03	1,25	0,06	1,18	1,18	1,17	(1,13; 1,21)
10	F	18	Body mass index (kg)	27,90	51,30	7,36	31	36,55	38,46	(34,79; 42,12)
			Height (m)	1,30	1,55	0,06	1,37	1,39	1,41	(1,37; 1,44)
			WC (m)	54	81	7,66	54	62,50	63,33	(59,52; 67,14)
			BMI	15,30	23,74	2,49	16,51	19,09	19,11	(17,87; 20,36)
			CI	1,04	1,25	0,05	1,04	1,10	1,11	(1,08; 1,14)
	M	11	Body mass index (kg)	24,80	55,80	9,28	-	43,70	42,76	(36; 52,49)
			Height (m)	1,34	1,63	0,07	1,46	1,46	1,46	(1,41; 1,51)
			WC (m)	53	86,00	10,16	-	68	68,36	(61,53; 75,19)
			BMI	13,81	25,82	3,38	-	20,13	19,77	(17,50; 22,04)
			CI	1,07	1,28	0,06	-	1,14	1,16	(1,11; 1,21)

Legend: N: sample size; F: female; M: male; WC: waist circumference; BMI: body mass index; CI: conicity index.

Since the fashion highlights the maximum frequency in the observed variable, the median represents the most robust statistic among the measures of centrality in the face of the data distribution and the average can be distorted by a small number of extremely high or low values, the fact of these three measures are significantly close, mainly the median and the average, we can assume that there are no discrepancies in the data collected, and this allows us to assume the average as the main parameter for the variables of the phenomenon under study in the scenario of children in general, disregarding the classes gender and age.

However, in the class scenario, there is a controversial behavior to that observed in table 1, in the sense that, with the absence of fashion and a very small number of observations in the classes, although it is still possible to keep the mean as a parameter for the distribution, it is necessary, however, a normality test to find correlations between the covariates considered.

In this line, figures 1 and 2 show the distribution for the variables BMI and CI where the Normal and Kernel curve are drawn in each of them to search for indications that the variables are normally distributed and adopt the relevant tests for the correlation analysis of interest.

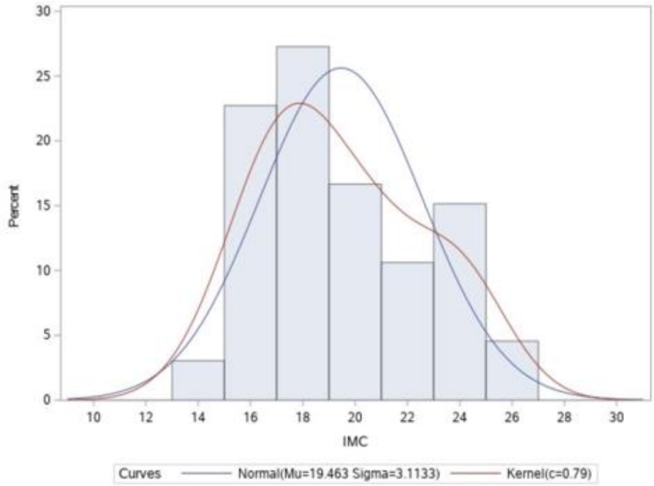

Figure 1: Distribution of the Normal and Kernel curves in relation to the BMI variable.

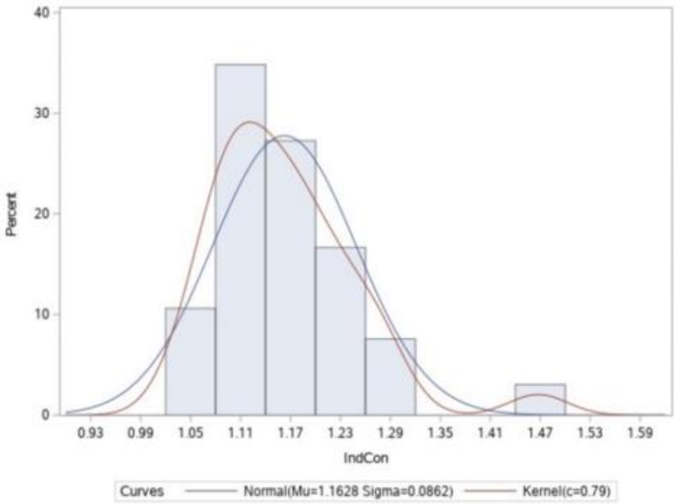

Figure 2: Distribution of the Normal and Kernel curves in relation to the IC variable.

In no case is normality indicated due to the Normal and Kernel curve as they are so distinct and do not follow the plots of the plotted histograms. As a result, normality tests were adopted and compared: Shapiro-Wilk, Kolmogorov-Smirnov, Cramer-von Mises and Anderson-Darling at a level of 5% significance. Through these, it was found that the variables are not normally distributed, given the p-values < 0.05 in each of the variables. Table 3 presents the results of the normality tests for the variables BMI and CI according to the methods adopted.

Table 3: Normality test for the variables BMI and CI.

Test	Test Statistics		p-value	
BMI				
Shapiro-Wilk	**W**	0,960013	**Pr < W**	0,0322
Kolmogorov-Smirnov	**D**	0,120192	**Pr > D**	0,0188
Cramer-von Mises	**W-Sq**	0,140063	**Pr > W-Sq**	0,0328
Anderson-Darling	**A-Sq**	0,875641	**Pr > A-Sq**	0,0238
CI				
Shapiro-Wilk	**W**	0,900343	**Pr < W**	<0,0001
Kolmogorov-Smirnov	**D**	0,09628	**Pr > D**	0,1315
Cramer-von Mises	**W-Sq**	0,165225	**Pr > W-Sq**	0,0158
Anderson-Darling	**A-Sq**	1,224984	**Pr > A-Sq**	<0,0050

Legend**:** BMI: body mass index; CI: conicity index.

In this way, the tests implemented, as well as the confidence intervals for the population means of interest, were obtained using the t-Student test. Then, the BMI and CI variables were taken to check if there is a significant correlation between them. In the case in which the classifications were disregarded, it is observed that under 5% of significance the hypothesis of the two variables is not correlated, that is, they are rejected, since p-value = 0,001 < 0,05 as shown in Table 4 below. However, given the correlation coefficient of 0,39557, there is a positive and weak correlation, as it is greater than 0 and less than 0,5.

Table 4: Pearson's correlation coefficient between the variables CI and BMI.

Statistic (N = 66)	Value
Pearson's Correlation Coefficient	0,39557
p-value	0,0010

Legend: N: sample size.

Then, the correlations between the investigated classifications are presented. Table 5 shows the correlation between genders and Table 6 between ages.

Table 5: Pearson's correlation coefficient between genders and the variables BMI and CI.

Statistic F (N = 39)	Valor
Pearson's Correlation Coefficient	0,22630
p-value	0,1660
Statistic M (N = 27)	**Valor**
Pearson's Correlation Coefficient	0,71930
p-value	< 0,0001

Legend: N: sample size; F: Female; M: Male.

Table 6: Pearson's correlation coefficient between the ages of 9,10 and 11 and the BMI.

Statistic (N = 28) 9 years	**Value**
Pearson's Correlation Coefficient	0,46750
p-value	0,0121
Statistic (N = 29) 10 years	**Value**
Pearson's Correlation Coefficient	0,76109
p-value	< 0,0001
Statistic (N = 9) 11 years	**Value**
Pearson's Correlation Coefficient	0,13143
p-value	0,7361

Legend: N: sample size; F: Female; M: Male.

Table 7 below shows the number of observations, the mean and the standard deviation of the male (M) and female (F) gender in the gender classification of the CI variable. For each class, we then have an average with a margin of error ± $\frac{Standard\ Deviation}{\sqrt{N}}$, respectively, ± 0.015614984 and ± 0.010875907, for female and male children, highlighting that the children's CI are contained in the interval 1,00 and 1,73 as proposed by Valdez et al. (1993).

Table 7. Gender classification of the CI variable.

Gender	N	Average	Standard Deviation
F	39	1,158756	0,09751555
M	27	1,168582	0,06792002

Legend: N: sample size; F: Female; M: Male.

5. Discussion.

Excess body mass in the abdominal region has been the focus of studies to investigate cardiovascular risk [24]. For [25] emphasize that the applicability of BMI is not an accurate identification method for cardiovascular risk, when it is related to obesity. However, CI has been largely correlated with metabolic and cardiovascular risk factors in all age groups [26]; [17]; [25]; [28].

[19] conducted a study in Brazil with 774 children and adolescents of both sexes aged 10 to 14 years, whose objective was to define CI cutoff points to predict changes in the lipid profile, but used the original formula. As for the cutoff points of the CI, according to the same authors, the cutoff point for boys aged 10 to 11 was 1,16, and for boys aged 12 to 14 years it was 1,14. In girls, the cutoff point was 1,14 for the 10-11 year old age group and 1,12 for the 12-14 year old age group.

In the present study, all values obtained by calculating the CI were within the cutoff established by [23] using his standard formula, which indicates that there are no outliers. The mean CI was 1,16 of the total sample without separating gender and age. The values of this study when compared to the study by [19] female children aged 10 and 11 years, the average was 1,11, and 1,28 respectively, being higher at the age of 11 years, this represents that in this study female children aged 11 years have a high risk for lipid changes based on [19]. In male children aged 10 and 11 years, the average was 1,16, and 1,15 respectively.

[29] carried out a cross-sectional study in Salvador, Bahia with 968 adults, aged between 30-74 years old, who proposed cut-off points for CI in adults, being 1,25 for men, 1,18 and 1,22 for women up to 49 and from 50 years of age, respectively.

Analyzing the values obtained in this study and comparing it with the cutoff points suggested for adults, it appears that the mean CI of the children in this study approached the cutoff point suggested for adults, hence the importance of analyzing the formula of the CI to avoid false positives in the classification of abdominal obesity in children.

The BMI evaluates the global body composition, different from the CI, which emphasizes abdominal adiposity, as it uses WC as variables for its calculation. According to [30];[29] BMI is an anthropometric tool that can be obtained quickly, however, factors such as bone tissue, muscle mass and especially the growth phase of children, influence their numerator and consequently their classification, impairing the interpretation to assess obesity and interfering in the correlation between BMI and CI.

6. Conclusion.

Based on the results obtained in the present study, it is concluded that the CI and BMI have no correlation, and values obtained by calculating the 95% confidence interval of the average of the children in this study are contained in the 1,00 and 1,73 intervals using the standard formula. Therefore, further studies are suggested in order to correct the CI formula for children and adolescents in order to compare whether there is a difference in the value to be obtained by the standard and the corrected formula.

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