Proposal of Cut Points for the Indication of Abdominal Obesity among Adolescents

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Abstract

Background: The absence of critical values for the cardiovascular risk identification among Brazilian adolescents represents an important limitation.

Objectives: To prepare critical values for the waist circumference and to analyze its efficiency in indicating increased values of the arterial pressure.

Methods: Transversal study that evaluated 1,145 adolescents, from 11 to 17 years old (536 of the male sex and 609 of the female), their body weight values, stature, resistance, reactance, tricipital cutaneous fold, waist circumference and arterial pressure (n = 334) were collected. The abdominal obesity was indicated by waist circumference values.

Results: The obese adolescents presented higher waist circumference values and, independently of the gender and age group, there was a significant relation between the waist circumference values and all the adiposity indicators adopted in the study. The proposed critical values presented higher sensibility in indicating increased values of the arterial pressure.

Conclusions: The critical values proposed for the waist circumference were more sensitive in the indication of increased values of the blood pressure. However, other studies to investigate their efficacy in the indication of other clinical and laboratorial parameters are still needed. (Arq Bras Cardiol 2009; 93(6):558-563)

Key Words: Overweight; adolescent; abdominal circunference; hypertension; risk factors; adiposity.

Introduction

Throughout the last decades, overweight and obesity (O/B) among scholar population have presented alarming rates of growth[1,2]. Nowadays, this increase represents a severe public health problem, which happens in childhood and adolescence, due to its association with different cardiovascular risk factors[3-5].

In comparison to this expressive increase in the occurrence of O/B, the importance in diagnosing, efficiently, such phenomenon in an epidemiological context was also raised. In this manner, because these values present significant relations with different indicators of metabolic risk[6,7], anthropometric techniques, as the body mass index (BMI) and the waist circumference (WC), used alone or together[7], have been used with great frequency for the detection of the increased cardiovascular risk in this population.

Furthermore, the excess of body fat located in the abdominal region, which can be indicated by WC (central obesity), has higher lipolysis rates and is a more relevant risk factor than general obesity itself[3]. However, in the Brazilian reality – in detriment of the public health problem that the obesity among adolescents population represents – and, differently from what happens with the BMI[8], there are no critical values for specific WC for the Brazilian population. It limits the use of the method isolated or even aiding the own BMI in the indication of the increased cardiovascular risk presence[9].

Thus, the objectives of the present study were two: (1) to propose critical values for the indication of abdominal obesity among adolescents and (2) to test their efficacy in indicating the presence of increased arterial pressure (IAP).

Methods

Sample

The present study has a transversal drawing and it was conducted in two distinct stages, in the cities of Presidente Prudente (2007) and Londrina (2008). In Presidente Prudente (stage I), the data referring to the elaboration of the cut points were collected; in Londrina (stage II), their efficiency was tested by the indication of increased values of arterial pressure.

In Presidente Prudente's city, the sample was composed of 805 individuals and it was calculated to detect an O/B prevalence of 28.5%[10], with a sample error of 3.1%, power of 80% and statistical significance of 5%. Based on data from

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a pilot study, a sample loss of 6% was estimated. Therefore, a collection of information concerning 853 individuals enrolled in five randomly selected private schools (the procedures referring to the selection of the sample were shown in a previous publication)[11] was planned. In the five elected schools, a total of 860 students agreed to participate in the research. They all declared not possessing a diagnosed metabolic disease and returned with the informed consent duly signed by who was responsible for them. Nevertheless, due to absences during the realization of the evaluations, 49 individuals were excluded from the sample (30 males and 19 females). As there were absences in the evaluations, it was not possible to detect the existence of possible differences in the analyzed variables between the excluded group (n = 49) and the studied sample (n = 811). Thus, the sample was composed of 811 adolescents of both genders and with ages varying from 11 to 17 years old (365 of the male gender and 446 of the female).

A more extensive study, carried out in Londrina, indicated a calculus of the sample size of 879 individuals, considering a prevalence of IAP of 10%[12], sample error of 3%, type II error of 80% and significance of 5%. These 879 students were randomly recruited in 12 schools (six private and six public schools, randomized elected), regarding the proportionality of different areas of the county (East, West, North, South, Central and the Peripheral ring). For the realization of the present study, the calculus sample denoted the need of collecting 334 adolescents, those which were randomly selected among 879 analyzed, with ages from 11 to 17 years old (171 male and 163 female) and that participated in this acknowledgment study. The proportion of IAP did not differ between the two sample groups (879 and 334 subjects).

In both cities, the formal consent was obtained from the participants and from the ones responsible for them before the realization of the study; the protocol was approved by the Ethics Research Committee of the Institutions of High School involved in the research.

Anthropometry

In Presidente Prudente and Londrina, the chronological age of the adolescents was determined in a centesimal manner, using the birth date and evaluation day. In the present study, the main anthropometric variables studied were: body weight (Presidente Prudente), stature (Presidente Prudente and Londrina), tricipital cutaneous fold (Dtr) (Presidente Prudente) and WC (Presidente Prudente and Londrina). The body weight was gauged using a digital portable balance, ranking 100 g and maximum capacity of 150 kg. The stature was gauged with the use of a stadiometer of wood, accuracy of 0.1 cm and maximum extension of 2 m. The BMI was calculated dividing the body weight by the squared stature's value (kg/m^2). All the body and stature's measures were done with barefooted individuals, who were wearing light clothes[13].

Dtr's value was used as an indicator of excess of the subcutaneous adipose tissue, being confronted with the use of an adipometer of the brand Lange (Cambridge Scientific Industries, Inc., Cambridge, Maryland, USA), and following the recommendations found in literature[13]. The WC's value was accepted as an excess indicator of the adipose tissue in the abdominal area, and the measures were taken repeatedly in the minimum circumference between the iliac crest and the last rib, using an anthropometric metallic string with accuracy in millimeters (mm)[13].

Bioelectrical impedance

In Presidente Prudente, resistance and corporal reactance (ohm) were checked with a portable analyzer of body composition (BIA Analyzer – 101Q, RJL Systems, Detroit, USA). The equipment was calibrated before the evaluations with the use of a resistor of 500 ohm, provided by the own manufacturer. The bioelectrical impedance analysis (BIA) was carried out in the morning after a fasting night and after the first urine. The procedures happened with the individual laid down in a plane surface of a non-conductor electricity material, and after taking off the shoes, socks or any type of metal which was in the body (earrings, bracelets, necklaces and so on). The electrode transmitters were put in the posterior surface of the right hand, in the distal phalange of the third metacarpus and in the anterior surface of the right foot, in the distal phalange of the second metatarsus, and in at least 5 cm distant of the receptor electrodes, those were put between the styloid process of the radium and the ulna and between the medial and lateral malleolus of the ankle[14].

The percentage of body fat (%GC-BIA) was calculated by the use of two specific equations for the sex, prepared by Sun et al[15]. To indicate the excess of body fat, specific critical values for gender, proposed by Williams et al[16], were used (GC ≥25% for male and GC ≥30% for female).

Indication of the IAP

To check the arterial pressure, an oscillometric equipment of the brand Omron, model HEM-742, previously validated for its use in adolescents[17] was used, with specific cuffs for kids and teenagers, following recommendations of the literature[18]. The arterial pressure was checked in the right arm of the individuals, who had been sitting down for at least five minutes of rest. After a first evaluation of the subjects, two minutes of pause for the realization of a second evaluation were standardized; here on, the systolic (SAP) and diastolic (DAP) arterial pressure values were esteemed by the mean of the two evaluations.

For the determination of IAP, the table recommended by the I Guideline of Atherosclerosis in Childhood and Adolescence[19] was adopted, in which all the subjects who presented value of SAP and/or DAP above the percentile 95 that is recommended for its respective age and stature were considered as porters of IAP.

Elaboration of the cut points for WC (Presidente Prudente)

To elaborate critical values for the WC, firstly, all the subjects were divided according to gender and, thereafter, stratified according to its respective age groups (11 to 17 years old). In a second moment, in both genders and in all the age groups, subjects were again subdivided, now dicotomically, regarding the %GC-BIA (%GC normal and %GC excessive), and each of the WC values' were registered in these two groups.

The scores of WC above the mean values for each of the age groups, composed by individuals with normal values of GC, were adopted as indicators of abdominal obesity.

Statistical analysis

The test of Kolmogorov-Smirnov (K-S) indicated the framing of all the analyzed variables in the Gaussian model of distribution. Hence, the quantitative variables were presented by the mean values and standard deviations. The comparisons between the categorical variables were established by the chi-square (χ^2) test, for a linear association, and the linear correlation of Pearson was used to analyze the relation between the values of BMI, Dtr, %GC-BIA and WC. The ROC curve and, consequently, its parameters (sensibility, specificity, area under curve – AUC) were used to analyze the performance of the proposed critical values for WC, in the indication of increased values of arterial pressure. The analysis was developed with the use of the specific software SPSS, version 13.0 (Statistical Package for Social Science, SPSS Inc, Illinois, USA), and the level of significance used was $p<0.05$.

Results

When the general characteristics of the sample between the genders were compared (Table 1), it was observed that the male sex presented the highest values of BMI and WC. However, the female sex presented the highest median scores of PAD.

Table 2 presents the distribution of the sample according to genders and age groups, as well as the occurrence of obesity in each of them. With regard to the test χ^2 for the linear association, there were no associations with the age and the excess of body fat.

The values of WC for the compound groups for euthrophic and obese people, in both genders, were statistically different in all age groups, in which the obese subjects presented higher values for the WC (Table 3).

Table 1 - Characteristics of the analyzed sample, stratified according to gender

Variables	Gender Male (n = 536)		Gender Female (n = 609)		t	p
	Mean	(SD)	Mean	(SD)		
Age (years)	13.4	2.1	13.7	2.1	-2.18	0.029
Weight (kg)	55.1	15.3	51.5	11.5	4.53	0.001
Stature (cm)	161.4	12.9	158.7	8.6	4.15	0.001
BMI (kg/m^2)	20.8	3.9	20.3	3.6	2.41	0.016
WC (cm)	70.3	10.1	66.3	8.1	7.28	0.001
SAP (mmHg)*	113.3	10.6	112.5	10.3	0.72	0.470
DAP (mmHg)*	61.5	6.8	63.4	7.3	-2.42	0.016

*SD - standard deviation; BMI - body mass index; WC - waist circumference; SAP - systolic arterial pressure; DAP - diastolic arterial pressure; * = 334 adolescents from Londrina.*

Table 2 - Distribution of the sample according to gender, age groups and values of body fat (Presidente Prudente).

Age group	Gender Male		Gender Female	
	n (%)	GC ≥25%	n (%)	GC ≥30%
11 years old	47 (12.7)	14 (29.7)	50 (11.0)	5 (10)
12 years old	48 (13.0)	10 (20.8)	48 (10.8)	4 (8.3)
13 years old	44 (11.9)	14 (31.8)	50 (11.2)	8 (16)
14 years old	63 (17.4)	17 (26.9)	55 (12.4)	2 (3.6)
15 years old	56 (15.5)	08 (14.2)	93 (20.9)	13 (13.9)
16 years old	41 (11.3)	11 (26.8)	62 (13.9)	8 (12.9)
17 years old	66 (18.2)	10 (15.1)	88 (19.8)	13 (14.7)
Total	365 (100)	84 (23.2)	446 (100)	53 (11.9)
	GC x age groups: (χ^2 = 3.513; p = 0.061)		GC x age groups: (χ^2 = 1.169; p = 0.280)	

GC - body fat evaluated by bioelectrical impedance.

Table 3 - Comparison of circumference values of thigh between eutrophic and with body fat excess (Presidente Prudente) adolescents.

Age group	Gender Male		Gender Female	
	Eutrophic	GC ≥25%	Eutrophic	GC ≥30%
	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)
11 years old (WC [cm])	63.4 (5.7)	82 (7.3)*	64.5 (6.1)	81.5 (7.7)*
12 years old (WC [cm])	65.5 (5.9)	78.7 (5.6)*	63.1 (6.4)	89.6 (17)*
13 years old (WC [cm])	68.9 (8.5)	83.1 (5.7)*	63.5 (5.1)	76.8 (7.7)*
14 years old (WC [cm])	68.8 (5.8)	87 (8.1)*	64.7 (4.8)	76.1 (12.5)*
15 years old (WC [cm])	70.9 (5.3)	82.4 (7.6)*	66.1 (5.5)	80 (10.2)*
16 years old (WC [cm])	68.5 (5.2)	86.9 (9.7)*	66.9 (4,2)	83.5 (13.8)*
17 years old (WC [cm])	71.6 (8.5)	87.3 (15.2)*	67.1 (5.1)	79.9 (5.1)*

*difference between eutrophic and excess of body fat ($p < 0.05$); SD - standard deviation; GC - body fat evaluated by bioelectrical impedance; WC - waist circumference.

The correlation coefficients (Table 4) indicate the existence of a positive and significant relation (values oscillating from moderate to high), between BMI, Dtr, %GC-BIA and WC for all the age groups and in both genders, its general coefficients of concomitance were high for the correlation between WC x BMI ($r = 0.88$ and $r = 0.87$, respectively) and WC x %GC-BIA ($r = 0.82$ for both), and moderate for the relation between WC x Dtr ($r = 0.62$ and 0.67, respectively).

In Table 5, it is shown the specific critical values for the gender and age groups proposed by Taylor et al[20] and also those presented in this study. The presented critical values were approximately 10% inferior to the North American ones.

The prevalence of IAP was 11.4%, and did not differ between the genders ($p = 0.719$). For the male sex, there was a significant relation between WC, SAP ($r = 0.29$; $p = 0.001$) and DAP ($r = 0.27$; $p = 0.001$); for the female, there were low correlation values, both for SAP ($r = 0.16$; $p = 0.031$) as for DAP ($r = 0.12$; $p = 0.103$). The efficacy of two critical values for WC to indicate increased values of arterial pressure are shown in Figure 1. For male adolescents, the current proposal was more sensitive in the indication of increased values of arterial pressure than the values proposed by Taylor et al[20]. In counterpart, the values of Taylor et al[20] were more specific than the present proposal. For the female gender, values were similar to those observed in the male.

For both genders, the general coefficients of sensibility and specificity (AUC) were similar.

Discussion

The use of BIA as an indicator of GC is justified by its significant relation with different indicators of adiposity, as well as for its relative efficacy in indicating increased fat values in the Brazilian pediatric population[11]. Besides, the absence of mistakes related to the appraiser shows that this method is a useful instrument to obesity's diagnosis.

In the present study, WC values of the obese subjects were significantly superior to those observed for the euthrophic adolescents. Furthermore, WC presented positive and significant relations with all the adiposity indicators, and this relation is observed independently on the gender and age group. In adolescents, such relation – between WC and different adiposity indicators[7,9,21] or with cardiovascular[22] risk indicators – was noted in previous publications and evidences the importance and the potential of the anthropometric measure, in the detection of the presence of increased cardiovascular risks in this population.

Nevertheless, the existence of linear relations between numerical values are positive indicators, but not definitive, about the application of WC in the indication of the increased cardiovascular risk in this population (for this, critical values must be adopted). Rosa et al[9] recently indicated that the absence of cut points of specific WC for the Brazilian population harms the use of the said method.

Thus, with the objective of comparing the efficiency of critical values proposed in the indication of cardiovascular risk (IAP), critical values for WC were accepted and prepared by Taylor et al[20], they possess relative efficacy in the detection of different clinical and laboratorial parameters related to obesity[21].

The ROC curve analysis indicated that the AUC values were similar in both classifications. But, for they are inferior to the values of Taylor et al[20], the values proposed in this study were more sensitive in the indication of IAP, while the values of Taylor et al[20] were generally more specific.

Hence, the option for the use of more specific or sensitive cut points depends directly on the context in which the method will be engaged. Based on the Brazilian reality – in which it is observed a crescent occurrence of O/B between kids and teenages[1,2] and, consequently, more occurrences of the different components of the metabolic syndrome in this age group[4,5] –, the increased values of sensibility noted for the present proposal constitute an opportunity of diagnosing

Table 4 - Coefficients of correlation between waist circumference and different indicators of body adiposity in adolescents.

	Male (n = 365)			Female (n = 446)		
	WC			WC		
	BMI	Dtr	GC-BIA	BMI	Dtr	GC-BIA
11 years old	r = 0.92	r = 0.94	r = 0.91	r = 0.91	r = 0.78	r = 0.89
12 years old	r = 0.92	r = 0.77	r = 0.90	r = 0.92	r = 0.77	r =0.90
13 years old	r = 0.80	r = 0.75	r = 0.79	r = 0.80	r = 0.75	r = 0.79
14 years old	r = 0.94	r = 0.72	r = 0.90	r = 0.94	r = 0.72	r = 0.90
15 years old	r = 0.87	r = 0.69	r = 0.79	r = 0.87	r = 0.69	r = 0.79
16 years old	r = 0.93	r = 0.58	r = 0.89	r = 0.93	r = 0.58	r = 0.89
17 years old	r = 0.84	r = 0.59	r = 0.73	r = 0.84	r = 0.59	r = 0.73
Total	r = 0.88	r = 0.62	r = 0.82	r = 0.87	r = 0.67	r = 0.82

r - correlation coefficient; BMI - body mass index; Dtr - tricipital cutaneous fold; WC - waist circumference.

Table 5 - Critical values for the indication of abdominal obesity between adolescents, specific for the gender and age (Presidente Prudente).

	Abdominal obesity (WC [cm])						
MALE	**11 years old**	**12 years old**	**13 years old**	**14 years old**	**15 years old**	**16 years old**	**17 years old**
Taylor et al.[17]	≥72.4	≥74.7	≥76.9	≥79.0	≥81.1	≥83.1	≥84.9
Local proposal	≥63.5	≥65.6	≥69.0	≥68.9	≥71.0	≥68.6	≥71.7
Difference (%)	-12.3	-12.2	- 10.3	- 12.8	- 12.4	-17.4	-15.5
FEMALE	**11 years old**	**12 years old**	**13 years old**	**14 years old**	**15 years old**	**16 years old**	**17 years old**
Taylor et al.[17]	≥71.8	≥73.8	≥75.6	≥77.0	≥78.3	≥79.1	≥79.8
Local proposal	≥64.6	≥63.2	≥63.6	≥64.8	≥66.2	≥70.0	≥67.2
Difference (%)	-10.0	-14.3	-15.8	-15.8	-15.4	-11.5	-15.8

WC - waist circumference.

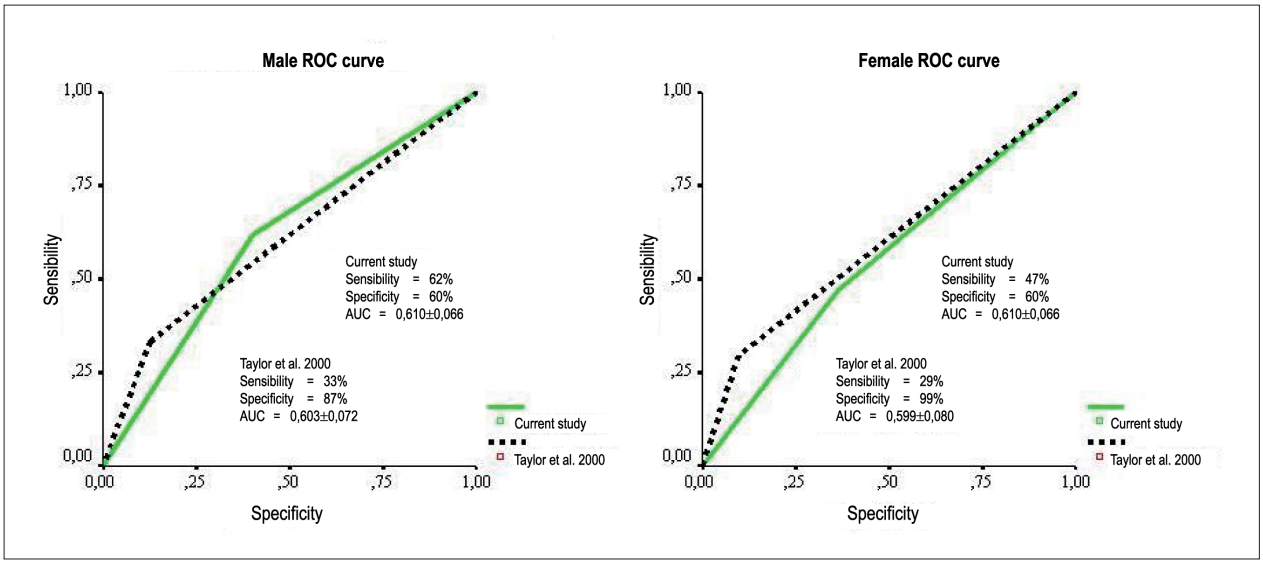

Figure 1 - *Sensibility and specificity of the waist circumference values in the indication of the IAP between adolescents in the city of Londrina, state of Paraná.*

the abdominal obesity, even more precocious in clinical environment and, in the same way, the misdeeds associated with its presence.

These values for the WC must be treated as a reference by health professionals and, based on the accentuated sensibility values, may be used with higher efficiency in the detecting teenagers in risk. Such findings acquire relevant importance, once there are no specific critical values of thigh for the Brazilian adolescent population, as already shown recently in literature[23].

The main limitations of the present study need to be pointed out. The Brazilian population presents an enormous miscegenation; its development is strongly influenced by the socioeconomical variables. The use of a compound sample by adolescents of private schools (President Prudente) to prepare these values makes uncertain its efficacy in the indication of clinical parameters in other populations, indicating, therefore, the necessity of analyzing such characteristics in populations of other areas of the country.

Thus, in future investigations, it will be important to detach the need of assessing the properties of these critical values in the detection of more risk indicators to the health of kids and Brazilian teenagers.

Conclusions

Based on the present results, it can be concluded that the critical values for WC proposed in the current study presented a high predictive value, when indicating the presence of IAP. Besides, before it can be used in an ample scale, future investigations analyzing other characteristics related to the detection of clinical and laboratorial parameters of such critical values are necessary.

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