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**Association Between Indicators of Corporal Adiposity and Cardiovascular Risk Factors Among Brazilian Adolescents**

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**ABSTRACT**

**Dantas MGB, Morais PAO, Silva TFA, Carvalho FO, Schwingel PA.** Association Between Indicators of Corporal Adiposity and Cardiovascular Risk Factors Among Brazilian Adolescents. **JEPonline** 2013;16(6):69-78. Obesity is currently an extremely large health problem. It affects individuals of all ages, especially the pediatric population. The purpose of this study was to compare blood pressure (BP) in a sample of adolescent students with body fat measured by body mass index (BMI) and body fat percentage (BF%) to verify if an increased waist circumference (WC) is associated with cardiovascular risk. The subjects consisted of 214 females and 86 males between 12 and 17 yrs of age. Height, body mass, waist circumference, and skinfold measurements were used to estimate the percent of adipose tissue. The results showed that females classified with excessive weight and a WC percentile >90 displayed higher BP compared to females with normal weight and a WC percentile <10. However, among the males the results did not demonstrate a similar association between body fat levels (BMI and WC) and BP.

**Key Words:** Blood Pressure, BMI, Waist Circumference, Skinfolts

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## INTRODUCTION

Obesity is a big health problem and it is getting worse. It reaches individuals of all ages and social classes with an increased prevalence in the pediatric population (6). Such a substantial public health problem merits special attention, especially considering the harmful physiological effects on health and quality of life (6). Health risks linked to obesity include heart disease, hypertension, dyslipidemia, cancer, and type 2 diabetes. These comorbid conditions result in a significant increase in the risk of many chronic physical and mental illnesses (17,23,35).

Prevention and treatment of obesity and associated diseases should begin during childhood and adolescence to avoid significant health and economic consequences during adulthood (11,20,41). The methods used to define obesity include body mass index (BMI) (7,19,23,35) and the body fat percentage (BF%) (35). The measurement of BMI is most often used to determine obesity. It is calculated by dividing total body weight in kilograms by the square of height in meters ( $\text{kg}\cdot\text{m}^{-2}$ ) (40).

The classification of obesity by BF% is a more accurate analysis of body composition, thus it appears to be more suitable for evaluating cardiovascular risk (15,39). The BF% analysis can be performed by bioelectrical impedance or anthropometric methods, including the evaluation of skinfolds (also known as the pinch test). The waist circumference (WC) evaluation is also used to estimate body fat. It is considered superior to the BMI method in the prediction of risk of cardiovascular disease (CVD) and systemic arterial hypertension (SAH) (23-25).

In Brazil, studies that relate these methods with blood pressure (BP) are still rare. Guimarães et al. (22) studied 319 male and female subjects between 11 and 18 yrs of age. They reported a significant association of weight gain and abdominal fat concentration with high blood pressure in both males and females. Their finding corroborates other studies (6,7,19,22,24,39) that indicate higher BMI and WC are good predictors of the risk of developing SAH among adolescents.

It is consistently observed that BF% (the amount of fat in the body) is linked to SAH. In fact, Carvalho and colleagues (10) reported that children and adolescents with a high BF% had elevated levels of systolic blood pressure (SBP), diastolic blood pressure (DBP) and mean arterial pressure (MAP). A higher WC was also considered an important predictor of cardiovascular risk.

Considering the importance of realizing further studies for evidence of an association between blood pressure and malnutrition or obesity, the purpose of the present study was to examine MAP in a sample of adolescent students in the city of Petrolina-PE classified with low, normal, and excessive weight (as evaluated by BMI and body fat obtained by skinfold measurements). Also, it was important to verify whether an increase in WC was associated with cardiovascular risk in this population, while observing which of the methods are more accurate in indicating increased cardiovascular risk.

## METHODS

### Subjects

The study consisted of a cross-sectional sample of 300 adolescent subjects 12 to 17 yrs of age. All subjects attended the Escola de Aplicação Professora Vande de Souza Ferreira of the Universidade de Pernambuco in the city of Petrolina, Pernambuco, Brazil.

The sample was voluntary. The minimum number of subjects required for this study ( $n = 158$ ) was calculated by WinPepi (1), given consideration of the total population of adolescent students at the school ( $n = 800$ ), bilateral statistic with an alpha of 5%, power of 80%, estimated proportion of

adolescents in the northeast region of the country with anthropometric profile considered outside the adequate levels (10.8%), standard error of 5%, and 20% for no-shows and refusals (2). All potential subjects who did not turn in the Terms of Consent dated and signed by a responsible party were excluded from the study, as well as those who related use of medication to control blood pressure or medications that would alter the measurement of blood pressure.

Data collection was performed by a team of trained professionals from the Research Laboratory for Musculoskeletal Rehabilitation and Women's Health at the Universidade de Pernambuco (LAPRESM-UPE). Evaluations were held at the school site in closed rooms with a previously planned schedule during the morning school session. The study was conducted in accordance with resolution 196/1996 of the National Council of Health. It was approved by the Committee of Ethics in Research at the Universidade de Pernambuco, UPE, under protocol number 0255.097.000-00.

### **Height, Body Mass, and BMI**

Height was measured using a portable scientific stadiometer (Seca, Hamburg, Germany). Total body mass was measured on a calibrated W200/5 digital scale (Welmy Indústria e Comércio Ltda., Santa Bárbara d'Oeste – SP, Brazil). All measurements were performed in triplicate from which the calculated average value was used. Kinanthropometric examinations were performed in accordance with the standards of the International Society for the Advancement of Kinanthropometry (ISAK) (27). All subjects were measured and weighed without shoes. Body mass index (BMI) was determined by body mass (kg) divided by the square of height (m<sup>2</sup>). The classification of adolescents of normal weight and excess weight (overweight/obese) was performed using specific cut-off points for age and gender as proposed by Cole and colleagues (12).

### **Skinfolds, Fat Percentile, and Waist Circumference**

The skinfold thickness of triceps and calf was measured following the standards of ISAK (27). Three readings were obtained at each anatomical point in a rotational pattern. All measurements were performed by a single experienced and trained examiner using Lange® skinfold calipers (Beta Technology Inc., Santa Cruz, CA, United States) with a precision of 0.5 mm. The sum of the skinfolds was used and the estimate of the percentage of body fat was obtained using the equation established by Slaughter et al. (38). The subjects were classified into low, medium, and high fat percentiles according to the cut-off points proposed by Deurenberg et al. (14).

Waist circumference was measured with a metallic inextensible tape measure (Sanny São Bernardo do Campo, SP, Brazil) with 0.1 cm precision according to Callaway and colleagues. (9). An experienced examiner performed the procedure. The cut-off points were established in the 10th percentile (P10) and 90th percentile (P90) of the study, divided by sex. Individuals with a waist circumference below the threshold were identified as P<10, and those above the threshold as P = 90, while the other subjects were designated as P<90.

### **Blood Pressure**

All BP measurements were performed using an analogue sphygmomanometer (Indústria Bic de Aparelhos Médicos Ltda., Itupeva, SP, Brazil) with manual air inflation and deflation and a Littmann® stethoscope (3M, St. Paul, MN, USA). The device measures oscillometric BP with pressure varying between 0 and 280 mmHg. Before measuring the subjects were asked to sit in a comfortable chair and remain at rest for 10 min. It was previously recommended to all subjects that they not engage in vigorous physical exercise 48 hrs prior to the measurement. They were told not to drink caffeinated beverages or use alcohol 24 hrs prior to measuring BP and to sleep at least 8 hrs the night before the exam.

All measurements were performed under similar conditions in the same place and position with the left arm raised to the midpoint of the sternum, the left palm turned upwards and resting on a table. The subjects' feet were touching the floor with the ankles touching the legs of the support chair.

### Statistical Analysis

Initially, the homoscedasticity and normality of the data were verified using the Kolmogorov-Smirnoff test. Before confirmation of a non-parametric distribution, descriptive statistics were performed to characterize the sample. Categorical data were presented in absolute and relative frequencies. Mann-Whitney and Kruskal-Wallis tests were used for the analyses. Data were processed using the Statistical Package for Social Sciences (SPSS), version 16.0.2 for Windows (SPSS Inc., Chicago, Illinois, USA). All tests were two-tailed. Statistical significance was set at  $P \leq 0.05$ .

## RESULTS

Table 1 shows the median and interquartile range of anthropometric data, physical characteristics and hemodynamics of the sample. Significant differences were found between the sexes in height, SBP, MAP, and BF%. As for anthropometric differences, males tended to be taller than females, while the females showed a greater BF%. Systolic blood pressure and MAP were significantly elevated in males versus females.

**Table 1. General Characteristics of the Sample (n = 300).**

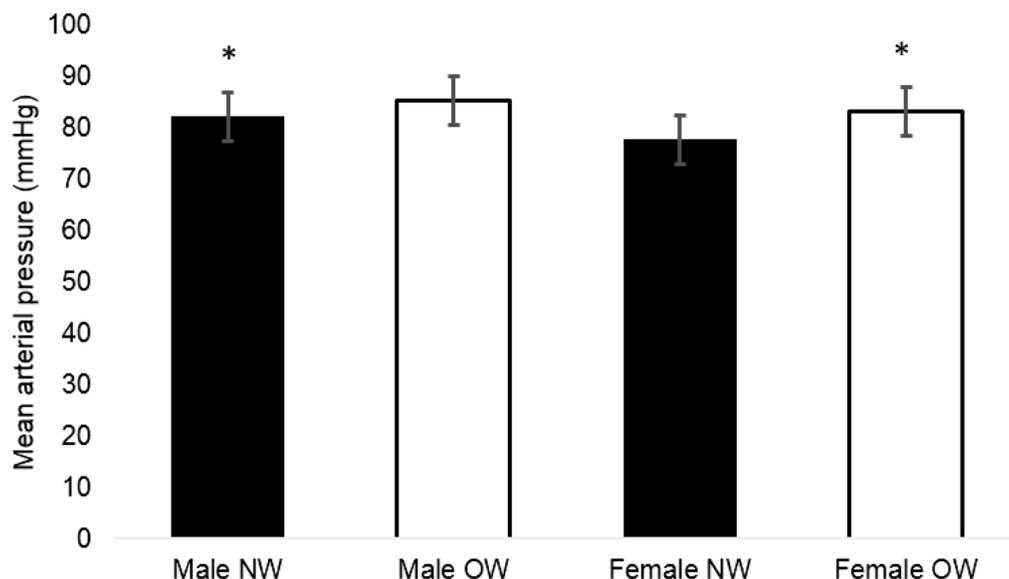
	Males (n = 86)		Females (n = 214)		P
	Median	(IQR)	Median	(IQR)	
<b>Age</b> (yrs)	14	(13-15.7)	13	(13-15)	0.0866
<b>Body mass</b> (kg)	52.58	(42.9-63.3)	48.68	(43.3-55.5)	0.0570
<b>Stature</b> (cm)	165	(157-171)	158.5	(154-162.5)	<0.0001*
<b>BMI</b> (kg·m <sup>-2</sup> )	18.9	(17.3-21.9)	19.15	(17.8-21.3)	0.4663
<b>SBP</b> (mmHg)	110	(100-120)	100	(100-110)	<0.0001*
<b>DBP</b> (mmHg)	70	(60-80)	70	(60-70)	0.0136
<b>MAP</b> (mmHg)	83.3	(74.2-86.7)	76.6	(73.3-83.3)	0.0004*
<b>Body Fat</b> %	18	(13.3-21.4)	24.3	(21-27.6)	<0.0001*

**BMI** = body mass index; **SBP** = systolic blood pressure; **DBP** = diastolic blood pressure; **MAP** = mean arterial pressure

From the cut-off points adjusted for age and sex, the subjects were distributed into groups of normal and excessive weight according to BMI. Among the males, 16.28% of the sample was considered overweight while 1.16% was considered obese. Among the females, the overweight group consisted of 15.42% of the study while 1.40% was considered obese.

The MAP values for males and females classified as normal or overweight according to the BMI cut-off points are shown in Figure 1. The average MAP of the group of males with normal BMI was  $82.22 \pm 9.99$  mmHg while in the group of overweight males the average MAP was  $85.48 \pm 8.01$  mmHg. The difference between the two groups was not statistically significant. However, among the females, the overweight group showed average MAP values statistically higher ( $P < 0.01$ ) than the group classified with normal weight ( $83.24 \pm 8.31$  mmHg vs.  $77.77 \pm 8.14$  mmHg, respectively). Comparisons between

the sexes revealed a difference between individuals classified with normal BMI. The male normal weight group had statistically higher MAP values than the female normal weight group ( $P < 0.01$ ).



**Figure 1. Mean Arterial Pressure Values for Males and Females Classified in Normal Weight (NW) and Overweight (OW) According BMI Cut-off Point.**  
\* $P < 0.01$  to females with NW.

Table 2 shows an analysis of blood pressure by sex and as a function of body fat level measured by skinfolds of the triceps and calves. There was no difference between SBP, diastolic blood pressure (DBP), and MAP between the medium and high fat percentage groups of the same sex.

**Table 2. Comparison of Blood Pressure in Different Levels of Body Fat Divided by Sex.**

	SBP	DBP	MAP
<b>Males</b> (n = 86)			
<b>Average</b> (n = 48)	110 (100-110)	70 (60-80)	83.3 (73.3-86.7)
<b>High</b> (n = 38)	110 (100-120)	70 (60-80)	83.3 (80.0-90.0)
<b>Females</b> (n = 214)			
<b>Average</b> (n = 91)	100 (100-110)	60 (60-70)	76.7 (76.3-80.0)
<b>High</b> (n = 123)	100 (100-110)	70 (60-70)	80.0 (75.3-85.8)

The MAP values for both sexes (divided according to cut-off points for waist circumference of 90th percentile and 10th percentile) are presented in Table 3. Average MAP for males with waist circumference greater than P90 was  $88.14 \pm 8.01$  mmHg, for males with WC less than P10 it was  $76.24 \pm 8.24$  mmHg, and  $82.80 \pm 9.74$  mmHg was the mean for the subjects whose WC fell between the 10th and 90th percentiles. There was no statistical difference between the groups. Females with waist circumference less than P10 showed MBP values of  $73.78 \pm 7.15$  mmHg, which was statistically different ( $P < 0.05$ ) from the values found in the group with WC over P90 ( $82.71 \pm 7.72$  mmHg).

## DISCUSSION

The primary objectives of the present study were to: (a) verify MAP values in adolescent male and female subjects and, then, classify the subjects according to low weight, normal weight, and overweight as evaluated by MBI and by percent body fat; (b) determine whether a greater WC was associated with an increase in cardiovascular risk in this population; and (c) observe which of these methods is more precise to indicate greater cardiovascular risk among adolescents.

While the association between indicators of adiposity and cardiovascular risk factors among Brazilian adolescents is little discussed, it is clear that adequate strategies must be developed so that future risk of developing cardiovascular disease in these adolescents can be avoided. As such, studies of this type are important and necessary.

Percentage of body fat (BF%), BMI, and WC are commonly used measurements of adiposity in clinical and epidemiological studies (6,16,19,23,30). The World Health Organization recommends use of BF% for obesity diagnoses in children and adolescents regardless of the limitations of its use, such as the possibility of intra- and inter-evaluator variation and the cost of equipment. This method is recommended as long as it is performed by a professional with specific training (31), which was the case in this study. While differences in research methods are to be expected, for the most part they reflect the individual characteristics of body fat distribution (8,28,37).

The higher blood pressure finding in the present study (i.e., SBP and MAP significantly higher in males vs. females) resembles that found in a recent study by Serrano et al. (36) while differing from the data found by Corseuil et al. (13) and Rosa et al. (34) who found greater prevalence of high blood pressure (and hypertension) among females. Apart from this subtle point, prevalence of overweight individuals was greater in the females, as Carvalho et al. (10) indicated in a study showing higher percentages of fat in women and girls. Interestingly, this greater percentage of females with excess weight diverges from international (3,32,33) and national (13,21) findings, where a higher prevalence among male adolescents is indicated. These findings indicate that the prevalence of obesity or hypertension between the two sexes varies according to the population that is analyzed.

Studies indicate that BF% determined by skinfolds is an important predictor of body fat levels, and show an association between high fat percentages and high levels of blood pressure as well as hypertension in the pediatric population (10,18,36). However, the present study did not verify an association between high levels of body fat and MAP, indicating BF% as a possibly questionable method when used in relation to cardiovascular risk factors. This could be explained by the lack of standardization of skinfold measurements, the equations used, and the cut-off points for classification in low, medium, and high body fat percentage, thus creating possible discrepancies between studies.

Various studies (7,11,15,19,23,30,37,39) disagree about the impact of excess weight and body fat on elevated blood pressure in children. Guimarães et al. (22) evaluated the blood pressure and BMI data of 536 adolescents between 11 and 18 yrs of age and concluded that with each increased unit of BMI there was an increase of 1.198 mmHg in SBP. In the present study, the group of overweight females showed an average increase of 5.47 mmHg in MAP, and in the group of overweight males (although not statistically significant), there was evidence of an increased trend of 3.6 mmHg in pressure.

Waist circumference is a convenient measurement of abdominal adipose tissue that is not related to height and, at the same time, remains closely related to BMI, although it is independently associated with cardiovascular risk factors (29). Carvalho et al. (10), Guimarães et al. (22) and Aounallah-Skhiri et al. (4) verified a significant association between WC and elevated pressure values. This fact makes

the evaluation method an important indicator of cardiovascular risk, which should be included in epidemiologic and clinical practice so as to help avoid the progression of adolescent cardiovascular disturbances into adult life.

### Limitations of this Study

Both BMI and WC were found in the present investigation as indicators of future cardiovascular risk in only the female subjects. However, it is important to acknowledge that this finding may be associated with the low prevalence of adolescent males (28.7%). Another possible limitation of the present study is the absence of information about family history with regards to hypertension, given that this variable is a strong predictor of high blood pressure (5). In view of these points, population-based studies with equivalent samples of adolescents of both sexes should be undertaken, as well as efforts to standardize the application of tests such as the measurement of fat percentage using skinfolds.

### CONCLUSIONS

The fat percentages measured showed no differences in cut-off point with blood pressure values in adolescents. Waist circumference and body mass index were found to be more accurate indicators of cardiovascular risk in the adolescent subjects, although this finding was observed only in the female subjects (where the pressure increase was associated with girls classified as overweight).

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