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# The Relationship of Body Fat Indicators with Cardiovascular Risk in Adolescents with Low Socioeconomic Status

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## ABSTRACT

**Carvalho FO, Oliveira WA, Carneiro MVO, Moraes JFVN, Moreira SR, Campbell CSG**. The Relationship of Body Fat Indicators with Cardiovascular Risk in Adolescents with Low Socioeconomic Status. **JEPonline** 2012;14(3):19-29. Increased body fat is considered an independent risk factor in developing cardiovascular diseases, especially systemic arterial hypertension (SAH). However, little is known about this subject in the adolescent population of low socioeconomic status. Therefore, the purpose of this study was to compare the blood pressure (BP) values in adolescents of low socioeconomic status with different relative body fat and verify if an increased waist circumference (WC) is associated with cardiovascular risk. The subjects consisted of 149 adolescents (85 boys and 64 girls) aged 11 to 16 from the city of Ceilândia, Distrito Federal, Brazil. Body mass, stature, and skinfold thickness were measured to estimate body fat percentage (BF%). Shapiro-Wilk's Test confirmed the normality of data and descriptive statistics were performed to characterize the sample. Comparison between body fat and sex was performed through a one-way ANOVA with Scheffe's *post-hoc*. WC above average was considered when the volunteer presented a value above the 90th percentile of the sample with the same sex. Statistical significance was set at P=0.05 and the software used for data analysis was the SPSS v.13.0. Results showed that for both sexes the adolescents with high and average BF% presented higher BP when compared to the subjects with low BF%. High BF% adolescents also presented higher BP when compared to the subjects with average BF%. Lastly, an association between increased WC and BP was found. Therefore, we concluded that body fat indicators (BF% and WC) presented significant associations with BP in adolescents of both sexes with low socioeconomic status.

**Key Words**: Blood Pressure, Low Socioeconomic Status, Waist Circumference

## INTRODUCTION

In the last decades, the adoption of obesogenic behaviors has impaired not only adults but especially children and adolescents from several countries in the world (26). In Brazil, there seems to be a trend of an increase in the body mass index (BMI) values of the youth population over the years (6). One reason for this increase is due to the bad feeding habits (4). Also, a sedentary lifestyle and the excessive intake of low nutritional value meals have contributed to the increase of the incidence of chronic-degenerative diseases in the pediatric population (9,33,44). Hence, children and adolescents who do not have healthy habits of eating the right foods and exercising frequently have a higher probability of becoming sedentary adults (21).

Increased body fat is an independent risk factor for cardiovascular diseases, especially systemic arterial hypertension (SAH) (12). This reality has come to the attention of numerous researchers (17,18,23,35,38,39) involved with health and exercise, particularly since it involves an increasing number of individuals of different ages in both developed and developing countries (such as Brazil where a significant part of the population can be characterized as low income). Studies with the purpose of clarifying the associations between cardiovascular risk and body adiposity indicators in low socioeconomic status adolescents are necessary in order to develop future strategies to prevent diseases in the adult life.

Even though the prevalence of SAH in children is generally considered as low (<5.0%) (43), the mean blood pressure (BP) values found from the NHANES III (1988-1994) to the NHANES (1999-2000) revealed an increase in the mean systolic blood pressure (SBP) of 1.4 mmHg, and of 3.3 mmHg in the mean diastolic blood pressure (DBP) in children and adolescents aged 8 – 17 (30). According to Whelton et al. (45), throughout time, a small variation of 2 mmHg in DBP can result in a 17% increase in the prevalence of SAH. Moreover, BP values above average during childhood suggest a higher chance of SAH and cardiovascular disease in the adult life (15). Therefore, it is important to monitor and control BP during childhood and adolescents.

Christou and colleagues (12) showed that body fat percentage (BF%) and waist circumference (WC) are independent risk factors to cardiovascular disease when compared to cardiovascular fitness. Moreover, WC has been widely used in studies, since it is a simple, inexpensive and easily applicable indicator of cardiovascular and metabolic risk in the adult and youth population. Therefore, the purpose of this study was to compare the blood pressure (BP) values in adolescents of low socioeconomic status with different relative body fat and verify if an increase in waist circumference (WC) is associated with cardiovascular risk.

## METHODS

### Sample

One hundred and forty-nine adolescents aged between 11 and 16 yrs, residents of Ceilândia, Distrito Federal, Brazil, who took part of a social project called *Projeto 2º Tempo*, participated in this study.

Data collection was performed during the subjects' school period. Socioeconomic status was verified using a questionnaire developed by Associação Brasileira dos Anunciantes/Associação Brasileira de Institutos de Pesquisa de Mercado (ABA/ABIPEME) and adapted by Almeida and Wickerhauser (2). The questionnaire's classification scale was divided into five categories (A, B, C, D, and E) according to the parents' education and family commodities. In order to participate in the study, the parents and/or guardians signed a consent form that explained the procedures, possible risks, and benefits. The study was approved by the Ethics Committee of the Federal University of Vale do São Francisco – UNIVASF, under the protocol number 08121001/2010.

**Body Mass, Stature and Body Mass Index Measurements**

Body mass was measured using a digital scale (IPLENNA, model 60420072266, Taichung City, Taiwan) with a 500 g precision. Stature was determined using a wooden stadiometer with a 2 mm precision, according to the procedures described by Gaya and Silva (20). All subjects were measured and weighed without shoes. Body mass index (BMI) was determined by the body mass (kg) divided by the stature$^2$ (m).

**Skinfold Thickness, Body Fat Percentage and Waist Circumference**

Triceps (TRI) and subscapular (SS) skinfold thickness were measured following the procedures described by Harrison et al. (26). Three measurements were obtained at each anatomic point in a rotational pattern. All measurements were performed by one experienced evaluator using a skinfold caliper (Lange, Beta Technology Incorporated), with a 0.5 mm precision. The sum of the skinfolds was used (SEDC) and estimation of body fat percentage was obtained using the Slaughter's et al. equation (42). Waist circumference was measured using a metric inextensible metallic tape (Sanny) with a 0.1 cm precision, as instructed by Callaway et al. (8). This procedure was performed by one experienced evaluator. A cutoff point was established at the 90th percentile (P90) of the sample, divided by sex. The subjects with waist circumference above the cutoff were identified as P=90, while the subjects below the cutoff point were designated as P<90.

**Blood Pressure (BP)**

The BP measurements were performed using a digital electronic measurement device (Omron, HEM 742) with an automatic inflation and deflation of air. The device measures BP trough oscillometry with pressure varying between 0 and 280 mmHg. It is validated for adolescent use (11). In addition, two type of arm cuffs were used according to the circumference of the arm (6 x 12 mm: kids size – 11 to 13 yrs; and 9 x 18 mm: adolescent size – 14 to 18 yrs of age, and for the subjects younger but with a body structure similar to a 14 to 18 yr old adolescent), following the specifications established by the American Heart Association (36). Before the measurements were taken, the subjects remained seated in a comfortable chair resting for 10 min. All measurements were performed in similar conditions, in the same place and position, with the left arm raised to the mid-point of the sternum. The palm of the left hand was turned upwards and laying on a table. The feet were touching the floor, and the ankles were touching the chair's support feet. All subjects were asked not to engage in any vigorous exercise the day before the measurements and urinary continence was to be avoided before the BP measurements.

**Statistical Procedures**

Shapiro-Wilk's Test was performed in order to verify data distribution. With the normality of data being confirmed, descriptive statistics were carried out to characterize the sample. Comparisons between body fat percentage and sex were performed using a one-way ANOVA and Scheffe's *post hoc*. Differences in BP between groups above and below waist circumference's 90th percentile were assessed by a two-way ANOVA followed by Scheffe's *post hoc*. Statistical significance was adopted as P=0.05. Data were processed using the Statistical Package for the Social Sciences (SPSS), version 13.0 for Windows.

## RESULTS

Table 1 presents the physical and hemodynamic characteristics of the sample. Significant differences between sexes in stature and body fat percentage were found. In stature, boys were significantly taller than girls, while girls had higher body fat percentage when compared to boys. Also, both sexes presented higher mean body fat percentage and body mass index for their age and gender.

**Table 1. General Characteristics of the Sample (n=149).**

| | Boys (n=85) | Girls (n=64) | *p* |
|---|---|---|---|
| **Age** (years) | 13.1 ± 1.2 | 13.2 ± 1.2 | 0.784 |
| **Body mass** (Kg) | 53.1 ± 8.7 | 51.7 ± 9.4 | 0.349 |
| **Stature** (m) | 1.60 ± 0.10 | 1.57 ± 0.08 | 0.018* |
| **BMI** ($kg/m^2$) | 20.5 ± 2.5 | 20.9 ± 3.3 | 0.345 |
| **SBP** (mmHg) | 110.9 ± 14.6 | 108.0 ± 13.2 | 0.205 |
| **DBP** (mmHg) | 64.5 ± 9.2 | 65.4 ± 9.3 | 0.567 |
| **MBP** (mmHg) | 80.0 ± 10.2 | 79.6 ± 9.7 | 0.811 |
| **Body Fat** % | 20.4 ± 8.5 | 27.7 ± 7.0 | < 0.001* |

BMI=body mass index; SBP=systolic blood pressure; DBP=diastolic blood pressure; MBP=mean blood pressure; *P=0.05.

The analysis of blood pressure based on the levels of body fat is expressed in Table 2. In both sexes, adolescents with high body fat percentage presented significantly higher SBP, DBP, and MBP values when compared to the subjects with low body fat percentage. Moreover, in both sexes, the subjects who presented high body fat percentage also presented significantly higher DBP and MBP values when compared to the subjects with average body fat percentage. Lastly, subjects with average body fat percentage showed higher SBP, DBP and MBP when compared to the subjects with low body fat percentage. Even though this was not the main objective of the study, it is worth highlighting that in the groups with average and low body fat percentage, the percentile of SBP and DBP was around 50 for both sexes. On the other hand, the subjects with a high body fat percentage presented SBP and DBP percentiles of around 75 and 64 for boys, and 67 and 58 for girls, respectively, according to the National Heart, Lung and Blood Institute (HHLBI) (32,34). No differences between sexes were found in this analysis.

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

| | **BOYS (n=85)** | | |
|---|---|---|---|
| | **Low (n=11)** | **Average (n=18)** | **High (n=56)** |
| **SBP** (mmHg) | 103.1 ± 12.4 | 109.5 ± 15.6* | 112.9 ± 14.3* |
| **DBP** (mmHg) | 58.7 ± 9.3 | 61.5 ± 9.8* | 66.6 ± 8.4*# |
| **MBP** (mmHg) | 73.5 ± 9.9 | 77.4 ± 11.0* | 82.1 ± 9.4*# |
| | **GIRLS (n=64)** | | |
| | **Low (n=7)** | **Average (n=13)** | **High (n=44)** |
| **SBP** (mmHg) | 94.0 ± 8.3 | 108.3 ± 18.6* | 111.7 ± 11.5* |
| **DBP** (mmHg) | 57.3 ± 8.6 | 65.7 ± 14.2* | 69.8 ± 7.7*# |
| **MBP** (mmHg) | 69.5 ± 6.5 | 79.9 ± 15.1* | 83.1 ± 7.9*# |

SBP=systolic blood pressure; DBP=diastolic blood pressure; MBP=mean blood pressure; *P=0.05 to low body fat percentage; #P=0.05 to average body fat percentage.

Figure 1 presents the MBP values for boys and girls divided by the waist circumference cutoff point (90th percentile). The boys who showed high waist circumference presented a MBP value of 85.7 ± 6.5 mmHg, while the subjects below the cutoff point had a mean waist circumference of 78.6 ± 7.2 mmHg (P=0.05). In the same perspective, the girls with waist circumference above the cutoff point also showed higher values (82.9 ± 6.7 mmHg *vs*. 78.1 ± 6.6 mmHg, respectively; P=0.05).

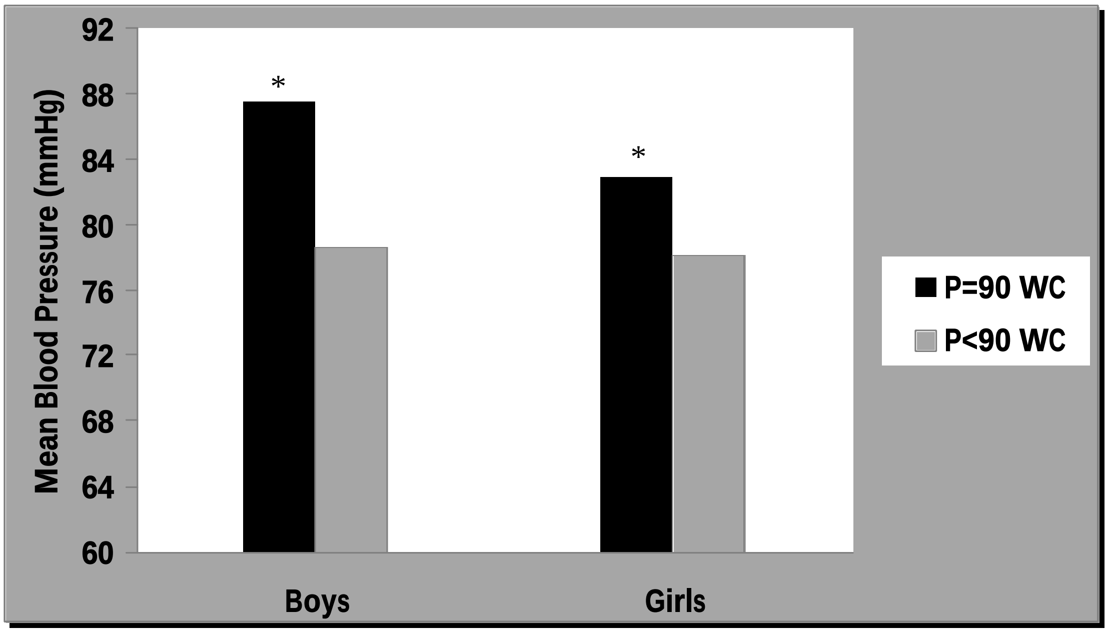


**Figure 1.** Mean blood pressure values for boys and girls above and below the waist circumference cutoff point (90th percentile). P=90= above 90th percentile; P<90=below 90th percentile; WC=waist circumference *P=0.05 to P<90 in the same sex.

## DISCUSSION

The main findings of the present study indicate that: (a) high body fat percentage is associated with significant increases in SBP, DBP, and MBP in adolescents with low socioeconomic status; and (b) waist circumference, when considered above cutoff point, can be an important indicator of future cardiovascular risk in the same population.

Little is known about the association of body adiposity indicators and cardiovascular risk factors in low income adolescents. Studies regarding this topic are important to developing appropriate health-related strategies to prevent the future risk of developing cardiovascular diseases.

The present study showed a difference of 9.8 mmHg in boys and 17.7 mmHg in girls when comparing the subjects with high body fat percentage with the subjects with low body fat percentage. This difference, throughout time, can represent an important factor in the development of cardiovascular morbidity and mortality.

Another highlighted variable in the present study is waist circumference. It is already well established in the literature that a high waist circumference is associated to cardiovascular risk in both male (12) and female (37) adults. In the present study, it was possible to identify that an increased waist circumference (above the 90th percentile) was associated with high blood pressure and, therefore, a higher cardiovascular risk in the low income adolescents. In fact, Rosa et al. (40) observed that in students 12 to 17 yrs of age from a neighborhood in Rio de Janeiro, the waist circumference had a specificity of 77% in predicting SAH with a 61% accuracy.

Whelton et al. (45) demonstrated that small variations in blood pressure are capable of influencing the cardiovascular survival of an individual. Alterations in SBP from 3 to 5 mmHg can increase the risk of a cardiac event in 8% to 14% and the risk of coronary disease in 5% to 9%, respectively. In addition, these same increases in SBP can enhance the all-cause mortality from 4% to 7%, correspondingly. The authors also stated that an increase of 2 mmHg in DBP can produce a 17% increase in the prevalence of SAH in the general population.

In the present study, even though not shown in the results, a higher difference than the ones found by Whelton et al. (45) was visible. This difference consisted of 4.47 mmHg and 2.93 mmHg in the boys' and girls' DBP, respectively, and 12.21 mmHg and 8.66 mmHg in boys' and girls' SBP, correspondingly, when comparing the adolescents with waist circumference above and below the cutoff point. Therefore, it is possible that the subjects with excessive circumference of the waist may develop cardiovascular problems in the future.

Although waist circumference cannot discriminate visceral fat from subcutaneous fat, studies do support the contention that adult individuals (22,25), children, and adolescents (34) with high waist circumference have a higher probability of developing SAH, diabetes, dislipidemia, and/or metabolic syndrome. In the present study, boys with high body fat percentage showed a waist circumference 15.8 cm larger than the subjects with low body fat percentage. The girls followed the same pattern as the boys with a difference of 11.5 cm between the subjects with high body fat percentage and low body fat percentage. These results suggest an enhancement in blood pressure, since 18.82% of the boys and 31.25% of the girls who were above the cutoff point for waist circumference presented a mean SBP of 120.87 mmHg and 113.95 mmHg, respectively.

Bozza et al. (7), evaluated adolescents aged 12 to 16 from the state of Paraná, Brazil. They reported that the boys who presented with a high body mass index had 2.14 more chances of presenting high blood pressure. This number was increased to 4.29 in the girls. Regarding waist circumference, they stated that the boys who presented with a waist circumference above the cutoff point had 2.34 more chances of being hypertensive. Among the girls this number increased to 4.12. Similarly, Christofaro et al. (10) analyzed Brazilian adolescents from the city of Londrina aged 10 to 17. They verified that excessive weight increased 2.80 times the chance of alterations in blood pressure. In addition, the authors indicated that excessive abdominal fat augmented this proportion to 4.09 times. In agreement, Mariath and Grillo (29) reported that overweight adolescents from the state of Santa Catarina, Brazil presented higher resting blood pressure when compared to their normal weight pairs.

Costa (14) reported a positive significant association between blood pressure and body mass, and between triceps skinfold and body mass index in adolescents from Rio de Janeiro (aged 12 to 19). Guimarães and colleagues (24) demonstrated that waist circumference influenced blood pressure in adolescents from private and public schools in the city of Salvador, Brazil. Both SBP and DBP were increased in 3.9 and 3.4 times in the boys, and 2.2 and 2.0 times in the girls with waist circumference above the 75th percentile, respectively. In addition, the prevalence ratio of increased SBP and DBP due to high waist circumference (above the 75th percentile) was 1.8 (CI 95% 1.0 to 3.0 [P=0.036]) and 1.4 (CI 95% 0.8 to 2.4), correspondingly.

Studies with children and adolescents from other countries have also shown similar results to what was found in the present study. In Tunisian adolescents aged 15 to 19, excessive weight enhanced the chances of having an altered blood pressure 2.1 times in the boys and 2.3 in the girls. If waist circumference was used as a parameter, these chances changed to 2.8 and 2.3 times in the males and the females, respectively (3). These findings are supported by the work of Adolfotouh et al. (1) who reported on Egyptian adolescents aged 11 to 19 (e.g., excessive weight identify by body mass index and waist circumference represented a risk 2.18 and 3.14 times greater of having elevated blood pressure).

In Taiwan, Lin et al. (28) evaluated students who were 12 to 14 yrs of age. They reported that excessive weight resulted in a risk 1.5 times greater of hypertension. Also, for each unit increment of body mass index and waist circumference, there was an increase of 4% to 13% in the risk of hypertension. Armas and colleagues (5) reported similar results with Spanish obese adolescents, where they found that an increase in waist circumference was associated with three or more metabolic syndrome components. Yet, in spite of all the evidence that favors good nutrition and regular exercise, it is worth highlighting that exercise promotes healthy cardiovascular adaptations that lead to a decrease in resting and exercise heart rate (13), post-exercise blood pressure (19,41) and psychophysiology benefits well after the exercise session (16) in children and adults.

## CONCLUSION

The authors conclude that body adiposity indicators (such as body fat percentage and waist circumference) present significant associations with blood pressure in low income adolescents from both sexes. Moreover, it is clear that waist circumference can be a good screening parameter to prevent cardiovascular risks in adolescents.

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