

# Hypertension and its association with overweight and obesity among adolescents: a school-based survey

## *Prevalência de hipertensão arterial e sua associação com sobrepeso e obesidade: estudo de base escolar*

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**Abstract** – This study aimed to investigate the association of overweight and obesity with hypertension in adolescents from public schools in Curitiba, southern Brazil. The sample comprised 1,549 randomly selected adolescents aged 12 to 18 years (744 males). Body mass index (BMI) was calculated and classified according to Conde and Monteiro (2006). Blood pressure was measured by the auscultation method on two occasions (different days) and was classified according to the fourth report of the *National High Blood Pressure Education Program* (NHBPEP). Prevalence ratio was used as a measure of association. Overweight and obesity were observed in 23% and 5.8% of boys, respectively. Among girls, 18.8% were overweight and 5.6% were obese. After two measurements, 7% of boys had prehypertension and 10.5% had hypertension. Prehypertension and hypertension were observed in 5.2% and 9.9% of girls, respectively. Obesity was significantly associated with high blood pressure among boys (PR = 1.19, 95% CI = 1.07-1.32). Overweight (PR = 1.11, 95% CI = 1.04-1.17) and obese (PR = 1.26, 95% CI = 1.13-1.40) girls were more likely to have high blood pressure levels in comparison to normal weight adolescents. These results showed alarming estimates of hypertension among young people and that the reduction of obesity during adolescence should be focused on public policies for hypertension prevention in the population.

**Key words:** Adolescent; Hypertension; Obesity; Overweight.

**Resumo** – O estudo objetivou investigar a associação do sobrepeso e obesidade com a hipertensão arterial em adolescentes da rede pública de ensino da cidade de Curitiba-PR. A amostra foi constituída por 1.549 adolescentes, de idades de 12 a 18 anos (744 do sexo masculino), selecionados de forma aleatória. O índice de massa corporal (IMC) foi calculado e classificado conforme Conde e Monteiro (2006). A pressão arterial foi aferida pelo método auscultatório em duas ocasiões e classificada conforme o quarto relatório do *National High Blood Pressure Education Program* (NHBPEP). A razão de prevalência foi usada como medida de associação. O sobrepeso e a obesidade estiveram presentes em 23% e 5,8% dos meninos, respectivamente. Entre meninas, 18,8% estavam com sobrepeso e 5,6% eram obesas. Após duas avaliações, 7% dos meninos apresentavam pré-hipertensão e 10,5% tinham hipertensão. A pré-hipertensão e hipertensão foram encontradas em 5,2% e 9,9% das meninas, respectivamente. Somente a obesidade esteve significativamente associada à pressão arterial elevada entre os meninos (RP = 1,19, IC 95% = 1,07-1,32). Meninas com sobrepeso (RP = 1,11, IC 95% = 1,04-1,17) e obesidade (RP = 1,26, IC 95% = 1,13-1,40) tiveram uma maior probabilidade de apresentar elevados níveis pressóricos em comparação às adolescentes eutróficas. Esses resultados evidenciaram estimativas preocupantes da hipertensão arterial entre adolescentes e que a redução da obesidade, ainda na juventude, deve ser focada em políticas públicas de prevenção da hipertensão arterial na população.

**Palavras-chave:** Adolescente; Hipertensão; Obesidade; Sobrepeso.

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## INTRODUCTION

Hypertension is characterized by high and sustained levels of blood pressure on artery walls and is associated with several functional and metabolic changes, resulting in a high risk for cardiovascular diseases<sup>1</sup>.

The high estimates of hypertension in the adult population of several countries have led it to become one of the main public health problems in the world<sup>2</sup>. Additionally, nearly 13% of all deaths occurring each year (7.5 million of deaths) may be attributed to high blood pressure<sup>2</sup>. However, increasingly more alarming levels of hypertension are also found in the initial years of life<sup>3</sup>. Since high blood pressure values in childhood and adolescence are closely related to hypertension in adulthood<sup>4</sup>, the prevention of this condition during adolescence should be a priority.

The literature presents some risk factors that may cause changes in blood pressure among young people, such as: excessive intake of foods with high caloric and salt content, sedentary lifestyle, family history, smoking, and drinking<sup>5</sup>. However, a factor that has been receiving special attention is the presence of overweight or obesity in childhood and adolescence. These conditions are directly related to changes in the current morbidity and mortality profile, especially with the onset of cardiovascular problems (type-2 diabetes, dyslipidemias and hypertension itself) already in the initial years of life<sup>2,6</sup>. Although with little scientific evidence, the pathophysiological aspects of hypertension show that high blood pressure is linked to body weight gain, because excess fat helps to increase sympathetic nervous activity, which, in turn, increases renin-angiotensin system activity. Moreover, insulin resistance may cause increased blood pressure, since insulin contributes to circulation through vasodilatation, a phenomenon that shows to be deficient in obese individuals<sup>7</sup>.

Despite the indications that overweight and obesity are associated with hypertension in the young population, these pieces of evidence are primarily obtained from epidemiological surveys with important methodological limitations in the classification and in the way of measuring blood pressure<sup>8</sup>, because it is frequent to find in the literature studies measuring blood pressure on a single visit, as well as different measuring methods and several cut-off points for classification. However, surveys with representative samples of a young population and that adopted a methodology to control these limitations related to blood pressure measurement are still scarce. Therefore, the present study aimed to investigate the prevalence of hypertension and its association with overweight and obesity in a representative sample of adolescents from public schools in Curitiba, southern Brazil.

## METHODOLOGY

### Population and sample

The probabilistic sample was constituted using a multistage sampling method. At the first stage, all public schools were listed and stratified

according to each of the 9 administrative regions of Curitiba (Human Development Index = 0.856). Among the schools, 160 corresponded to primary school classes and 106 to high school classes.

Sample size was calculated according to the criteria described by Luiz and Magnanini<sup>9</sup>: a) population of 115,524 adolescents; b) 95% confidence interval; c) sampling error of 2% and prevalence of 7.4%<sup>10</sup>. These parameters indicated a minimum sample size of 654 adolescents. Since the sample was obtained by multiple stages, we chose to consider a design effect of 1.5, which resulted in a sample of 982 adolescents. A further 30% of individuals were added to this estimate in order to minimize possible losses related to those who refused to participate in the study, did not provide a free and informed consent signed by parents or guardians up to the day of data collection, or were excluded due to the presence of one of the exclusion criteria. Hence, the total sample size comprised 1,276 adolescents.

At the second stage, 5 schools were drawn in each of the 9 regions, one school for each grade (6<sup>th</sup>, 7<sup>th</sup> and 8<sup>th</sup> grades of primary school, and 1<sup>st</sup> and 2<sup>nd</sup> grades of high school), from morning and afternoon shifts. At the third stage, 1 to 3 classes (clusters) were randomly selected, considering the number of adolescents per administrative region of the city. All students from these classes were invited to participate in the study.

This process of sample selection yielded a sample of 1,812 adolescents. The following exclusion criteria were considered for the present study: i) age below 12 years and above 18 years; ii) regular use of anti-hypertensive drugs, or pregnancy; iii) missing one or both blood pressure measurements. Therefore, the final sample comprised 1,549 adolescents, 744 males and 805 females, aged between 12 and 17.9 years and enrolled in 44 schools in Curitiba.

The present study was registered and approved by the Research Ethics Committee of the Department of Health Sciences at Universidade Federal do Paraná under the number 624.161.08.09. The participation of the adolescents was authorized by parents/guardians, who signed the free and informed consent.

### Anthropometric measures

Height and body mass were measured according to standardized procedures<sup>11</sup>. Body mass index (BMI) was calculated by dividing body mass by height squared (Kg/m<sup>2</sup>). BMI was classified (underweight, normal weight, overweight and obesity) according to specific cut-off points for gender and age, proposed by Conde and Monteiro for Brazilian adolescents<sup>12</sup>. For analysis purposes, adolescents classified as underweight were grouped together with normal weight adolescents.

### Blood pressure

Systolic and diastolic blood pressures were measured by the auscultation method and classified according to the guidelines established by the 4<sup>th</sup> report of the *National High Blood Pressure Education Program* (NHBPEP)<sup>13</sup>.

Measurements were taken from the right arm of the adolescents, using an aneroid sphygmomanometer positioned at the heart level of the subjects, and a stethoscope placed above the brachial artery. Systolic blood pressure was defined as Korotkoff sound phase 1 (K1), and diastolic blood pressure as Korotkoff sound phase 5 (K5).

Blood pressure was classified considering NHBPEP standards<sup>13</sup>. This classification was performed according to age, gender, and height percentile<sup>13</sup>. The classification of the height-for-age percentile considered the curves proposed by the Center for Diseases Control and Prevention<sup>14</sup>.

Before the final classification of adolescents regarding hypertension, a second visit was made to reassess individuals who showed high blood pressure values. This new measurement (conducted on the day following the first measurement) was important for the pressure characterization of these subjects, because high pressure tends to decrease due to the reduced anxiety degrees resulting from a new visit. In addition, all measurements were taken by a single evaluator, in order to eliminate any type of inter-rater error.

### Statistical analysis

Descriptive statistics, with mean and standard deviation, was used to characterize the sample and present the data. The Komolgorov-Smirnov test was used to test data normality. The Student's *t* test was applied to compare descriptive variables between the genders. Simple and relative frequency analysis was used to present the prevalences of overweight and obesity and the prevalences of hypertension. In order to examine the association of overweight and obesity with hypertension, prevalence ratio was used, determined through Poisson regression with robust variance. For the association analyses, prehypertensive and hypertensive individuals were grouped into a single category (adolescents with hypertension).

The *Statistical Package for the Social Science* (SPSS) software, version 18.0, was used for all analyses, and the level of significance was set up at  $p < 0.05$ .

## RESULTS

Table 1 shows means and standard deviations for anthropometric variables, as well as mean and standard deviation for blood pressure at the first and second measurements, according to gender. Mean values for height, body mass, SBP 1 and SBP 2 were significantly higher in male adolescents in comparison to their female counterparts.

Table 2 shows the percentage of adolescents in each BMI classification, according to gender. Boys showed a higher percentage of overweight and obesity than girls, while girls had higher values for underweight and normal weight.

**Table 1.** Description of the sample, Curitiba, Brazil (n= 1,549).

Variables	Male (n = 744)	Females (n = 805)	T	p
Age (years)	14.52±1.44	14.44±1.42	1.038	0.299
Height (m)	1.65±0.10	1.59±0.06	14.224	0.0001
Body mass (Kg)	56.85±14.03	52.95±10.28	6.195	0.0001
BMI	20.64±3.79	20.90±3.51	-1.402	0.161
SBP 1	112.98±12.25	108.87±10.47	7.074	0.0001
DBP 1	71.87±8.78	71.32±8.21	1.266	0.206
SBP 2	111.56±11.18	108.00±9.96	6.594	0.0001
DBP 2	70.26±7.65	70.14±7.35	0.329	0.742

BMI: Body mass index; SBP 1: Systolic blood pressure at the first visit;  
DBP 1: Diastolic blood pressure at the first visit; SBP 2: Systolic blood pressure at the second visit;  
DBP 2: Diastolic blood pressure at the second visit.

**Table 2.** Simple and relative frequency of adolescents in each body mass index classification, Curitiba, Brazil (n= 1,549).

BMI classification	Total (n = 1,549)		Male (n = 744)		Female (n = 805)	
	n	%	n	%	n	%
Underweight	18	1.1	1	0.1	17	2.1
Normal	1,121	72.4	529	71.1	592	73.5
Overweight	322	20.8	171	23.0	151	18.8
Obese	88	5.7	43	5.8	45	5.6

BMI: body mass index.

Table 3 shows absolute and relative frequency values for blood pressure classifications at the first and second visits, respectively. The number of individuals classified as prehypertensive and hypertensive was lower at the second visit in comparison to the first visit, regardless of gender.

**Table 3.** Simple and relative frequency of adolescents in each blood pressure classification, according to the day of visit, Curitiba, Brazil (n= 1,549).

Blood pressure classification	Total (n = 1.549)		Male (n = 744)		Female (n = 805)	
	n	%	n	%	n	%
First visit						
Normal	1,063	68.7	484	65.0	579	71.9
Prehypertensive	225	14.6	119	16.0	106	13.2
Hypertensive	261	16.8	141	19.0	120	14.9
Second visit						
Normal	1,297	83.7	614	82.5	683	84.9
Prehypertensive	94	6.1	52	7.0	42	5.2
Hypertensive	158	10.2	78	10.5	80	9.9

Table 4 shows the association of overweight and obesity with hypertension in adolescents. It was found that obese boys were more likely to have high blood pressure in comparison to their normal weight counterparts (PR= 1.19, 95% CI = 1.07-1.32). In turn, overweight (RP= 1.11, 95% CI =

1.04-1.17) and obese (PR= 1.26, 95% CI = 1.13-1.40) girls were more likely to have high blood pressure levels in comparison to their normal weight counterparts.

Tabela 4. Prevalence of hypertension and its association with overweight and obesity in adolescents, Curitiba, Brazil (n= 1,549).

BMI classification	Hypertension*					
	Male (n = 744)			Female (n = 805)		
	n	%	PR (95% CI)	n	%	PR (95% CI)
Normal weight	82	15.5	1	69	11.3	1
Overweight	32	18.7	1.03 (0.97-1.09)	35	23.2	1.11 (1.04-1.17)
Obese	16	37.2	1.19 (1.07-1.32)	18	40.0	1.26 (1.13-1.40)

\*Undesirable (systolic blood pressure and/or diastolic blood pressure  $\geq 90$ th); BMI = body mass index; PR (95% CI) = prevalence ratio and 95% confidence interval.

## DISCUSSION

The prevalence of excess weight (overweight or obesity) found in the present study (26.5%) was close to those obtained in adolescents from other Brazilian cities, such as Cubatão, state of São Paulo (24%)<sup>15</sup> and Fortaleza, state of Ceará (19.5%)<sup>16</sup>. Generally speaking, these estimates show that adolescents from different regions of the country are already belonging to a group at risk for developing future diseases resulting from the excessive accumulation of body fat<sup>2,16</sup>.

In comparison to international data, it becomes evident that the problem of overweight and obesity at the initial years of life is not limited to Brazilian adolescents. In the United States, for example, data for 2007 show that excess weight (overweight or obesity) were observed in 31.6% of children<sup>17</sup>. On the other hand, in a research conducted by Ottova *et al.*<sup>18</sup> in different countries of Europe, the mean prevalence of overweight in children and adolescents was 14.2%, ranging from 9.4% (France) to 17.6% (Spain). The discrepancies between the studies may be explained by behavioral and cultural differences, which imply differences in the nutritional status of young people from different regions. However, methodological differences (age group, BMI classification criteria) may also explain these differences.

Epidemiological data on hypertension in children and adolescents are also widely reported by the national and international literature<sup>19,20</sup>. Nonetheless, it is frequent to find a wide variation in the prevalence of hypertension in this population, and these differences may be directly related to the methodology used in the studies<sup>8</sup>. Because of that, in the present research two visits were made for measuring blood pressure, following internationally accepted recommendations<sup>13</sup>, and most studies use two or more measurements on the same day.

An investigation conducted by Queiroz *et al.*<sup>19</sup> found a prevalence of high blood pressure levels of 13.6%, out of a total of 750 schoolchildren

from João Pessoa, northeastern Brazil. In a study conducted by Romanzini *et al.*<sup>21</sup> in Londrina, southern Brazil, high blood pressure was diagnosed in 18.6% of the adolescents investigated. However, the comparison of the above-mentioned studies with the present research should be made with caution, since these blood pressure measurements were taken on the same day, differently from the measurements obtained in the present study.

International data on hypertension in children and adolescents show that prevalence rates ranged from 4.2% to 16.3%<sup>8,22,23</sup>. Considering the above-mentioned prevalences of hypertension, it should be taken into account that, in the present research, the first blood pressure measurement showed higher values. A decrease in prevalence rates was observed in the second measurement, probably due to the reduction in anxiety and the familiarization with the procedures<sup>13</sup>. Nonetheless, it becomes evident that blood pressure screening and control should be made already in the first years of life, because even the child and/or adolescent classified as prehypertensive already belongs to a risk group with potential for developing hypertension and its associated comorbidities<sup>13,24</sup>.

Several factors are associated with increased blood pressure levels in children and adolescents<sup>5,12</sup>. Among these factors, some of the most remarkable are overweight and obesity, because excessive accumulation of body fat has been growing dramatically among this population all over the world in the last years<sup>10</sup>.

The present study identified a significant association between obesity and hypertension among boys. For girls, both overweight and obesity showed to be significantly associated with hypertension. Thus, it is observed that both overweight and obese girls were more likely to have high blood pressure in comparison to normal weight girls, a fact that, for boys, occurred only with obese subjects in comparison to overweight and normal weight boys. A possible explanation for these differences between the genders may be linked to hormonal actions resulting from the onset of puberty, as well as to the excess gain in fat mass that occurs during this period, because girls at pubertal age have more body fat, especially at the hip area and visceral fat, while boys increase their muscle mass during this period<sup>25</sup>.

International surveys have also observed a trend of excess weight representing a risk condition for cardiovascular health, including the presence of hypertension in children and adolescents. For instance, in a study conducted by Salvadori *et al.*<sup>20</sup> in Canada, obesity in children aged 6-13 years was associated with prehypertension and hypertension.

The pathophysiological mechanisms through which hypertension resulting from excess body weight develops have been little explored yet. Some authors suggest that hyperinsulinemia and insulin resistance may be factors involved in the genesis of obesity, which, in turn, is associated with increased blood pressure<sup>7</sup>. In obese individuals, the maintenance of the energy balance performed by the sympathetic nervous system is stimulated by hyperinsulinemia, and this reaction may lead to an increase in blood pressure, because, through these mechanisms, sodium retention



occurs in the kidneys and, consequently, the heart works harder, due to the increase in cardiac output<sup>7</sup>.

Moreover, insulin is a hormone that helps in vasodilatation, contributing to the increase in blood flow to skeletal muscles; however, this physiologic mechanism does not function normally in obese individuals<sup>26</sup>. Another factor linked to increased blood pressure values is the higher release of free fatty acids into the portal vein; this physiological dysfunction is found in individuals with high body fat levels, especially in the abdominal area<sup>27</sup>.

It is important to highlight some possible methodological limitations of the present study. The present research used BMI to classify nutritional status. Although BMI is a reliable variable used in several studies, the use of indicators of fat distribution in different areas of body (such as abdominal or subcutaneous) could have been a factor that would help to provide an answer about the association of overweight and obesity with increased blood pressure. Previous studies have reported this association<sup>28,29</sup>. Another possible limitation refers to the lack of assessment of maturational stage, because the age range analyzed in the present study comprises a period during which physiological changes, resulting from the onset of puberty, become more evident, contributing thus to the increase in body fat, especially in girls, a fact that may collaborate to increase blood pressure levels<sup>25</sup>.

Still regarding possible limitations, the levels of physical activity and physical fitness of the sample were not analyzed. These variables could have influenced the results for blood pressure, since overweight and obesity are closely related to low levels of physical activity and physical fitness in children and adolescents<sup>11</sup>.

However, one of the strengths of the present study was measuring blood pressure on different days. This methodological approach was different from those adopted in most national and international investigations<sup>8</sup>. This approach is recommended by the NHBPEP<sup>13</sup>, which advocates the use of more than one measurement for the diagnosis of hypertension in order to avoid overestimating its prevalence in the young population. Another strength of the present study was the estimation of hypertension prevalence in a representative sample of adolescents from public schools in Curitiba. Several studies in the national and international literature did not work with representative samples of their respective populations, which may imply erroneous estimates of hypertension prevalence and its associated factors.

## CONCLUSIONS

The present study found that obese adolescents, regardless of gender, were more likely to have hypertension (prehypertension or hypertension) already during adolescence. In addition, overweight girls were also more likely to have hypertension, in comparison with their normal weight counterparts.

These results highlight the importance of surveillance policies to identify overweight and obesity in children and adolescents, as well as of intervention strategies to combat these health risk conditions. Focusing



on interventions on nutritional status may be crucial for hypertension treatment and prevention in young people, a condition increasingly more present in this population. Future investigations should take into account the blood pressure measurement on more than one occasion, because the results showed that, in many cases, blood pressure decreases on the second measurement. This evidence was also observed in the present study. Thus, the use of several measurements on the same day may lead to diagnostic errors in the estimated rates of hypertension among young people.

## REFERENCES

1. Sociedade Brasileira de Hipertensão, Sociedade Brasileira de Cardiologia, Sociedade Brasileira de Nefrologia. 6ª Diretrizes Brasileiras de Hipertensão Arterial 2010;17(1):4-60.
2. World Health Organization. Global health risks: mortality and burden of disease attributable to selected major risks. Geneva; 2009.
3. Molina MCB, Faria CP, Montero MP, Cade NV, Mill JG. Fatores de risco cardiovascular em crianças de 7 a 10 anos de área urbana, Vitória, Espírito Santo, Brasil. *Cad Saúde Pública* 2010;26(5):909-17.
4. Chen X, Wang Y. Tracking of blood pressure from childhood to adulthood : a systematic review and meta-regression analysis. *Circulation* 2008;117(25):3171-80.
5. Araújo TL, Lopes MVO, Moreira RP, Cavalcante TF, Guedes NG, Silva VM. Pressão arterial de crianças e adolescentes de uma escola pública de Fortaleza – Ceará. *Acta Paul Enferm* 2007;20(4):476-82.
6. Redwine KM, Daniels SR. Prehypertension in adolescents: Risk and progression. *J Clin Hypertens* 2012;14(6):360-364.
7. Aneja A, El-Atat F, Mcfarlane SI, Sowers AR. Hypertension and obesity. *Recent Progress in Hormone Research* 2004;59:169-205.
8. Christofaro DGD, Andrade SM, Fernandes RA, Cabrera MAS, Ritti-Dias RM. Prevalência de pressão arterial elevada em crianças e adolescentes: revisão sistemática. *Rev Bras Saude Mater Infant* 2011;11(4):361-7.
9. Luiz RR, Magnanini MMF. A lógica da determinação do tamanho da amostra em investigações epidemiológicas. *Cad Saúde Colet* 2000;8(2):9-28.
10. Silva KS, Farias Júnior JC. Fatores de risco associados à pressão arterial elevada em adolescentes. *Rev Bras Med Esporte* 2007;13(4):237-40.
11. Alvarez BR, Pavan AL. Alturas e comprimentos. In: Petroski EL. *Antropometria: Técnicas e Padronizações*. Porto Alegre: Palotti; 2009. p. 9-29
12. Conde WL, Monteiro CA. Valores críticos do índice de massa corporal para classificação do estado nutricional de crianças e adolescentes brasileiros. *J Pediatr (Rio J)* 2006;82(4):266-72.
13. National high blood pressure education program working group on high blood pressure in children and adolescents. The Fourth Report on the Diagnosis, Evaluation, and Treatment of High Blood Pressure in Children and Adolescents. *Pediatrics* 2004;114(2):555-76.
14. Kuczumski RJ, Ogden CL, Grummer-Strawn LM, Flegal KM, Guo SS, Wei R. et al. CDC growth charts: United States. *Adv data* 2000;314:1-28.
15. Silva MCP, Ramos CHB, Costa RF. Estado nutricional e níveis pressóricos de escolares adolescentes da cidade de Cubatão – SP, Brasil. *Rev Bras Crescimento Desenvol Hum* 2008;18(3):288-97.
16. Campos LA, Leite AJM, Almeida PC. Prevalência de sobrepeso e obesidade em adolescentes escolares do município de Fortaleza, Brasil. *Rev Bras Saúde Mater Infant* 2007;7(2):183-90.
17. Singh GK, Kogan MD, Van Dyck PC. Changes in state-specific childhood obesity and overweight prevalence in the United States from 2003 to 2007. *Arch Pediatr Adol Med* 2010;164(7):598-607.

18. Ottova V, Erhart M, Rajmil L, Dettenborn-Betz L, Ravens-Sieberer U. Overweight and its impact on the health-related quality of life in children and adolescents: results from the European KIDSCREEN survey. *Qual Life Res* 2011;20(4):59-69.
19. Queiroz VM, Moreira PVL, Vasconcelos THC, Vianna RPT. Prevalência e preditores antropométricos de pressão arterial elevada em escolares de João Pessoa – PB. *Arq Bras Cardiol* 2010;95(5):629-34.
20. Salvadori M, Sontrop JM, Garg AX, Truong J, Suri RS, Mahmud FH et al. Elevated blood pressure in relation to overweight and obesity among children in a rural Canadian community. *Pediatrics* 2008;122(4):820-8.
21. Romanzini M, Reichert FF, Lopes AS, Petroski EL, Farias Júnior JC. Prevalência de fatores de risco cardiovascular em adolescentes. *Cad Saúde Pública* 2008;24(11):2573-81.
22. Pileggi C, Carbone V, Nobile CGA, Pavia M. Blood pressure and related cardiovascular disease risk factors in 6–18 year-old students in Italy. *J Paediatr Child Health* 2005;41(7):347-52.
23. Genovesi S, Giussani M, Pieruzzi F, Vigorita F, Arcovio C, Cavuto S et al. Results of blood pressure screening in a population of school-aged children in the province of Milan: role of overweight. *J Hypertens* 2005;23(3):493-7.
24. Campana EM, Brandão AA, Magalhães, ME, Freitas EV, Pozzan R, Brandão AP. Pré-hipertensão em crianças e adolescentes. *Rev Bras Hipertens* 2009;16(2):92-102.
25. Malina RM, Bouchard C, O Bar-Or Growth, maturation and physical activity. Champaign: Human Kinetics; 2004.
26. Barreto-Filho JAS, Colombo FMC, Lopes HF. Hipertensão arterial e obesidade: causa secundária ou sinais independentes da síndrome plurimetabólica? *Rev Bras Hipertens* 2002;9(2):174-84.
27. Oliveira AMA, Oliveira AC, Almeida MS, Almeida FS, Ferreira JBC, Silva CEP et al. Fatores ambientais e antropométricos associados à hipertensão arterial infantil. *Arq Bras de Endoc Metab* 2004;48(6):849-54.
28. Hirschler V, Aranda C, Calcagno ML, Maccalini G, Jadzinsky M. Can waist circumference identify children with the metabolic syndrome? *Arch Pediatr Adolesc Med* 2005;159:740-4.
29. Sarni RS, Souza FIS, Schoeps DO, Catherino P, Oliveira MCCC, Pessotti CFX et al. Relação da cintura abdominal com a condição nutricional, perfil lipídico e pressão arterial em pré-escolares de baixo estrato socioeconômico. *Arq Bras Cardiol* 2006;87(2):153-8.

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