High blood pressure and abdominal obesity in adolescents

Pressão arterial elevada e obesidade abdominal em adolescentes

Presión arterial elevada y obesidad abdominal en adolescentess

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ABSTRACT

Objective: To analyze the association between abdominal obesity and high blood pressure among adolescents of public schools from Londrina (PR), Brazil.

Methods: The sample was composed by 656 adolescents with age ranging from ten to 13 years old. The following measures were taken: body mass, height, waist circumference and blood pressure at rest. Mann-Whitney and Student's t-test were used to compare and analyze numerical variables. The chi-square test analyzed the association between blood pressure and waist circumference.

Results: Association between abdominal obesity and high blood pressure was present in both genders (PR 2.7; 95%CI 1.8-4.2). Abdominal obesity was associated with higher blood pressure independently of age.

Conclusions: Abdominal obesity was associated to high blood pressure in adolescents.

Key-words: adolescent; obesity, abdominal; blood pressure.

RESUMO

Objetivo: Analisar a associação entre obesidade abdominal e pressão arterial elevada em adolescentes da rede pública de ensino da região metropolitana da cidade de Londrina (PR).

Métodos: Constituiu-se uma amostra de 656 adolescentes com idades entre dez e 13 anos. Foram realizadas análises antropométricas de massa corporal, estatura e circunferência de cintura, além da aferição da pressão arterial de repouso. Para análise e comparação dos dados, foram aplicados Mann-Whitney e o teste *t* de Student. Também foram analisadas as possíveis associações entre pressão arterial e circunferência de cintura por meio do teste do qui-quadrado.

Resultados: Foram identificadas associações entre obesidade abdominal e pressão arterial elevada em ambos os sexos (RP 2,7; IC95% 1,8-4,2). Além disso, verificou-se que, independentemente do grupo etário, a obesidade abdominal associa-se com valores mais elevados de pressão arterial.

Conclusões: A obesidade abdominal está associada à ocorrência de aumento da pressão arterial em adolescentes.

Palavras-chave: adolescente; obesidade abdominal; pressão arterial.

RESUMEN

Objetivo: Analizar la asociación entre obesidad abdominal y presión arterial elevada en adolescentes de la red

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pública de enseñanza de la región metropolitana de la ciudad de Londrina, región norte del Paraná - Brasil.

Métodos: Se constituyó una muestra de 656 adolescentes con edades entre 10 y 13 años. Se realizaron análisis antropométricos de masa corporal, estatura y circunferencia de cintura, además de la verificación de la presión arterial de reposo. Para análisis y comparación de los datos, se utilizaron las pruebas estadísticas «U» de Mann-Whitney y la prueba «T» de Student. También se analizaron las posibles asociaciones entre presión arterial y circunferencia de cintura por medio de la prueba de Chi-cuadrado, siendo el nivel de significancia establecido en $p<0,05$.

Resultados: Se identificaron asociaciones entre obesidad abdominal y presión arterial elevada en ambos sexos (RP=2,7; IC95%=1,8-4,2). Además, se verificó que independientemente del grupo de edad, la obesidad abdominal se asocia con valores más elevados de presión arterial.

Conclusiones: La obesidad abdominal está asociada a la ocurrencia de aumento de la presión arterial en adolescentes.

Palabras clave: Adolescentes; obesidad abdominal; presión arterial.

Introduction

Some decades ago, infectious diseases were the leading cause of death worldwide. More recently however, chronic degenerative diseases have accounted for the majority of deaths in the population[1]. Several risk factors may be associated with these conditions, such as excess body fat, diabetes mellitus, inadequate dietary habits, insufficient physical activity, and hypertension[2].

According to some studies[3], the second most prevalent risk factor in adult populations is overweight, led only by sedentary lifestyle. Individuals with a body mass index (BMI) far above the normal range usually have higher blood pressure (BP) and higher rates of frank hypertension[4]. Abdominal adiposity poses a particular risk to health, as it is subject to higher rates of lipolysis and is located in close proximity to major blood vessels[5].

This pathological association between body fat distribution and BP is especially important in pediatric populations, as anthropometric indicators of obesity, such as waist circumference (WC), are considered good alternatives in children and adolescents in view of their ease of measurement and status as strong predictors of all-cause and cardiovascular mortality[6]. On the other hand, there is little information on this topic in the Brazilian pediatric literature.

Therefore, the aim of this study was to evaluate the association between abdominal obesity and high blood pressure (HBP) in adolescent students of public schools in the metropolitan area of Londrina, in the northern region of the state of Paraná, Brazil.

Method

The sample comprised elementary school students of both genders, between the ages of 10 and 13 years, recruited from the pool of regularly enrolled students of public schools in the municipality of Londrina, state of Paraná, Brazil. For sample selection purposes, the city was divided into six regions: north, south, east, west, center, and outskirts. One school from each region was then selected by means of a random numbers table and the number of participants to be recruited from each school was calculated on the basis of the proportion of students required from each region. Had any of the chosen schools failed to meet the required proportion, one more school from the region would have been selected, but this procedure was not necessary.

Sample size was calculated for an expected HBP prevalence rate of 10% (according to data reported in the literature[7], a tolerable error rate of 3%, and 80% statistical power. Thus estimated, the required sample size was 364 subjects. However, as the present study considered each class of each school as a cluster, we increased the projected sample size by 50% to correct for design effect, yielding a sample size of 573 adolescents. A further 20% was added to account for possible sampling loss during the course of the experiment, and the final minimum sample size was thus defined as 656. A total of 671 subjects were assessed in the study, thus meeting this requirement. It should be noted that the study sample was restricted to adolescents enrolled at the chosen schools who did not have any preexisting diagnosis of metabolic disease and were not taking antihypertensive agents for blood pressure control.

Prior to the study, all subjects and their parents or legal guardians were made aware of the objectives of the study and provided written informed consent for participation. The study was approved by the Universidade Estadual de Londrina Research Ethics Committee (accredited by the Brazilian Ministry of Health) and conducted in accordance with National Health Council Resolution 196/96 on human subject research.

All anthropometric measurements were obtained with participants wearing light clothing and no shoes. Body mass was measured using an electronic scale with 150 kg capacity and 100 g resolution, and height, with a portable stadiometer capable of measuring up to 200 cm and precise to 0.1 cm. The body mass index (BMI) was calculated by dividing body mass in kilograms

by the square of the height in meters. Waist circumference (WC) was defined as the smallest circumference between the iliac crest and lowest rib, as measured using a nonstretching tape measure with mm increments. The cutoff points used for definition of abdominal obesity were those recommended by Taylor *et al*[8].

Blood pressure was measured with an automatic oscillometric sphygmomanometer (Omron HEM-742) previously validated for use in adolescents[9]. Cuff size and placement followed American Heart Association recommendations[10]. Subjects were kept at rest in a seating position for 5 minutes prior to the first BP measurement. A second measurement was obtained 1 minute after the first, and the mean of these two measurements was used to determine systolic (SBP) and diastolic blood pressure (DBP). Participants were classified according to the National High Blood Pressure Education Program criteria[11]. Therefore, those with BP measurements above the 95th percentile were classified as having HBP.

The Shapiro–Wilk test was used to assess the normality of data. Descriptive statistics were used for characterization of the sample (means, standard deviations, proportions, and frequencies), and the Student *t* test for independent samples was used to assess any possible gender differences in the variables of interest. The Mann-Whitney U was used for comparison between the mean BP values of subjects with and without abdominal obesity in each age range. The chi-square test was used to determine potential associations between BP and WC. The significance level was set at $p<0.05$. All statistical analyses were performed in the SPSS 17.0 software package.

Results

Table 1 shows the general characteristics of the study sample. Significant gender differences in mean WC and DBP values were found, with higher WC measurements in males and higher DBP in females.

An association between abdominal obesity and HBP was found in both genders (Table 2). The overall prevalence of HBP in subjects with abdominal obesity was 17.3 percentage points higher than in subjects with normal WC measurements. In girls, the difference was 19 percentage points, and in boys, 15.9 percentage points. The overall risk of HBP was 170% greater in the presence of abdominal obesity (197% greater in girls, 147% in boys).

In subjects with abdominal obesity, mean SBP values were also significantly higher than those measured in participants with a normal WC, both in the 10-to-11 age group (114±10.1

Table 1 - Sample profile

	Males (n=314)		Females (n=357)		*p*	Total (671)	
	Mean	SD	Mean	DP		Mean	SD
Age (years)	11.5	1.1	11.5	2.0	0.925	11.5	1.1
Body mass (kg)	43.6	10.8	43.2	10.8	0.695	43.4	10.8
Height (cm)	151.9	10.0	152.2	9.4	0.686	152.0	9.7
BMI (kg/m^2)	18.7	3.4	18.5	3.4	0.409	18.6	3.4
WC (cm)	65.4	8.6	62.6	7.5	<0.001	64.9	8.2
SBP (mmHg)	112.3	10.5	112.0	9.9	0.723	112.1	10.2
DBP (mmHg)	61.6	7.0	62.8	7.2	0.030	62.3	7.1

BMI: body mass index; DBP: diastolic blood pressure; SBP: systolic blood pressure; SD: standard deviation; WC: waist circumference.

Table 2 - Prevalence and prevalence ratio (95% confidence interval) of high blood pressure according to waist circumference in a sample of adolescents, Londrina, Paraná, Brazil

	Normal BP (%)	High BP (%)	Prevalence Ratio (95%CI)	*p*
Males (n=314)				
Normal WC	89.2	10.8	1.0	0.003
AO	73.3	26.7	2.5 (1.4-4.5)	
Females (n=357)				
Normal WC	90.4	9.6	1.0	0.001
AO	71.4	28.6	3.0 (1.6-5.5)	
Total (n=671)				
Normal WC	89.8	10.2	1.0	<0.001
AO	72.5	27.5	2.7 (1.8-4.2)	

AO: abdominal obesity; WC: waist circumference.

vs. 110±8.6mmHg) and in the 12-to-13 group (118±12.8 vs. 114±10.8 mmHg) (Figure 1). A similar difference was found in DBP values, both in the 10-to-11 group (65±7.2 vs. 61±6.7mmHg) and in the 12-to-13 group (68±7.1 vs. 63±7.1mmHg) (Figure 2).

Discussion

This study assessed the prevalence of, and association between, HBP and abdominal obesity in a sample of 10-to-13-year-old students of public schools in the municipality of Londrina, Paraná, Brazil. The overall prevalence of HBP was 12.2% (13.1% in boys and 11.5% in girls). Although the prevalence of HBP varies by country, the percentages found in this study

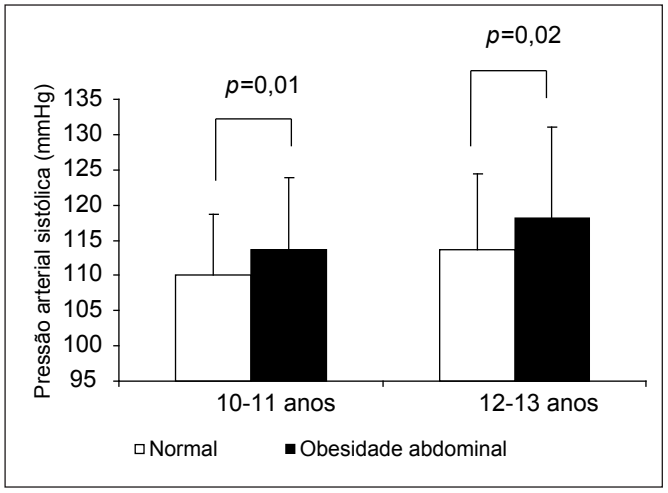

Figure 1 - Comparison of mean systolic blood pressure according to waist circumference in subjects aged 10–13 years.

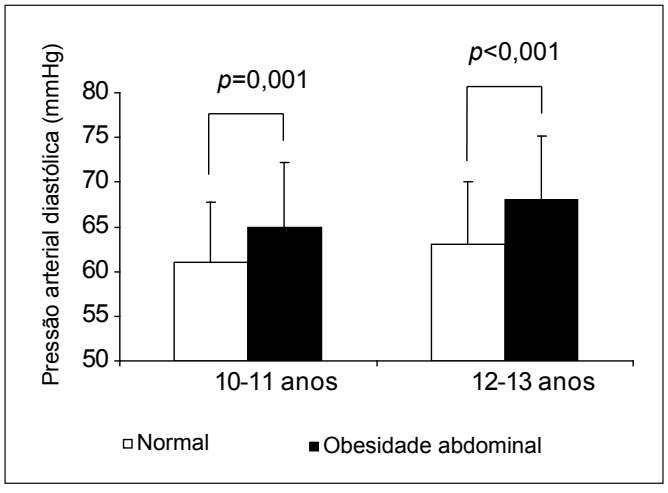

Figure 2 - Comparison of mean diastolic blood pressure according to waist circumference in subjects aged 10–13 years.

are consistent to those reported elsewhere in the literature[12-14], which have ranged from 1% to 22.8%.

A previous study of Brazilian children and adolescents[6] found a 1.7 percentage point reduction in the prevalence of hypertension when a second BP measurement was obtained 2 minutes after the first. In the present study, two standardized measurements were obtained at least 1 minute apart in an attempt to minimize this potential bias. Another important factor that should be taken into account is the use of different cutoffs for BP classification in different studies, leading to a lack of convergence in the results reported in the literature.

In addition to HBP, obesity has been considered one of the main risk factors for cardiovascular disease, particularly when there is a central distribution of adipose tissue. This is a worrisome finding, as the recent literature indicates that WC measurements have been increasing over the past decades in male and female adolescents alike[15]. Of the various anthropometric indicators available for classification of obesity, WC is considered a good option due to the ease of measurement and to the fact that, according to studies, it is a good predictor of all-cause and cardiovascular mortality[6]. Nevertheless, a recent systematic review[16] showed the scarcity of studies that have used WC as an indicator of abdominal obesity in Brazilian children and adolescents.

In the present study, the overall prevalence of abdominal obesity was 11.9%. This rate was higher in boys (14.3%) than in age-matched girls (9.8%). Other experiments conducted in Brazil using WC as an indicator of abdominal obesity reported prevalence rates of 6%[17] and 14.8%[18] in age ranges different from that assessed herein.

Although obesity is considered a grave public health issue[19], few nationwide surveys have assessed the frequency and distribution of abdominal obesity in adolescents and its association with comorbidities such as hypertension. Therefore, another objective of the present study was to ascertain whether an association exists between abdominal obesity and HBP. The risk of HBP was approximately 2.5 times higher in girls with abdominal obesity than in their non-obese peers; in boys, the risk was nearly threefold. Considering both genders, the overall risk of HBP was 2.7 times greater in subjects with abdominal obesity.

The findings of this investigation are consistent with those previously published in the literature[7,20,21]. Although use of the BMI as a marker is routine in studies on the topic, these findings suggest that WC may be superior for identification of adolescents with HBP[21], as WC measurement appears to provide a better estimate of intra-abdominal fat, whereas BMI seems more sensitive to total and subcutaneous adiposity[22-24].

Obesity appears to be associated with HBP, although the causes of this are not fully known. One of the many mechanisms possibly implicated in the influence of central obesity on BP in adolescents involves reduced insulin sensitivity, with subsequent development of compensatory hyperinsulinemia. Excess insulin secretion, which has been observed in obese adolescents and appears to be associated with the presence of intra-abdominal fat[25], is believed to increase retention of sodium and, consequently, fluid; this would stimulate sympathetic activity, ultimately increasing blood pressure. Therefore, salt ingestion – which was not taken into account in the present study-may have been a confounder.

Another potential limitation of this study concerns BP measurement, which, while procured in a standardized manner and in duplicate, with a minimum interval of 1 minute between measurements, was assessed over the course of a single day and period. Moreover, the choice to include only students of public schools may have led to underestimation of the prevalence of obesity, which tends to be higher among students of private educational institutions[26]. Furthermore, the cross-sectional study design precludes establishment of a causal relationship.

On the basis of these results, we conclude that abdominal adiposity was associated with HBP in this sample of adolescents. Public policies geared at preventing obesity, including monitoring of body composition during the transition from childhood to adolescence and then to adulthood, as well as BP monitoring in this population, are necessary.

References

1. World Health Organization. Preventing chronic diseases: a vital investment. Geneva: WHO; 2005.
2. World Health Organization. Prevention of cardiovascular disease: guidelines for assessment and management of cardiovascular risk. Geneva: WHO; 2007.
3. Galobardes B, Costanza MC, Bernstein MS, Delhumeau C, Morabia A. Trends in risk factors for lifestyle-related diseases by socioeconomic position in Geneva, Switzerland, 1993-2000: health inequalities persist. Am J Public Health 2003;93:1302-9.
4. Cercato C, Mancini MC, Arguello AM, Passos VQ, Villares SM, Halpern A. Systemic hypertension, diabetes mellitus, and dyslipidemia in relation to body mass index: evaluation of a Brazilian population. Rev Hosp Clin 2004;59:113-8.
5. Slentz CA, Houmard JA, Kraus WE. Exercise, abdominal obesity, skeletal muscle, and metabolic risk: evidence for a dose response. Obesity (Silver Spring) 2009;17 (Suppl 3):S27-33.
6. Welborn TA, Dhaliwal SS. Preferred clinical measures of central obesity for predicting mortality. Eur J Clin Nutr 2007;61:1373-9.
7. Moura AA, Silva MA, Ferraz MR, Rivera IR. Prevalence of high blood pressure in children and adolescents from the city of Maceió, Brazil. J Pediatr (Rio J) 2004;80:35-40.
8. Taylor RW, Jones IE, Williams SM, Goulding A. Evaluation of waist circumference, waist-to-hip ratio, and the conicity index as screening tools for high trunk fat mass, as measured by dual-energy X-ray absorptiometry, in children aged 3-19 y. Am J Clin Nutr 2000;72:490-5.
9. Christofaro DG, Casonatto J, Polito MD, Cardoso JR, Fernandes R, Guariglia DA *et al*. Evaluation of the Omron MX3 Plus monitor for blood pressure measurement in adolescents. Eur J Pediatr 2009;168:1349-54.
10. Pickering TG, Hall JE, Appel LJ, Falkner BE, Graves J, Hill MN *et al*. Recommendations for blood pressure measurement in humans and experimental animals. Part 1: blood pressure measurement in humans: a statement for professionals from the Subcommittee of Professional and Public Education of the American Heart Association Council on High Blood Pressure Research. Hypertension 2005;45:142-61.
11. 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 2005;115:826-7.
12. Salgado CM, Carvalhaes JT. Arterial hypertension in childhood. J Pediatr (Rio J) 2003;79 (Suppl 1):S115-24.
13. Colín-Ramírez E, Castillo-Martínez L, Orea-Tejeda A, Villa Romero AR, Vergara Castañeda A, Asensio Lafuente E. Waist circumference and fat intake are associated with high blood pressure in Mexican children aged 8 to 10 years. J Am Diet Assoc 2009;109:996-1003.
14. Al-Sendi AM, Shetty P, Musaiger AO, Myatt M. Relationship between body composition and blood pressure in Bahraini adolescents. Br J Nutr 2003;90:837-44.
15. Li C, Ford ES, Mokdad AH, Cook S. Recent trends in waist circumference and waist-height ratio among US children and adolescents. Pediatrics 2006;118:e1390-8.
16. Cavalcanti CB, Barros MV, Menêses AL, Santos CM, Azevedo AM, Guimarães FJ. Abdominal obesity in adolescents: prevalence and association with physical activity and eating habits. Arq Bras Cardiol 2010;94:371-7.
17. Cavalcanti CB, Carvalho SC, Barros MV. Anthropometric indicators of abdominal obesity: review of the papers indexed on SciELO electronic library. Rev Bras Cineantropom Desempenho Hum 2009;11:217-25.
18. Fernandes RA, Casonatto J, Christofaro DG, Cucato GG, Oliveira AR, Freitas Júnior IF. Family factors associated with abdominal obesity in adolescents. Rev Bras Saude Mater Infant 2009;9:451-7.
19. Popkin BM, Doak CM. The obesity epidemic is a worldwide phenomenon. Nutr Rev 1998;56:106-14.
20. Guimarães IC, Almeida AM, Santos AS, Barbosa DB, Guimarães AC. Blood pressure: effect of body mass index and of waist circumference on adolescents. Arq Bras Cardiol 2008;90:426-32.
21. Flores-Huerta S, Klünder-Klünder M, Reyes de la Cruz L, Santos JI. Increase in body mass index and waist circumference is associated with high blood pressure in children and adolescents in Mexico City. Arch Med Res 2009;40:208-15.
22. Lee S, Bacha F, Arslanian SA. Waist circumference, blood pressure, and lipid components of the metabolic syndrome. J Pediatr 2006;149:809-16.
23. Benfield LL, Fox KR, Peters DM, Blake H, Rogers I, Grant C *et al*. Magnetic resonance imaging of abdominal adiposity in a large cohort of British children. Int J Obes (Lond) 2008;32:91-9.
24. Lee S, Bacha F, Gungor N, Arslanian SA. Waist circumference is an independent predictor of insulin resistance in black and white youths. J Pediatr 2006;148:188-94.
25. Caprio S, Tamborlane WV. Metabolic impact of obesity in childhood. Endocrinol Metab Clin North Am 1999;28:731-47.
26. Brasil LM, Fisberg M, Maranhão HS. Excess weight in children from Brazilian Northeast: difference between public and private schools. Rev Bras Saude Mater Infant 2007;7:405-12.