DOI: 10.1590/1413-81232015211.00262015

Isolated and combined presence of elevated anthropometric indices in children: prevalence and sociodemographic correlates

Valter Cordeiro Barbosa Filho [1]
Wagner de Campos [2]
Ricardo Rosa Fagundes [2]
Adair da Silva Lopes [1]
Evanice Avelino de Souza [3]

Abstract *This study analyzed the prevalence and sociodemographic factors associated to the isolated and combined presence of elevated anthropometric indices among children. A cross-sectional study was performed with 2,035 children (aged 6-11 years, 50.1% of girls) who were randomly selected in schools from Colombo, Brazil. Body Mass Index (BMI), Waist Circumference (WC) and Waist-to-Height Ratio (WHtR) were classified using reference values. Age, gender, type of school, shift, and residence area were potential risk factors. Binary logistic regression was used (p < 0.05). The prevalence of children with isolated presence of elevated BMI, WHtR or WC was observed in 9.4% (confidence interval [CI] of 95%: 3.3; 15.7), 8.7% (CI 95%: 1.7; 15.9) and 4.4% (CI 95%: 1.0; 7.9), 8.7% of children, respectively. The presence of one or more elevated anthropometric index was observed in 16.9% (CI 95%: 5.4; 28.5) of children. Boys (BMI), younger children (WC) and children from public schools (BMI, WC or WHtR) were high-risk subgroups to the isolated presence of elevated anthropometric indices. Children from public schools and rural areas were high-risk subgroup to the combined presence of elevated anthropometric indices. In conclusion, Public policies to combat childhood obesity may be more effective whether they targeted at children from public schools and rural areas.*

Key words *Obesity, Cross-sectional study, Child health, Risk factors*

[1] Departamento de Educação Física, Centro de Desportos, Universidade Federal de Santa Catarina. Campus Universitário, Trindade. 88040-900 Florianópolis SC Brasil. valtercbf@gmail.com
[2] Departamento de Educação Física, Universidade Federal do Paraná.
[3] Grupo de Pesquisa em Atividade Física e Saúde na Escola. Instituto de Educação Física e Esportes. Universidade Federal do Ceará.

Introduction

Obesity is a serious public health problem, which has been recognized since the late 1990s[1], but obesity rates have grown in various locations, specifically in developing countries and younger ages[2,3]. For example, the prevalence rates of general obesity exceed 10% among children aged 5–9 years in Brazil[4]. Additionally, central obesity (excessive fat accumulation in the central region of the body) has also grown in children from different countries[5,6].

Different anthropometric indices have been used to identify the presence of general (especially, body mass index [BMI]) or centralized (e.g., waist circumference [WC], and waist-to-height ratio [WHtR]) obesity[1,7,8]. BMI is an example of an indicator of general obesity that is often used in clinical and epidemiological practice due to easy application, low cost and good screening of cardiovascular risk factors (e.g., high blood pressure and hyperglyceridemia) in children[1,7]. WC represents the accumulation of abdominal fat and can predict cardiovascular risk as well as or even better than BMI[8,9]. Other studies have highlighted that WHtR is an important indicator of central obesity in children, and it increases the prediction of cardiovascular risk when combined with BMI classification[10,11]. Therefore, the diagnosis of obesity based on the combination of these anthropometric indices can provide a more reliable estimate of the cardiovascular risk among children[9,10].

Although Brazilian literature often discusses the epidemiology of general obesity among adolescents[12,13], assessing the presence of central obesity in Brazilian children requires more research[14]. Additionally, epidemiological studies with children have used only one anthropometric index to identify obesity[15-17]. Therefore, studies that include children to assess the presence of general and central obesity are encouraged. Finally, the association between sociodemographic factors (such as gender, age, living area or school system) with the general[15,16,18-20] and central[15,17,18,21-24] obesity in children and adolescents has been researched, but the association between sociodemographic factors and the combined presence of general and central obesity is unknown. Studies in this direction are important for indicating whether there are differences in the child subgroups regarding a higher risk of having different manifested forms of obesity – general or abdominal obesity, or a combination of these two. This evidence may help to target public strategies to combat childhood obesity.

In this perspective, this study aimed to identify the isolated and combined presence of elevated anthropometric indices (BMI, WC and WHtR), and the sociodemographic factors associated with these conditions among children of a Brazilian municipality.

Method

Population and sample

This cross-sectional study was conducted in the city of Colombo, Parana, southern Brazil, which is located in the metropolitan area of Curitiba and has a Human Development Index (HDI, 2010) of 0.733, which is 73rd in the Parana state. In 2010, the city of Colombo had 27,000 children regularly enrolled from 1st to 5th grades in public and private elementary schools. This was the study population. Data collection was conducted from March to September 2012.

The following statistical parameters were adopted to calculate the sample size: (i) a confidence level of 95%; (ii) a sampling error of three percentage points; (iii) a prevalence of the outcome of interest (at least one indicator of obesity) of 50.0%, which considers a maximum variance and overestimates the sample size; and (iv) a design effect of 2.0[25]. Based on these parameters, the minimum sample size of the study was estimated to be 1,978 children. A margin of about 20% for possible losses and refusals during data collection was added. Therefore, the sample was estimated to be 2,400 children.

The local schools were grouped into three categories: public schools in urban areas, public schools in the countryside and private network schools (39, 5 and 16 schools, respectively). Initially, schools that would participate in the study were randomly drawn (sampling unit) using an electronic random number generator (http://www.random.org). This draw was done by strata, and the number of schools represented the proportion of children in each stratum. Subsequently, all children in 1st to 5th-grade classes in elementary schools, enrolled in schools drawn, were invited to participate. Fourteen schools were vis-

Ciência & Saúde Coletiva, 21(1):213-224, 2016

ited (seven from public schools in urban areas, two public and five in rural areas of the private network), for a total of 138 classes.

Children without informed consent (IC), who refused to participate in the study or who were outside the age range of interest (6–11 years old) were not evaluated or were excluded from the final sample.

The estimate of the statistical power of the sample was performed a posteriori, considering the confidence level of 95% (α= 0.05) and 80% power (α= 0.20). With a final sample of 2,035 teenagers, it was possible to detect statistical significance for odds ratios > 1.36 as risk and < 0.64 as protection for elevated BMI> 1.53 as risk and <0.47 as protection for elevated WC, > 1.42 as risk and < 0.58 as protection for elevated WHtR, and > 1.30 as risk and <0.70 as protection for the combination of elevated anthropometric indices. In these calculations, we used the prevalence of 9.2%, 4.2%, 7.7%, and 16.5% for non-exposed groups with elevated BMIs, WCs, or WHtRs, and the combination of elevated anthropometric indices, respectively.

Instruments and procedures

Data collection was based on anthropometric measures (weight, height and WC). The children were initially organized in the reserved room for anthropometric assessment. Each child was assessed individually, aiming to minimize constraints. All measurements were performed by a single experienced evaluator. Two scholars of Physical Education assisted in recording the anthropometric data.

The materials used in this study were: a tape measure (scale of 0.1 cm, Easyread® brand and Cateb model) fixed on a flat wall with no baseboard to determine height; a digital scale (resolution of 100 g and capacity of 150 kg, Wiso® model and W903 brand) to measure body mass; and a metal tape (scale of 0.1 cm, Cescorf® brand) to measure WC. Height and body mass were measured according to standards proposed by Gordon et al.[26]. Height was measured without shoes, heels together and head oriented to the Frankfurt plane.

To determine body mass, the children were evaluated in a standing position, without shoes and wearing their Physical Education uniform. Body mass and height were used to calculate BMI (kg/m^2). The z-score of BMI for children, specific for gender and age, was calculated using the World Health Organization's ANTHRO Plus program (Centers for Disease Control and Prevention, Atlanta, USA). Children with BMI z-score values equal to or greater than two were considered to have elevated BMIs[7].

WC was measured with the children standing, with a relaxed abdomen, arms lateral along the body, and body weight distributed equally on both legs. The tape was placed horizontally at the midpoint between the lower border of the last rib and the iliac crest[27]. Two measurements were obtained from each child and the average of the two was calculated (intraclass correlation coefficient = 0.99). Subsequently, WC was classified according to specific cutoff points for gender and age, as proposed by Fernández et al.[28]. The 90th percentile for age and gender determined elevated WC[28]. Finally, WHtR was obtained by calculating the ratio of WC and height[8]. WHtR less than 0.50 was considered elevated[10].

The isolated presence of elevated anthropometric indices was analyzed considering BMI, WC, and WHtR separately. To analyze the combined presence of elevated anthropometric indices, a new variable was created to record the amount of elevated anthropometric indices of each child (none, one, two or three). In exploratory analyses, the outcome was analyzed as whether or not there was at least one elevated anthropometric index (BMI, WC, and/or WHtR).

Age was calculated as the difference between the date of birth and date of collection. During the analysis of the explanatory variables, children were grouped into three age groups: 6–7, 8–9 and 10–11 years. The variables gender (male and female), school system (public or private), study shift (morning or afternoon), grades (1st, 2nd, 3rd, 4th or 5th) and living area (urban or rural) were determined according with the information passed on by the school administration and the school.

Data analysis

Descriptive statistics were used to present the data based on means and standard deviations for continuous variables, and absolute and relative frequencies for categorical variables. The Kolmogorov-Smirnov test was used to check the distribution of continuous data (age and anthropometric variables). Student's t-test for independent samples was used to compare continuous variables between genders. The chi-square test for heterogeneity or linear trends, as appropriate, was used to identify possible discrepancies between genders in the distribution of categorical variables (age, type of school, turn series, housing zone). The 95% confidence interval (95% CI) was calculated for the isolated (BMI, WC and WHtR analyzed separately) and combined (pooled BMI classification, WC and WHtR) prevalence of high anthropometric indices, separately by gender.

Crude and adjusted logistic regression models were used to identify factors associated (gender, age, school system, shift, number, and housing zone) with the isolated or combined presence of elevated anthropometric indices among children. The crude and adjusted odds ratios, as well as their respective 95% Cis, were calculated. All variables were entered simultaneously in a multivariate regression model, independent of the p-value of the crude analysis. The level of significance was set at 5% ($p < 0.05$) for the final analysis. Statistical procedures for complex samples were included in all analyses by adding the prefix "svyset" to ponder stratum, conglomerates and sample weights using the software STATA version 11 (Stata Corp., College Station, TX, USA).

Ethical aspects

The study was approved by the Ethics Committee of the Federal University of Parana, following the norms of the National Health Council (Resolution 196/96). All children received permission from parents/guardians to participate in the study.

Results

The selection process resulted in 2,750 children who were invited to participate in this study. Of these, 20.0% did not return the informed consent form signed by parents/guardians and 6% refused to participate in the study. A child was excluded from the final sample because he was 15 years old. There was no sample loss due to incomplete data. Thus, the final sample consisted of 2,035 children (1,016 boys and 1,019 girls). The proportion of the population represented by this sample was 11.6%, 12.2%, 11.3%, 14.9% and 13.3% for children from 1st, 2nd, 3rd, 4th, and 5th grades, respectively. The average age was 8.87 years, with a standard deviation of 1.35 years.

Most children were from 1st and 2nd grades (21.4% and 22.3%, respectively), were enrolled in classes in the morning period (55.4%) and attended public (63.3%) schools. Additionally, 98.0% of children were studying in schools in the urban area. There were no significant differences between genders for the descriptive variables studied ($p > 0.05$, Table 1).

Figures 1A and 1B show the prevalence and 95% isolated and combined presence of elevated anthropometric indices between boys and girls. The prevalence of these indices was similarly present between genders (there was an overlap of 95% CIs). The elevated BMI was present in 9.4% (95% CI: 3.3, 15.7) of children. The elevated WHtR was observed in 8.7% (95% CI: 1.7, 15.9) of children, while 4.4% (95% CI: 1.0, 7.9) had elevated WCs.

The presence of at least one elevated anthropometric index (BMI, WC, and/or WHtR combined) was observed in 16.9% (95% CI: 5.4, 28.5) of children. However, the accumulation of two or three elevated anthropometric indices was less than 5% in both boys and girls (Figure 1B).

In the crude analysis, gender and school system were associated with elevated BMI among children. The odds ratios remained significant after adjusting for other independent variables ($p < 0.05$). After adjusting for confounders, girls and children from private schools had lower odds ratios for having elevated BMIs (Table 2).

The age group and the school system were factors associated with elevated WC among children, both in crude and adjusted analyses. Eight and nine-year-olds had lower odds ratios for having elevated WCs when compared to children aged six and seven years. Children from private schools had a lower odds ratio for having elevated WCs in comparison with their peers from public schools (Table 3).

The age group and the school system were associated with elevated WHtRs in the crude analysis. In the adjusted analysis, only the school system remained associated with high WHtRs. Children from private school had a 90% lower odds ratio for having elevated WHtRs in comparison to their peers from public schools (Table 3).

Considering the presence of at least one elevated anthropometric index (BMI, WC, and/

Table 1. Characteristics of the sample. Colombo, Parana, Brazil (2012

Variables	All (n = 2,035)	Boys (n = 1,016)	Girls (n = 1,019)	p-value
Continuous variables, Mean (SD)				
Age (years)	8.87 (1.35)	8.86 (1.35)	8.89 (1.34)	0.66*
Body weight (kg)	29.65 (7.88)	29.61 (7.92)	29.68 (7.85)	0.85*
Height (cm)	131.23 (12.59)	131.49 (13.35)	130.99 (11.79)	0.37*
BMIC (kg/m²)	17.05 (2.95)	16.99 (2.97)	17.10 (2.92)	0.40*
WC (cm)	57.00 (6.88)	56.88 (6.98)	57.13 (6.77)	0.42*
WHtR	0.44 (0.05)	0.43 (0.05)	0.44 (0.05)	0.13*
Categorical variables, n (%)				
Age groups (years)				0.67***
6	174 (8.6)	85 (8.3)	89 (8.8)	
7	442 (21.7)	228 (22.3)	214 (21.1)	
8	469 (23.0)	241 (23.6)	228 (22.5)	
9	453 (23.3)	221 (21.6)	232 (32.9)	
10	371 (18.2)	184 (18.0)	187 (18.5)	
11	126 (6.2)	63 (6.2)	63 (6.2)	
Grade				0.41***
1st	435 (21.4)	226 (22.1)	209 (20.6)	
2nd	454 (22.3)	222 (21.7)	232 (22.9)	
3rd	405 (19.9)	207 (20.3)	198 (19.5)	
4th	391 (19.2)	203 (19.9)	188 (18.6)	
5th	350 (17.2)	164 (16.0)	186 (18.4)	
Study shift				0.26**
Morning	1,128 (55.4)	554 (54.2)	574 (56.7)	
Afternoon	907 (44.6)	468 (45.8)	439 (43.3)	
School system				0.12**
Private	746 (36.7)	358 (35.0)	388 (38.3)	
Public	1289 (63.3)	664 (65.0)	625 (61.7)	
School area				0.85**
Rural	41 (2.0)	20 (2.0)	21 (2.1)	
Urban	1,994 (98.0)	1,002 (98.0)	992 (97.9)	

* P-values obtained using the t-test for independent samples. ** P-values obtained using the Chi-square test for heterogeneity. *** P-values obtained using the Chi-square test for linear trends. Age groups were defined as follows: 6.00-6.99 = 6 years; 7.00-7.99= 7 years; 8.00-8.99 = 8 years; 9.00-9.99 = 9 years; 10.00-10.99 = 10 years; and 11.00-11.99 = 11 years. BMI: body mass index; WC: waist circumference; WHtR: waist-to-height ratio. SD: standard deviation.

or WHtR combined), the crude and adjusted analyses showed that school system and residence area were significantly associated with the combined presence of elevated anthropometric indices ($p<0.05$). Private school children had a lower odds ratio for the combined presence of elevated anthropometric indices. In contrast, rural children had a higher odds ratio for having the combined presence of elevated anthropometric indices in comparison to their peers from urban areas (Table 4).

Discussion

This study identified the prevalence of isolated anthropometric indices in around 10% of children in Colombo, Brazil. These were lower prevalence rates in comparison to those found in other pediatric populations when considering the isolated presence of elevated BMI[4,15,16,18] (ranging from 19.2%[15] to 32.0%[4]), WC[17,18,21] (ranging from 10.9%[21] to 30%[17]), or WHtR[15-18,21] (ranging from 11.9%[16] to 18.3%[21]). This evidence indicated that, while the isolated presence of some elevat-

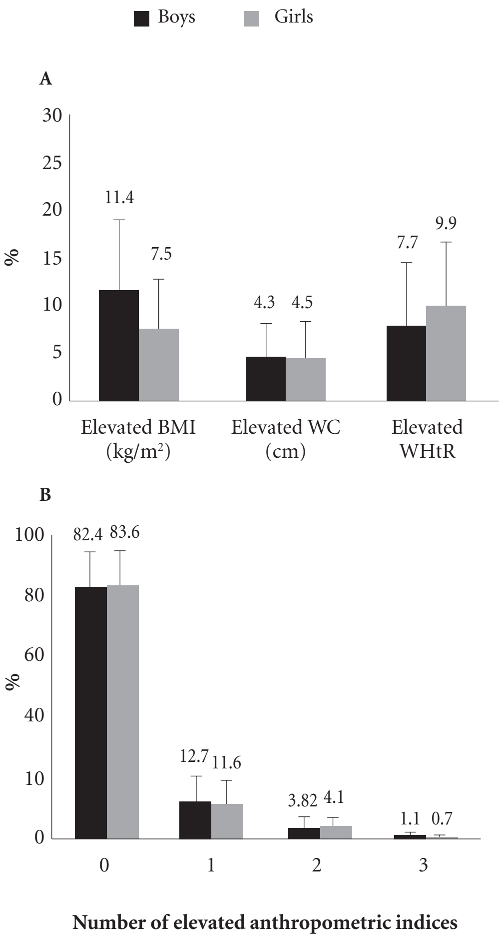

Figure 1. Prevalence and confidence interval of 95% of the isolated (A) and combined (B) presence of elevated BMI, WC, and/or WHtR among boys and girls. Colombo, Parana, Brazil (2012).

BMI: body mass index; WC: waist circumference; WHtR: waist-to-height ratio.

ed anthropometric indices (especially BMI and WHtR) was worrisome in children of Colombo, their estimates were lower than the prevalence rates found in other locations.

The literature has shown that prevalence rates of general or central obesity could vary according to location/region[2,4], which might partly explain the differences between the studies. Multifactorial issues (genetic, social, behavioral, and/or economic) may also contribute to the difference in obesity estimates between populations[29]. Also, the use of different classification criteria may explain such distinctions. Barbosa Filho et al.[30] found that the use of different BMI classification criteria could double the prevalence of obesity in the same sample. Additionally, Moraes et al.[31] observed the use of 18 different criteria for WC classification in studies on central obesity, which makes understanding the real distinctions of this condition among child populations difficult. Finally, the studies included different age groups (which implies different stages of life) and adopted different sampling procedures that made it impracticable to accurately compare the prevalence rates of elevated anthropometric indices between studies.

The presence of at least one elevated anthropometric indices (BMI, WC, and/or WHtR) was observed in 16.9% of children. Studies with similar estimates are rare and focused only on adolescents[18] or only on the combined presence of WC and high WHtR[21]. This made the comparison impracticable.

The overall and central obesity represented a risk to the children's health[9-11], especially when they were combined. Janssen et al.[9] showed that the combination of elevated WC and BMI improved the prediction of cardiovascular risk factors in children, such as high blood pressure, hyperglyceridemia and hypercholesterolemia. Mokha et al.[10] showed that WHtR detected not only cardiovascular risk among children with normal weight, but pointed to the lack of risk among those with overweight and obesity. Although the estimate of children with general and central obesity combined was low (less than 5%, see Figure 1B), combining BMI, WHtR and CC was important to indicate more precisely the proportion of children with health risks through the different manifestations of obesity. Boys were a subgroup associated with high BMI in this study. Systematic reviews indicated that the direction of the association between gender and general obesity (elevated BMI) might vary between studies[12,13]. These differences might be due to behavioral and sociocultural variations between countries/regions, so that children of a specific gender adopted some behaviors that were obesogenic, which might not have happened in other places[3]. However, these differences between boys and girls were not reflected when centralized obesity indices (WC and WHtR) were evaluated, as observed in this study. Therefore, more studies are needed to identify the behavioral and socio-cultural mediators of the relationship between gender and general and central obesity. Also, the distinctions

Ciência & Saúde Coletiva, 21(1):213-224, 2016

Table 2. Factors associated with elevated body mass index among children. Colombo, Parana, Brazil (2012).

Variables	IMC elevado, escore-z ≥ 2				
	n (%)	Crude OR (IC 95%)	p-value**	Adjusted OR (IC 95%)*	p-value**
Gender			< 0.01		< 0.01
Boys	117 (11.4)	1.0		1.0	
Girls	76 (7.5)	0.63 (0.49; 0.81)		0.63 (0.50;0.81)	
Age groups (years)			0.76		0.23
6-7	59 (9.6)	1.0		1.0	
8-9	75 (8.1)	0.84 (0.24;2.88)		0.74 (0.23;2.38)	
10-11	59 (11.9)	1.27 (0.39;4.19)		0.94 (0.37;2.43)	
Study shift			0.40		0.20
Morning	123 (10.9)	1.0		1.0	
Afternoon	70 (7.7)	0.69 (0.26;1.77)		0.62 (0.28;1.33)	
School system			< 0.01		< 0.01
Public	180 (14.0)	1.0		1.0	
Private	13 (1.7)	0.11 (0.05;0.22)		0.12 (0.05;0.25)	
School area			0.12		0.33
Urban	184 (9.2)	1.0		1.0	
Rural	9 (22.0)	2.8 (0.74;10.31)		1.72 (0.55;5.34)	

BMI: body mass index; OR (IC 95%): odds ratio ad confidence interval of 95%. * Odds ratio and CI 95% adjusted to other independent variables. ** P-values obtained using binary logistic regression with crude and adjusted models.

between countries/regions should be considered in the implementation of gender-specific strategies to combat childhood obesity.

Age was inversely associated with the isolated presence of elevated WC. The higher presence of abdominal obesity common in younger children was also found in a study of Chinese children[17]. This result concerned the fact that the assessment of central obesity at younger ages has not been sufficiently considered in clinical and epidemiological practice, often due to the difficulty of knowing which reference values were used for the diagnosis[29]. Therefore, these results supported the early anthropometric monitoring for centralized obesity identification, both in clinical and public health practices.

In this study, children from public schools were a subgroup associated with elevated anthropometric indices – general (BMI) and central (WC and WHtR) obesity, as well as the accumulation of elevated anthropometric indices. This result differed from another study that showed an increased risk of general and central obesity in children from private schools[20]. Another worrying result was the largest combined presence of elevated anthropometric indices in rural children. This finding was similar to that observed in a study of Iranian[19] and South African[24] children, although other studies indicated a higher prevalence of general[4,20] and central[20] obesity in urban areas.

General[2] and central[31] obesity emerged in the poorest populations of children and developing countries, as confirmed in the above results. In families that lived in rural areas and had low financial conditions (and enrolled their children in public schools), there was an increase in the acquisition and access to energy-dense foods (such as candies and soft drinks), as well as greater access to more sedentary activities in daily living[3]. Unsafe neighborhoods or simply more comfortable transport alternatives (e.g., a school bus instead of walking or biking) were other aspects that favored a sedentary lifestyle[3]. This situation was compounded by lower coverage and more difficult access to health and primary care services among the families with lower financial conditions[3], which increased the negative impact of socio-cultural and structural changes in public health problems such as childhood obesity.

These findings have important practical implications, as they indicate the need to expand

Table 3. Factors associated with elevated waist circumference and waist-to-height ratio among children. Colombo, Parana, Brazil (2012).

Variables	Elevated WC, ≥ 90th				
	n (%)	Crude OR (IC 95%)	p-value**	Adjusted OR (IC 95%)*	p-value**
Gender			0.83		0.75
Boys	44 (4.3)	1.0		1.0	
Girls	46 (4.5)	1.05 (0.61; 1.83)		1.07 (0.87; 1.52)	
Age groups (years)			0.02		0.02
6-7	40 (6.5)	1.0		1.0	
8-9	26 (2.8)	0.41(0.24; 0.73)		0.54 (0.32; 0.90)	
10-11	24 (4.8)	0.73 (0.42; 1.25)		1.10 (0.59; 2.05)	
Study shift			0.54		0.12
Morning	54 (4.8)	1.0		1.0	
Afternoon	36 (4.0)	0.82 (0.41; 1.62)		0.63 (0.34; 1.15)	
School system			< 0.01		< 0.01
Public	84 (6.5)	1.0		1.0	
Private	6 (0.8)	0.12 (0.04; 0.28)		0.11 (0.05; 0.28)	
School area			0.13		0.28
Urban	83 (4.2)	1.0		1.0	
Rural	7 (17.1)	4.74 (0.61; 9.99)		2.61 (0.41; 9.35)	

Variables	Elevated WHtR (≥ 0.50)				
	n (%)	Crude OR (IC 95%)	p-value**	Adjusted OR (IC 95%)*	p-value**
Gender					0.08
Boys	79 (7.7)	1.0	0.13	1.0	
Girls	100 (9.9)	1.31 (0.91; 1.88)		0.83 (0.58; 1.19)	
Age groups (years)					0.30
6-7	58 (9.4)	1.0	0.57	1.0	
8-9	74 (8.0)	0.84 (0.55; 0.73)		0.84 (0.49; 1.45)	
10-11	47 (9.5)	1.00 (0.73; 1.39)		1.39 (0.96; 2.00)	
Study shift					0.70
Morning	101 (9.0)	1.0	0.88	1.0	
Afternoon	78 (8.6)	0.96 (0.52; 1.76)		0.88 (0.45; 1.72)	
School system					< 0.01
Public	169 (13.1)	1.0	< 0.01	1.0	
Private	10 (1.3)	0.10 (0.03; 0.31)		0.09 (0.02; 0.33)	
School area					0.24
Urban	168 (8.4)	1.0	0.09	1.0	
Rural	11 (26.8)	3.99 (0.79;10.12)		2.45 (0.50; 11.92)	

WC: waist circumference; WHtR: waist-to-height ratio; OR (IC 95%): odds ratio and confidence interval of 95%. * Odds ratio and CI 95% adjusted to other independent variables. ** P-values obtained using binary logistic regression with crude and adjusted models.

policies that combat childhood obesity to cover populations in rural areas and those attending public schools.

Some strengths can be highlighted in this study. First, the representativeness of the sample, as children were selected from different regions (urban and rural) and education systems (public or private), allowed for the analysis to be extrapolated to the pediatric population of the municipality. Another strong point was the use of three different anthropometric indices of obesity, which contributed to the diagnosis of general and centralized obesity in children as well as their potential sociodemographic correlates. Finally, it

Ciência & Saúde Coletiva, 21(1):213-224, 2016

Table 4. Factors associated with the combined presence of elevated anthropometric indices among children. Colombo, Parana, Brazil (2012).

Variables	Combined presence of elevated anthropometric indices (BMI, WC, and/or WHtR)				
	n (%)	Crude OR (IC 95%)	p-value**	Adjusted OR (IC 95%)*	p-value**
Gender			0.50		0.75
Boys	179 (17.5)	1.0		1.0	
Girls	166 (16.4)	0.92 (0.73; 1.17)		0.96 (0.75; 1.22)	
Age groups (years)			0.20		0.43
6-7	107 (17.4)	1.0		1.0	
8-9	138 (15.0)	0.84 (0.50; 1.39)		0.78 (0.50; 1.21)	
10-11	100 (20.1)	1.20 (0.72; 1.99)		0.95 (0.61; 1.48)	
Study shift			0.20		0.08
Morning	204 (18.1)	1.0		1.0	
Afternoon	141 (15.5)	0.83 (0.63; 1.10)		0.77 (0.58; 1.02)	
School system			< 0.01		< 0.01
Public	322 (25.0)	1.0		1.0	
Private	23 (3.1)	0.09 (0.05; 0.18)		0.10 (0.05; 0.18)	
School area			< 0.01		0.04
Urban	329 (16.5)	1.0		1.0	
Rural	16 (39.0)	3.24 (1.72; 6.10)		1.90 (1.02; 3.54)	

BMI: body mass index; WC: waist circumference; WHtR: waist-to-height ratio. OR (IC 95%): odds ratio and confidence interval of 95%. * Odds ratio and CI 95% adjusted to other independent variables. ** P-values obtained using binary logistic regression with crude and adjusted models.

is important to highlight the evaluation of potential factors associated with the simultaneous presence of anthropometric indices of obesity; an analysis with little evidence in the literature.

This study also has limitations. The first, based on the study sample evaluated in a Brazilian city, makes it impossible to extrapolate these results to children elsewhere. Another limitation refers to the use of anthropometric indices rather than objective measures (e.g., DXA or plethysmography), in the estimation of body fat in children. However, these indices have high precision and are important clinical and epidemiological tools when evaluating general obesity and abdominal identification in children[8]. Finally, although it is a criterion commonly used in Brazilian studies[13,14], the cutoff points proposed by Fernandéz et al.[28] were based on the WC percentile of American children and adolescents, and may not adequately reflect the presence of abdominal obesity in Brazilian children.

Conclusion

Overall, prevalence rates for elevated anthropometric indices (BMI, WC, or WHtR) ranged from 4.4% (elevated WC) to 9.4% (elevated BMI). However, about two in 10 children had at least a high anthropometric index. Being a female or an older child was associated with a lower odds ratio for having an elevated BMI and WC, respectively. However, children from public schools had higher odds ratios for the isolated presence of elevated BMI, WC, and WHtR; the public school system and rural residence were positively associated with the accumulation of elevated anthropometric indices.

These findings suggest that, for some populations, the vulnerable context and living in areas far from urban centers may worsen the factors associated with general and central obesity. Public policies for child health in this region must direct their attention to these peculiarities. Promoting a positive school community, children's healthy eating and an active lifestyle can be promising strategies for health promotion and obesity prevention in this population.

Collaborations

VC Barbosa Filho participated in all stages of the study, the definition and delimitation of collection, data analysis and article writing. EA Souza participated in the interpretation and discussion of results. RR Fagundes took part in the definition of the study, coordinated the data collection and contributed to the writing of the article. W Campos and AS Lopes took part in the study of problem definition and reviewed the article in its different stages. All authors approved the final version of the study.

Acknowledgments

VC Barbosa Filho thanks the *Coordenação de Aperfeiçoamento de Pessoal de Nível Superior* (CAPES) for funding during the Doctoral scholarship.

References

1. World Health Organization (WHO). *Obesity: Preventing and managing the global epidemic*. Geneva: WHO; 2000.
2. De Onis M, Blössner M, Borghi E. Global prevalence and trends of overweight and obesity among preschool children. *Am J Clin Nutr* 2010; 92(5):1257-1264.
3. Dinsa G, Goryakin Y, Fumagalli E, Suhrcke M. Obesity and socioeconomic status in developing countries: A systematic review. *Obes Rev* 2012; 13(11):1067-1079.
4. Instituto Brasileiro de Geografia e Estatística (IBGE). *Pesquisa de Orçamentos Familiares: Antropometria e estado nutricional de crianças, adolescentes e adultos no Brasil.* Rio de Janeiro: IBGE; 2010.
5. Garnett SP, Baur LA, Cowell CT. The prevalence of increased central adiposity in Australian school children 1985 to 2007. *Obes Rev* 2011; 12(11):887-896.
6. McCarthy H, Jarrett K, Emmett P, Rogers I. Trends in waist circumferences in young British children: A comparative study. *Int J Obes* 2005; 29(2):157-162.
7. World Health Organization (WHO). *Growth reference data for 5-19 years.* Geneva: WHO; 2007.
8. World Health Organization (WHO). *Waist circumference and waist-hip ratio: Report of a WHO expert consultation*. Geneva: WHO; 2008.
9. Janssen I, Katzmarzyk PT, Srinivasan SR, Chen W, Malina RM, Bouchard C, Berenson GS. Combined influence of body mass index and waist circumference on coronary artery disease risk factors among children and adolescents. *Pediatr* 2005; 115(6):1623-1630.
10. Mokha JS, Srinivasan SR, DasMahapatra P, Fernandez C, Chen W, Xu J, Berenson GS. Utility of waist-to-height ratio in assessing the status of central obesity and related cardiometabolic risk profile among normal weight and overweight/obese children: The bogalusa heart study. *BMC Pediatr* 2010;10:73.
11. Adair L, Gordon Larsen P, Du S, Zhang B, Popkin B. The emergence of cardiometabolic disease risk in chinese children and adults: Consequences of changes in diet, physical activity and obesity. *Obes Rev* 2014; 15(Supl. 1):49-59.
12. Araújo VC, Konrad LM, Rabacow FM, Graup S, Amboni R, Farias Júnior JC. Prevalência de excesso de peso em adolescentes brasileiros: Um estudo de revisão sistemática. *Rev Bras Ativ Fís Saúde* 2012; 12(3):79-87.
13. Tassitano RM, Tenório MCM, Hallal PC. Revisão sistemática sobre obesidade em adolescentes brasileiros. *Rev Bras Cineantropom Desempenho Hum* 2009; 11(4):449-456.
14. Cavalcanti CB, Carvalho SC, Barros MVG. Indicadores antropométricos de obesidade abdominal: revisão dos artigos indexados na biblioteca Scielo. *Rev Bras Cineantropom Desempenho Hum* 2009; 11(2):217-225.
15. Rafraf M, Mohamadi E, Gargari B. Prevalence of overall and abdominal obesity among adolescent high school girls in Tabriz, Iran. *Int Med J Malaysia* 2013; 12(1):27-32.
16. Ricardo GD, Gabriel CG, Corso ACT. Anthropometric profile and abdominal adiposity of school children aged between 6 and 10 years in southern Brazil. *Rev Bras Cineantropom Desempenho Hum* 2012; 14(6):636-646.

17. Xiong F, Garnett SP, Cowell CT, Biesheuvel C, Zeng Y, Long C-L, Wang Q, Wang D-G, Luo Y-H, Luo S-Q. Waist circumference and waist-to-height ratio in Han Chinese children living in Chongqing, south-west China. *Public Health Nutr* 2011; 14(1):20-26.
18. Pinto ICS, Arruda IKG, Diniz AS, Cavalcanti AMT. Prevalência de excesso de peso e obesidade abdominal, segundo parâmetros antropométricos, e associação com maturação sexual em adolescentes escolares. *Cad Saude Publica* 2010; 26(9):1727-1737.
19. Maddah M, Nikooyeh B. Obesity among Iranian adolescent girls: Location of residence and parental obesity. *J Health Popul Nutr* 2010; 28(1):61-66.
20. Misra A, Shah P, Goel K, Hazra DK, Gupta R, Seth P, Tallikoti P, Mohan I, Bhargava R, Bajaj S. The high burden of obesity and abdominal obesity in urban Indian schoolchildren: A multicentric study of 38,296 children. *Ann Nutr Metab* 2011; 58(3):203-211.
21. Bamoshmoosh M, Massetti L, Aklan H, Al-Karewany M, Al Goshae H, Modesti PA. Central obesity in Yemeni children: A population based cross-sectional study. *World J Cardiol* 2013; 5(8):295-304.
22. Pedroni JL, Rech RR, Halpern R, Marin S, Roth LR, Sirtoli M, Cavalli A. Prevalência de obesidade abdominal e excesso de gordura em escolares de uma cidade serrana no sul do Brasil. *Cien Saude Colet* 2013; 18(5):1417-1425.
23. Silva DAS, Pelegrini A, Silva AF, Grigollo LR, Petroski EL. Obesidade abdominal e fatores associados em adolescentes: comparação de duas regiões brasileiras diferentes economicamente. *Arq Bras Endocrinol Metab* 2012; 56(5):291-299.
24. Toriola A, Moselakgomo V, Shaw B, Goon D, Anyanwu F. Are rural south african children abdominally obese? *Pak J Med Sci* 2013; 29(3):740-743.
25. Luiz R, Magnanini M. The logic of sample size determination in epidemiological research. *Cad Saúde Colet* 2000; 8(2):9-28.
26. Gordon C, Chumlea W, Roche A. Stature, recumbent length, and weight. In: Lohman TG, Martorell R, ed. *Anthropometric standardization reference manual.* Champaign: Human kinetics Books. 1988:3-8.
27. Callaway CW, Chumlea WC, Bouchard C, Himes JH, Lohman TG, Martin AD, Mitchell CD, Mueller WH, Roche AF, Seefeldt VD. Circumferences. In: Lohman TG, Martorell R, editors. *Anthropometric standardization reference manual.* Champaign: Human Kinetics Books; 1988. p. 39-54.
28. Fernández JR, Redden DT, Pietrobelli A, Allison DB. Waist circumference percentiles in nationally representative samples of African-American, European-American, and Mexican-American children and adolescents. *J Pediatr* 2004; 145(4):439-444.
29. Barbosa Filho VC, Campos W, Fagundes RR, Lopes AS. Anthropometric indices among schoolchildren from a municipality in southern Brazil: A descriptive analysis using the LMS method. *Rev Paulista Pediatr* 2014; 32(4):333-341.
30. Barbosa Filho VC, Quadros TMB, Souza EA, Gordia AP, Campos W. A utilização do critério da Organização Mundial de Saúde para classificação do estado nutricional em crianças. *Motr Rev Educ Fís* 2010; 16(4):811-819.
31. Moraes AC, Fadoni R, Ricardi L, Souza T, Rosaneli C, Nakashima A, Falcão M. Prevalence of abdominal obesity in adolescents: A systematic review. *Obes Rev* 2011; 12(2):69-77.

Article submitted 27/04/2014
Approved 15/04/2015
Final version submitted 17/04/2015