Original Article

Relationship Between Waist Circumference and Nutritional Status, Lipid Profile and Blood Pressure in Low Socioeconomic Level Pre-School Children

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Objective

To evaluate anthropometric data, blood lipid levels, blood pressure (BP) and waist circumference (WC) in preschool children. To relate WC with blood lipid levels and BP in obese and non-obese children.

Methods

In a transversal study we investigated 65 preschool children of low socioeconomic level in Santo André, São Paulo. The evaluation consisted of BP measurement (Task Force, 1996), weight (W), height (H) expressed as z score (WHO,1995) and body mass index (BMI), triglycerides, total and fractions of cholesterol blood levels (Kwiterovich and AHA). Statistical analysis: Fisher test and correlations.

Results

We observed high BP and lipid levels unrelated to nutritional status. WC was significantly and positively correlated to BMI and ZWH (r = 0,87 and r = 0,83, respectively). Using as a cut-off 75 percentile of WC we found an accuracy of 89,1% with 87,2% specificity and 70,6% sensitivity and predictive value (+) 66,7% and (-) 66,7%. There was no relationship between WC and lipid and BP levels.

Conclusions

WC showed direct correlation with anthropometric indexes commonly used and in preschool children wasn't predictor of cardiovascular risk.

Key words

Obesity, waist circumference, lipid levels.

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Obesity has been clearly identified in literature as a critical risk factor for the development of cardiovascular diseases (CVD). However, other factors are known to play a part in that risk, whether the individual is obese or not. Among those factors, waist circumference stands out. It has been widely investigated in adults as part of the metabolic syndrome[1] and more recently identified as a risk factor in the pediatric age range[2,3,4].

Visceral fat increase is considered one of the most relevant risk factors for CVD, diabetes and other metabolic conditions[5]. Different methods used to study visceral fat are currently in use – one of the simplest, and easy to use and to reproduce is waist circumference[5,6].

In a study carried out with severely obese children – mean age 10.15±2.01 years – abdominal fat index (sum of skinfolds as related to limbs) proved to be positively correlated to total cholesterol (TC) triglycerides (TG), LDL-c, and negatively to HDL-c. Marelli et al[7] have found significant correlation between waist-hip ratio and TG level. Those results confirm that even in childhood severe obesity is related to lipid changes, and that abdominal adiposity is associated to profile worsening[7,8].

Results from the *Bogalusa Heart Study* have also emphasized the relevance of body fat distribution, especially waist circumference. According to the authors, that measure may help identify lipid and serum insulin changes. Children with waist circumference in the 90 percentile reported mean values above those in the 10 percentile for LDL-c, and TG, and lower for HDL-c. Those differences – highly significant – showed not to be related to body weight or height for boys or girls, in all ethnic groups[9].

Having in mind the already confirmed relevance of waist circumference in adults metabolic syndrome, as well as the perspectives of international literature pointing towards an association of that measure in childhood with morbid-mortality in adult age, we have decided to conduct the present study that focuses the following objectives: to assess nutritional diagnosis, lipid profile, blood pressure levels, and waist circumference in a sample of pre-schoolers in Santo André, São Paulo, S.P., Brazil. The purpose was to investigate whether waist circumference is associated to other usual anthropometric measures involved in obesity diagnosis, such as blood pressure and lipid profile in the population under study.

Methods

Sample population was made up of 65 low socioeconomic level pre-schoolers, screened from a total of 297 children enrolled at the Municipal School in Santo André, São Paulo, Brazil (age range – from 4 years old to 6 years old and 11 months). School visit took place on 5 consecutive days (April, 2001) by researchers. Out of the total number, 84.2% (250/297) of pre-schoolers were evaluated. The protocol was approved by the Ethics Committee at the ABC Medical School.

Based on mean and standard deviation waist circumference measures in the obese (62.5cm – 5.01) and non-obese group (52.4cm – 3.9), the sample reporting 18 and 45 showed > 90% power for the 0.05 (5%) significance level. The sampsi procedure was used (software STATA 8.0).

The study only included children whose parents or guardians signed the written consent. Children with the following conditions were excluded from the study: chronic conditions (nephropathy, cardiopathy, endocrinopathy, collagenosis, neuropathies, and hepatopathies); genetic syndromes, immunodeficiencies, or those under systemic corticotherapy or current morbid condition.

Comparative analysis of the anthropometric assessment of the obese children included and not included in the study did not show statistically significant difference. BMI mean and SD was 20.76 kg/m^2 (1.92) and 19.96 kg/m^2 (2.05), for those included and not included, respectively (Student t-test, p=0.28).

Children were weighted on platform scales (capacity 150 kg, 100 g gradation), on a flat surface, with scale reviewed before every weighing procedure. Height was obtained from a stadiometer, with the T-square adjusted to scalp, in a straight angle with stadiometer, following Jellife recommendations[10].

Based on weight and height data, weight indices were calculated for weight according to height (ZWH), height according to age (ZHA), and weight according to age (ZWA), all expressed in z score, and body mass index (BMI). Obese or undernourished children were those reporting 2 SD above or below reference pattern in relation to ZWH[11], respectively.

Waist circumference was obtained through extensible measure tape with millimeter gradation by one examiner only, as recommended by MacCarthy HD et al, 2001[12].

Blood pressure (BP) was obtained through *one single measure,* by one examiner only, and values obtained were classified individually according to reference pattern for gender, age, and height percentile[13].

Blood was collected (5 mL) through peripheral venopuncture after at least 12-hour fasting for TC, HDL-c, LDL-c, VLDL-c and TG (enzyme method)[14]. As reference for TC, LDL-c, HDL-c and TG, Kwiterowich[15] pattern was used. For VLDL-c, the classification proposed by the *American Heart Association*[16] was used.

Descriptive methods were used for the variables under study (median and interquartile intervals), and Fisher Exact Test for comparisons of those measures between obese and non-obese. In the study to correlate waist circumference and anthropometric indices for BMI and ZWH, linear correlation was used. In order to determine obesity diagnosis power for waist circumference, the sensitivity, specificity, positive and negative predictive value study was used in WC quartiles of population under study (percentiles 25, 50 and 75).Rejection level for null hypothesis was fixed at 0.05 or 5%.

Results

Out of the 65 pre-schoolers under study, 53.8% (35/65) were males. Median age was 5.8 years. Obese children: 27.7% (18/65).

Table 2 shows medians and interquartile intervals for waist circumference, ZWH and BMI, among obese and non-obese. Statistically significant difference was found for all variables in the two groups.

BMI and ZWH were compared to waist through linear correlation (Table 3). It should be pointed out that the waist keeps statistically significant correlation with the two variables, both for the population in general as when genders are considered. Such result is also found in figure 1, as indicated by dispersion and by r values (linear correlation coefficient). No significant difference was found for that tendency between males and females (p=0.23 for BMI and p=0.30 for ZWH). The obese are seen to be concentrated in the upper corner in the figures. The groups are visually well discriminated.

Using percentile 75 as the cutt-off point for WC for the population under study (58.2cm), and ZWH as the pattern, accuracy reported is 89.1%, matching values for specificity, sensitivity, and positive and negative predictive values (Table 4).

Table 1 – Inadequacy percentage among obese (n=18) and non-obese (n=47), in regard to SBP, DBP, TC, LDL-c, HDL-c, VLDL-c and TG

	Non-obese	Obese	p
SBP	13%	22%	0.44
DBP	14%	38%	0.11
TC	14%	27%	0.16
LDL-c	22%	27%	0.74
HDL-c	11%	20%	0.71
VLDL-c	18%	27%	0.48
TG	22%	23%	0.71

Fisher exact test; SBP - systolic blood pressure; DBP - diastolic blood pressure; TC - total cholesterol; TG - triglycerides.

No statistically significant correlation was found between WC and BP (SBP – systolic blood pressure and DBP – diastolic blood pressure) or lipid profile in the population under study. (Table 5). When WC was compared (characterized as quartiles: First quartile 45¬51; Second quartile 51¬53; Third quartile 53¬58; and Fourth quartile 58¬70) to BP and lipid profile – both for the population as a whole as for obese and non-obese – no statistically significant different was found either.

Discussion

Metabolic syndrome or X-syndrome is defined as a set of risk factors for CVD, including: hyperinsulinemia/ insulin resistance, hypertension, dyslipidemia, obesity and glucose intolerance[17]. The association of that syndrome to CVD has been documented by epidemiological studies in children and adults[18,19].

In our study, the prevalence of high BP level, the increase in TG, TC, LDL-c and VLDL-c, and low levels of HDL-c showed to be higher than that found in other papers carried out in Brazil, as the one with schoolers in Porto Alegre[20], thus placing the population in our study – low socioeconomic level pre-schoolers—under high cardiovascular risk (Table 1).

The present study reported the correlation between waist circumference and BMI and ZWH, with straight correlation between those patterns while identifying adiposity level in pre-schoolers. (Figure 1, Table 2 and 3). A recent study carried out with 87 American children in the 4-11 age range, showed that waist circumference and fat percentage are extremely relevant factors for CVD. The present work defined values between 33% and 71 cm as the cut-off points for high risk of CVD: fat percentage (determined by dual X-ray absorptiometry – DXA) and waist circumference, respectively[3].

Another cross-sectional, more recent study was carried out with 1,254 children in the 6-12 year-old age range, correlating anthropometric measures (waist included) and serum lipids and BP. The work showed

Table 2 – Median and interquartile interval (p25; p75) of BMI (Kg/m²), ZWH and waist diameter (cm), among obese and non-obese, by gender

	n	Non-obese		n	Obese	
Males						
BMI *	27	16.8	(16;17)	8	20.6	(19;22)
Waist *	25	52	(51;54)	8	62	(58;65)
ZWH*	27	0.6	(0.2;0.6)	8	3.4	(2.5;4.5)
Females						
BMI *	20	16.1	(15;17)	10	20.6	(19;22)
Waist *	19	51	(49;53)	10	63.5	(58;67)
ZWH*	20	0.7	(0.2;1)	10	2.9	(2.1;4.2)

** p<0.001; BMI - body mass index; ZWH - weight-height index.*

Table 3 – Coefficients of linear correlation for BMI, ZWH and Waist circumference

BMI	r	p
Female	0.87	<0.001
Male	0.87	<0.001
General	0.87	<0.001
ZWH	**r**	**p**
Female	0.82	<0.001
Male	0.85	<0.001
General	0.83	<0.001

BMI - body mass index; ZWH - weight-height index.

Table 4 – Study on the power in diagnosis for waist circumference (cut-off point at percentile 75 for population under study), with ZWH as pattern

	Pattern = ZWH		
Waist	Obese	Non-obese	Total
>p75	12	6	18
<p75	5	41	46
Total	17	47	64

Sensitivity 70.6%; specificity 87.2%; predictive value (+) 66.7%; predictive value (-) 66.7%; accuracy 89.1%; ZWH - weight-height index.

strong waist correlation between increased SP and DP – stronger than that between body weight and tricipital and subscapular skinfolds. Through a multivariate linear analysis model we were able to also show that changes in SBP, DBP and HDL-c were significantly associated to waist circumference, thus pointing out its relevance: an easy to do and to put into practice measure, with good reproductibility[4].

The results found in the present study are evidence that waist circumference is discriminating in the diagnosis for obesity. However, due to sample size, the quantification of such power in diagnosis – as sensitivity and specificity – must be interpreted with caution.

It is interesting to point out the similarity in the behavior of waist circumference between boys and girls (Table 2), which differs from adult individuals but do match results from studies with other children in similar age range as the one in our study[3].

Age range effect should be investigated. The present study did not carry out that investigation due to sample size constraints. A British study carried out with 8,355 children – both boys and girls – where waist circumference was stratified in percentiles - showed that waist circumference average increases with age: for girls, the curve reaches a plateau before they are 13, whereas for boys, it goes on increasing quite strongly after 13. The authors point out the fact that such findings are related to Caucasian children characteristics, and encourage comparison with children from other countries[12].

Obesity and abdominal fat distribution are associated to HDL-c reduction and TG increase, as shown by many studies with adults and teenagers[21,22,23]. Visceral fat is associated to the increase of circulating free fatty acids, hyperinsulinemia, insulin resistance, and increase of TG synthesis and VLDL-c secretion by the liver. In the light of all this, the definition of a cut-off point for waist circumference in children has been extensively investigated in the literature, since it has proven to be a better risk predictor for cardiovascular diseases than BMI[24,25].

The present study has not reported correlation between waist measure and blood pressure levels or lipid profile (Table 5) - either for all children or when assessment is restrained to nutritional condition (obese and non-obese). That may have been due to age range and sample size constraints. NHANES III – a study carried out with 5,056 American children in the 4-11-year-old range - identified a positive, non-dependent relationship between waist-hip ratio and triglycerides level in pre-puberty children[26].

In regard to BP, some studies have demonstrated a negative correlation between DBP and sensitivity to insulin, and a positive correlation with insulin levels, with no correlation, however, to adiposity in pre-puberty children[27,28].

A definition of local patterns for central adiposity measures is, therefore, to be encouraged for pediatric

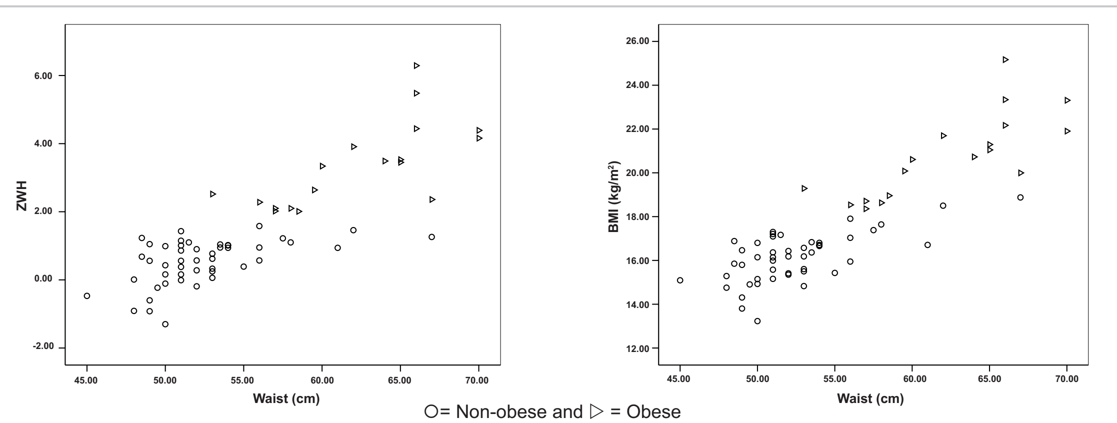

Fig. 1 – Dispersion between BMI x Waist and ZWH x Waist, in regard to nutritional status.

Table 5 – Correlations between waist circumference and blood lipids and blood pressure

	SBP	DBP	TOTCL	LDL	VLDL	HDL	TG
SBP	1.00						
DBP	0.27	1.00					
TOTCL	0.14	0.36	1.00				
LDL	0.07	0.24	0.96	1.00			
VLDL	0.37	-0.05	0.58	0.49	1.00		
HDL	0.03	0.68	0.66	0.49	0.11	1.00	
TG	0.30	-0.10	0.43	0.38	0.91	-0.07	1.00
Waist	0.15	-0.11	-0.01	-0.09	0.09	0.13	0.11

SBP - systolic blood pressure; DBP - diastolic blood pressure; TOTCL - total cholesterol; TG - triglycerides.

age range. Although not conclusive at this point, studies as ours do encourage the investigation of this new measure (waist) while searching for cut-off points and reference distributions as a help tool in the diagnosis of obesity in childhood and in setting parameters for cardiovascular risk.

Potencial Conflict of Interest

No potential conflict of interest relevant to this article was reported.

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