



## ASSOCIATION BETWEEN ANTHROPOMETRIC INDICATORS AND SERUM LIPID PROFILE IN ADOLESCENTS

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### ABSTRACT

**Purpose.** The aim of this study was to verify and analyze the association between anthropometric indicators and serum lipid profiles in adolescents. **Methods.** The study included 250 adolescents aged 11–17 years from both sexes. The anthropometric variables measured were body weight, height and waist circumference. Body mass index and waist circumference were used to calculate a nutritional status rating (whether normal weight or overweight) and abdominal obesity, respectively. Total cholesterol, high-density lipoproteins, low-density lipoprotein and triglyceride levels were determined by an enzymatic colorimetric method using automatic spectrophotometry and were categorized according to cutoff points established by the III Brazilian Guidelines on Dyslipidemia and Atherosclerosis Prevention from the Brazilian Society of Cardiology. **Results.** The overweight and abdominal obesity prevalence was found to be 23.6% and 40.0%, respectively. Undesirable total cholesterol, high-density lipoprotein, low-density lipoprotein and triglyceride levels were found in 40.8%, 8.4%, 36.0% and 13.6% of the studied adolescents, respectively. Overweight adolescents were 2.29 (CI 95%, 1.07-4.91) times more likely to have high triglyceride levels, and those with abdominal obesity were 2.47 (CI 95%, 1.14-5.37) times more likely to show high triglyceride levels. **Conclusions.** A high prevalence of overweight and abdominally obese adolescents, with high levels of serum lipid profiles, were observed. Moreover, overweight and abdominally obese adolescents were more likely to have high triglyceride levels.

**Key words:** dyslipidemia, risk factors, body mass index, abdominal obesity, adolescents

### Introduction

Obesity has been considered a worldwide public health problem [1]. In Brazil, a rise in overweight and obesity levels from 4% to 13% was observed among children and adolescents (6-18 years of age) from the 1970s to the 1990s [2]. This excess is associated with a number of metabolic and cardiovascular complications [3], even among children. One complication which stands out in particular is dyslipidemia, which is characterized by increased plasma total cholesterol and/or triglyceride levels or decreased high-density lipoprotein (HDL-C) [4].

Although clinical manifestations of cardiovascular disease occur only in adulthood, a number of risk factors can be present already in childhood and adolescence [5], which can lead to an increased risk of morbidity and mortality in adulthood [6]. To this effect, determining the prevalence of these risk factors in children should be considered a priority as early diagnosis favors the adoption of health promotion strategies and a healthy lifestyle that may persist into adulthood [7].

A number of anthropometric indicators have been recommended for the identification of cardiovascular risk factors in a pediatric population [8, 9]. Body mass

index (BMI) is considered an indicator of overall adiposity, while waist circumference (WC) is an indicator of central fat tissue distribution [10]. In addition, most studies linking obesity and cardiovascular risk factors in adolescents have been conducted in intermediate- and large-sized cities. Only one survey was conducted among adolescents in a small city in southern Brazil [11]. Thus, this study aimed to determine and analyze the association between anthropometric indicators and the serum lipid profile of adolescents residing in both urban and rural areas, and of European descent, in a city in southern Brazil.

### Material and methods

This study, on the association of anthropometric indicators and serum lipid profile in adolescents, was developed as a part of a cross-sectional study entitled “Interaction Between Variables That May Influence Body Fat Accumulation and Lipid Profile of Parents and Children” and was approved by the Ethics Research Committee of the Catholic University of Brasilia (Process No. 026/2009). This study was conducted on a representative sample of adolescents from the municipality of Saudades, located in the extreme western part of the state of Santa Catarina (SC) in southern Brazil. This town is predominantly composed of individuals who are of German descent and consists of only 8,880

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inhabitants. Saudades-SC is classified as having a high human development index with a Human Development Index of 0.82 [12].

The entire study population consisted of 1381 adolescents aged 11 to 17 years enrolled in public schools; there are no private schools in the city. Students attending their 5<sup>th</sup> year of elementary school education up to those finishing their 3<sup>rd</sup> year of secondary school were selected from the only school found in an urban area, with a group of elementary school students (from the 1<sup>st</sup> to 9<sup>th</sup> years) from another school located in a rural area also added.

As this analysis was part of a broader study, several sample sizes were calculated for different health outcomes. For this analysis, a known prevalence level of 28% was adopted for high total cholesterol and used to calculate a representative sample size [13]. In addition, an acceptable error of seven percentage points was assigned with a confidence level of 95% and a design effect of 1.4, increased by 10% for eventual losses and refusals. Thus, an assessment of 219 adolescents would be required for statistical analysis. Due to the characteristics of the sampling process, which involved all of the individuals belonging to various city areas, 250 adolescents participated in the sample.

For anthropometric measurement, the height and weight measurements of each child were collected. Subsequently, the body mass index was calculated [BMI = body mass (kg)/height<sup>2</sup> (m<sup>2</sup>)]. For BMI classification, cut-off points recommended by the International Obesity Task Force were used [14], which vary according to gender and age. Adolescents were grouped into categories of normal weight and excess weight (which included those who are overweight and obese). The waist circumference was measured 2.5 cm above the umbilicus [15] using a tape measure. Abdominal obesity was classified according to cutoff points established by Katzmarzyk et al. [16], which vary according to gender and age.

For analysis of serum lipid levels, 5 mL of blood were collected from each of the subjects to measure blood concentrations of total cholesterol, HDL-C, LDL-C and triglyceride levels. Blood samples were collected by venipuncture after a fasting period from 12 to 14 hours. The blood samples were stored in flasks containing a coagulation accelerator. Total cholesterol, HDL-C and triglyceride (TG) levels were determined by an enzymatic colorimetric method (using reagents from Lab-test, Brazil) by automatic spectrophotometry (Cobas Mira Plus, Roche, Switzerland) according to the standardized procedures established by the reagent's maker and by the manufacturer of the equipment. LDL-C was calculated using a formula proposed by Friedewald et al. [17], where the triglyceride concentration is below 400 mg/dL. The cutoff points used were those proposed by the III Brazilian Guidelines on Dyslipidemia and Atherosclerosis Prevention from the Brazilian Society of Cardiology [18], with desirable values for TC

< 170 mg/dL, LDL-C < 110 mg/dL, HDL-C ≥ 35 mg/dL and TG ≤ 130 mg/dL.

A descriptive analysis of the variables, mean values, standard deviations and frequency distribution were used for statistical analysis. The association between outcome/dependent variable (serum lipid profile) and independent variables (anthropometric indicators) was analyzed by logistic regression, estimating the odds ratios and their confidence intervals at 95%. Two models were tested, one simple and another adjusted (including all independent variables). In all tests, the significance level adopted was 5%.

## Results

Mean (± SD) results of the study participants were: age (years): 14.1 (± 1.9), BMI (kg/m<sup>2</sup>): 20.3 (± 3.3), WC (cm): 71.8 (± 8.6). The serum lipid profile is exhibited in Table 1.

The prevalence of overweight and obesity among the subjects was 23.6% and 40.0%, respectively. Of the adolescents surveyed, 40.8% had high total cholesterol levels, 36.0% had increased LDL-C, 13.6% had high triglyceride levels and 8.4% had low HDL-C (Tab. 2). Of the previously mentioned risk factors (total cholesterol, triglyceride, HDL-C and LDL-C levels), it was found that 14.4% of adolescents had one risk factor, 33.2% had two risk factors, 5.2% had three risk factors and 0.4% had all four risk factors (data not shown).

Table 1. Mean and standard deviation of serum lipid profiles in adolescents according to gender (N = 250)

	Total x̄ (dp)	Boys x̄ (dp)	Girls x̄ (dp)
Total Cholesterol (md/dL)	167.16 (30.45)	160.35 (28.95)	172.08 (30.65)
HDL-C (md/dL)	47.84 (10.40)	47.16 (11.37)	48.32 (9.64)
LDL-C (md/dL)	103.88 (26.04)	98.70 (24.78)	107.63 (26.38)
Triglycerides (md/dL)	76.58 (45.41)	71.93 (42.71)	79.95 (47.13)

HDL-C – HDL lipoproteins, LDL-C – LDL lipoproteins

Table 2. Proportion of adolescents with desirable and undesirable anthropometric indicators and serum lipid profile values (N = 250)

	Desirable		Undesirable	
	N	%	N	%
BMI	191	76.4	59	23.6
WC	150	60.0	100	40.0
Total Cholesterol	148	59.2	102	40.8
HDL-C	229	91.6	21	8.4
LDL-C	160	64.0	90	36.0
Triglycerides	216	86.4	34	13.6

BMI – body mass index, WC – waist circumference, HDL-C – HDL lipoproteins, LDL-C – LDL lipoproteins

Table 3. Odds ratios between BMI, WC and serum lipid profile among the studied adolescents ( $N = 250$ )

	BMI		WC	
	OR (CI95%)	OR* (CI95%)	OR (CI95%)	OR* (CI95%)
Total Cholesterol	0.75 (0.41–1.38)	0.43 (0.15–1.22)	0.88 (0.53–1.48)	0.71 (0.30–1.68)
HDL-C	2.69 (1.07–6.73) <sup>†</sup>	2.08 (0.79–5.43)	2.14 (0.87–5.28)	1.79 (0.70–4.58)
LDL-C	0.98 (0.53–1.80)	1.92 (0.68–5.37)	0.93 (0.55–1.58)	1.23 (0.52–2.92)
Triglycerides	2.29 (1.07–4.91) <sup>†</sup>	2.52 (1.11–5.72) <sup>†</sup>	2.43 (1.16–5.07) <sup>†</sup>	2.47 (1.14–5.37) <sup>†</sup>

BMI – body mass index, WC – waist circumference

HDL-C – lipoprotein HDL, LDL-C – lipoprotein LDL

OR – odds ratio, CI – confidence interval, \* OR adjusted for all lipid profile variables, <sup>†</sup>  $p < 0.05$

Table 3 shows the crude and adjusted odds-ratio values and the confidence intervals between the anthropometric indicators and serum lipid profile of the adolescents. Crude analysis found an association between HDL-C and triglyceride levels with BMI. When the analysis was adjusted for all independent variables, it was observed that only triglycerides remained associated with BMI. These results show that obese adolescents were 2.29 (CI 95% = 1.07-4.91) times more likely to show high triglyceride levels compared to eutrophic individuals. Similarly, it was observed that abdominally obese adolescents, verified by WC, were 2.47 (CI 95% = 1.14-5.37) times more likely to have high triglyceride levels.

## Discussion

The findings in this study found that 23.6% of studied adolescents are considered overweight. Overweight prevalence among adolescents may be explained by changes in eating patterns (increased consumption of simple sugars, processed foods and an inadequate intake of fruits and vegetables) and by a progressive reduction of physical activity combined with more time dedicated to low-intensity activities (watching television, computer usage and playing video games) [19]. Sedentary behavior may cause an increase in body weight and thus contribute to the increased prevalence overweight and obese adolescents [20].

It was observed that 40% of adolescents in this study were abdominally obese. Beck et al. [11] investigated adolescents aged 14–19 years in the city of Três de Maio, in state of Rio Grande do Sul, by using the same cutoff points as in this study and found that 32.6% of adolescents had abdominal obesity. These data show the need for public policies aimed at reducing body fat in the central region of the body in children and adolescents, especially when considering its relationship with the occurrence of cardiovascular diseases in adulthood [21].

Among the additional findings of this study, the high prevalence of total cholesterol (40.8%) among adolescents attracted attention. Lower prevalence levels have been found among adolescents in another Brazilian

city [22]. This difference in total cholesterol levels in childhood and adolescence is a predictor of cholesterol levels in adulthood. In addition, the onset of atherosclerosis in childhood could be increased in later life by obesity and by a number of other factors such as family history, physical inactivity and hypertension [23].

The proportion of adolescents with increased LDL-C levels was found to be 36.0%. Lower prevalence levels have been found in other Brazilian studies [22]. Epidemiological and laboratory evidence support the hypothesis that the increased concentration of both total cholesterol and LDL-C levels leads to coronary artery disease [24]. Furthermore, high LDL-C concentrations in children and young adults are associated with an increased risk of atherosclerotic disease [25] due to oxidation and the deposition of LDL-C in the artery walls [26].

The 13.6% of adolescents with increased serum triglyceride levels found in this study was similar to what was found in other Brazilian cities [27]. As for HDL-C, a low prevalence of adolescents with levels below the recommended value for this variable was observed (8.4%). Low levels of this lipoprotein are alarming given its importance as a protective factor against chronic diseases, particularly atherosclerosis [28]. This is partly due the function of HDL-C, which acts in reverse cholesterol transport, i.e., it helps remove cholesterol from artery walls to the liver where it is re-used or converted into bile acids or discarded [29].

Adolescents who are overweight, as determined by BMI, are twice as likely to show increased triglyceride levels when compared to adolescents with normal weight. Similar results were found by Cobayashi et al. [30], who analyzed two groups of adolescents (obese and normal) and found that obese adolescents are more likely to have elevated serum triglycerides and low HDL-C levels compared to eutrophic adolescents. Although the clinical symptoms caused by cardiovascular disease occur in adulthood, atherosclerosis can begin in childhood, with being overweight a major determinant factor [31].

As for abdominal obesity, it was found that adolescents with high central adiposity are more likely to have elevated triglyceride levels. Weight and body fat are the main modulators of plasma lipid levels. Triglyce-

ride, total cholesterol and LDL-C levels above the recommended values, combined with decreased HDL-C, increase the likelihood of developing cardiovascular diseases [32].

The main limitations of this study were the use of a cross-sectional design that does not allow for establishing a cause/effect relationship between the outcome and independent variables, which may point to a reverse causality between such associations. It should be stressed that this study, with the objective of searching for associations between anthropometric indicators and serum lipid profiles, was the first to be conducted on adolescents of European ancestry, who are different from the mixed Brazilian population and who reside in rural and urban areas.

The results shown in this study allow for the conclusion that a large proportion of adolescents have high serum lipid profile levels. Moreover, those with overweight and abdominal obesity are more likely to have elevated triglyceride levels.

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