Original Article

Additional Cardiovascular Risk Factors Associated with Excess Weigth in Children and Adolescents. The Belo Horizonte Heart Study

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OBJECTIVE

To examine the association of overweight and obesity with physical activity, blood pressure (BP) and serum lipid profiles.

METHODS

Epidemiologic investigation of 1,450 students, between the ages of 6 and 18, in the city of Belo Horizonte, MG. Data: weight, height, BP, skinfold thickness, waist circumference, physical activity, total cholesterol (TC), LDL-c, HDL-c, and dietary habits.

RESULTS

The prevalence rates for overweight and obesity were 8.4% and 3.1%, respectively. In relation to the students in the lower quartile (Q1) of the distribution of subscapular skinfold, the students in the upper quartile (Q4) presented a 3.7 times higher risk (odds ratio) of having elevated TC levels. Overweight and obese students had a 3.6 times higher risk of having elevated systolic blood pressure, and a 2.7 times higher risk of elevated diastolic blood pressure when compared to normal weight students. The less active students in the Q1 of distribution of MET presented a 3.8 times higher risk of having elevated TC levels compared to those who were more active (Q4).

CONCLUSION

Students who were overweight, obese or in the upper quartiles for other adiposity variables, as well as students with low levels of physical activity or a sedentary lifestyle presented higher blood pressure levels and a lipid profile indicative of an increased risk of developing atherosclerosis.

KEY WORDS

Obesity, blood pressure, motor activity, nutrition, child, adolescent.

The current epidemic of ischemic cardiovascular diseases (CVD) in the developing countries has brought an increased burden for public health in terms of Disability Adjusted Life Years (DALY)[1]. In Brazil, DCVs account for the highest burden of disease (9.6 DALY) followed by diabetes mellitus (5.1 DALY), both sharing excess weight as a common risk factor[2].

Recent and profound lifestyle changes regarding dietary habits characterized by a high intake of saturated fat, hypercaloric beverages and low levels of physical activity resulted in a widespread epidemic of overweight and obesity, and their consequent comorbidities, CVDs and non-insulin-dependent diabetes mellitus (NIDDM)[1].

Children are becoming increasingly more vulnerable to excess weight, in a "Junior" version of the global adult obesity epidemic, and they even present with insulin resistance, type 2 diabetes mellitus[3] and early onset atherosclerosis[4] comprising the manifestations of the metabolic syndrome.

Recent studies have shown a decline in the prevalence of malnutrition and a predominance of excess weight in children and adolescents with significant yearly increase rates of the latter. Wang et al[5] verified a three-fold increase in the prevalence of excess weight in Brazil whereas the prevalence of underweight people showed a sharp decline to almost half of previous numbers.

METHODS

A school-based epidemiologic cross-sectional study was conducted in the city of Belo Horizonte, State of Minas Gerais, Brazil. Initially, twenty out of the 521 public and private schools of Belo Horizonte were randomized. The second step was to choose two classrooms from each school to compose a sample of 1,450 students to be investigated. The sample size was calculated for the first two stages using the Kish method[6], based on the Student's t-test and pre-specifying the α and β errors as 0.05 and 0.20, respectively.

A Written Consent Form was given to the students. This study was approved by the Research Ethics Committee of UFMG and by the Research Ethics Committee of USP.

All instruments were tested in a previous pilot study conducted at two schools (one public and one private).

The anthropometric measurements included weight, height and central body fat distribution indicators –triceps, subscapula and suprailiac skinfold thickness, and waist and hip measurements. The percentage of body fat was estimated using a Tanita bioelectric impedance scale. Height measurements were taken using a portable aluminum stadiometer, with a tolerance of approximately 0.1 cm, with the students standing without shoes. Body weights were taken with the Tanita scale, with a tolerance of approximately 0.1 kg. and systematically confirmed after every ten measurements with a OMS portable electronic scale. Skinfold thickness measurements were

recorded to the closest millimeter using Lange skinfold calipers (Cambridge Scientific, Cambridge, MA).

Serum levels of total cholesterol (TC), and LDL-c and HDL-c lipoproteins were analyzed by Cobas Mira Plus (Roche Corp.) in accordance with the protocols of the National Cholesterol Education Panel. Since there were no triglyceride serum levels higher than 400 mg/dl, the LDL serum levels were calculated using the Friedewald formula.

Systemic blood pressure (systolic and diastolic) readings were taken in accordance with the recommendations of the American Heart Association[7]. The mean of the two blood pressure readings was used in the statistical analyses.

The parents or guardians of each child or adolescent under 14 years of age and the students were interviewed using a questionnaire to obtain information regarding demographic aspects, dietary habits, physical and sedentary activities, smoking and family history of early onset CVD.

The energy expenditure, evaluated in kilocalories – MET (metabolic cost or unit of resting metabolic rate) was obtained using a 24-hour record questionnaire of the student's physical activities, modified from the Spark questionnaire[8]. For statistical analyses, physical activities were classified in accordance with energy expenditure levels in four intervals or quartiles. In this analysis, only the upper interval or quartile (Q4) and the lower interval or quartile (Q1) were considered in order to obtain a more marked contrast between the most active and the least active students. A qualitative question was also included for the students to compare their daily level of physical activity with their counterparts[9].

The questionnaire also evaluated sedentary activities including the number of hours spent watching TV and videos, number of hours spent playing computer games, videogames and handheld computer games and the number of hours spent listening to music (without dancing) for relaxation[9].

A quantitative food frequency evaluation questionnaire was prepared based on a North American questionnaire that was prepared for cardiovascular disease screening studies, and developed by Gladys Block et al and organized by Thompson and Byers[10] in the Dietary Assessment Resource Manual.

From the scale mentioned above, three levels of nutrition standard were established: adequate (a diet with low lipid levels and a high concentration of fruits and vegetables); inadequate (high fat content and low fruit and vegetable content); very inadequate (very high fat content and very low fruit and vegetable content). The consumption of these foods was evaluated on a weekly and monthly basis using a diet record.

We considered students up to age 11 as children and students between 12 and 18 as adolescents. The social-economic variable was defined in accordance with the Brazilian Association of Market Research Institutes and

grouped for statistical analysis purposes in an upper level (AB) and a lower level (CDE).

In order to compare our results with those of other studies previously conducted, and following the recommendations for epidemiologic inquiry evaluations for the prevalence of excess weight in children and adolescents, and inference of associations and risk of subsequent comorbidities, overweight was considered as a BMI between the 85th and 94th percentiles, and obesity equal to or higher than the 95th percentile according to age and gender[11,12]. In the present study, students were considered with "excess weight" when they were either overweight or obese, that is, anyone with a BMI over the 85th percentile. Those considered with a "normal weight" had a BMI between the 5th and 85th percentiles. By defining the 85th percentile as the cut-off point for excess weight, overweight – a CVD risk factor[12] – was included in the data, and there was a much higher number of overweight students than obese students in the sample.

Blood pressure was considered "high normal" (borderline) when the systolic blood pressure (SBP) or diastolic blood pressure (DBP) was between the 90th and 95th percentiles for the reference population; significant high blood pressure was defined as a systolic or diastolic pressure above the 95th percentile, and severe high blood pressure as a systolic or diastolic pressure above the 99th percentile for the reference population, or approximately 10 mmHg above the 95th percentile in accordance with the National High Blood Pressure Education Program Working Group on Hypertension Control in Children and Adolescents[13]. We considered "blood pressure higher than normal" or "high blood pressure" when the SBP or DBP levels were above the 90th percentile for the reference population.

Statistical Analysis - All significance tests were considered at a level of 0.05 for the type I error, that is, a level of 5% for the hypothesis that each parameter is equal to zero was used to reject the hypothesis whenever the estimated parameter value exceeded the estimated standard error 1.96 times. Initially the analyses were conducted in the Department of Statistics of the Institute of Exact Sciences, *Universidade Federal de Minas Gerais*, using the statistical analysis program SPSS for Windows (Release 8.0 Chicago, IL, USA). The inferential analysis was conducted in the Institute of Mathematics and Statistics, *Universidade de São Paulo*[14], using the Statistical Analysis Software-SAS (Release 8.02, SAS Institute Inc, Cary, NC, USA).

Risk factors were clustered according to the total of the four risk variables studied, that is, total cholesterol > 200 mg/dl, systolic blood pressure ≥ 90th percentile, diastolic blood pressure (DBP) ≥ 90th percentile, and BMI > 85th percentile.

Univariate analyses for the significance test of the associations were conducted using the Student's t-test for continuous variables and the Chi-square test for discrete variables. To evaluate the strength of the association, the odds ratio calculation was used, which in a clinical focus study, such as this one, can be used as a risk proxy for both univariate and multivariate analyses. The adequacy assumptions of the linear model were evaluated graphically and using the Ryan-Joiner test (similar to Shapiro-Wilk) to verify the normality of the model error distribution.

The independent association of predictive variables with elevated blood pressure levels, overweight and obesity were evaluated using the backward stepwise logistic regression, keeping the variables at a maximum descriptive level of 0.01 in the null test of their effect to determine which energy expenditure levels, sedentary activities, dietary habits, social-economic class, excess weight (BMI) and variables indicative of central body fat distribution would be the most predictive of adverse levels of total cholesterol and lipoprotein fractions, and of systolic and diastolic blood pressure. All regression analyses were controlled for various confounding factors including skin color and age.

RESULTS

From the initial 1,450 participants, five were excluded for inconsistent data. From the remaining 1,445 that responded adequately to the questions and had their anthropometrical data collected, 1,382 (95.3%) agreed to have a blood sample drawn. The majority of the participants attended public schools (76%), 53% were female and 47% male, 56% were from the lower social classes (below middle class - CDE), 45% were white, 44.4% were dark skinned and 14.5% were black. For statistical analysis purposes the white and dark skinned participants were grouped together since there were no significant differences between dark skin and the other variables. As such, the skin color variable was defined as white and black.

Table 1 shows the mean values, standard deviation (SD), minimum, maximum, median, and lower and upper quartiles of the variables studied.

Tables 2 and 3 show the distribution (mean and standard deviation) of serum lipids, blood pressure, physical and sedentary activities and adiposity variables, according to the demographic characteristics of the participants.

In relation to the ranges classified as "desirable", "borderline" and "elevated", one third (32.9%) of these students presented total cholesterol levels higher than the values considered desirable (> 170 mg/dl), and one quarter (25.1%) also presented LDL-c levels higher than the values considered desirable (> 110 mg/dl). In relation to HDL-c, approximately one fifth (17%) of the students presented values considered as undesirable (Table 4).

According to the levels found and the criteria of NCEP/

Table 1 – Distribution of the lipid, blood pressure and adiposity variables among the students, children and adolescents, of Belo Horizonte

Variable	N	Mean	SD	Min.	Max.	Q1	median	Q3
TC	1,372	158.02	28.54	73.00	256.00	137.00	157.00	176.00
LDL-c	1,370	93.86	25.14	28.80	182.70	75.68	92.25	110.25
HDL-c	1,371	46.45	10.28	15.50	88.60	39.10	45.60	52.30
Mean SBP	1,405	109.69	14.73	68.00	179.00	99.00	109.00	119.00
Mean DBP	1,405	68.34	11.68	34.00	125.00	60.00	68.00	76.00
BMI	1,403	18.99	3.48	10.89	35.58	16.44	18.64	20.99
Subscapula	1,398	11.77	6.24	4.00	55.00	7.00	10.00	14.00
Suprailiac	1,398	15.18	8.95	3.00	60.00	8.00	13.00	20.00
Sum of Skinfolds	1,398	41.74	19.77	11.00	155.00	27.00	38.00	52.00
Waist Circum.	1,400	65.28	9.48	33.80	104.20	58.00	64.35	70.40
% of fat	1,255	17.78	9.98	1.00	60.00	10.00	17.00	25.00

TC: total cholesterol (mg/dl); LDL-c: low density lipoprotein (mg/dl); HDL-c: high density lipoprotein (mg/dl); SBP: systolic blood pressure (mmHg); DBP: diastolic blood pressure (mmHg); BMI: body mass index; Subscapula: thickness of subscapular skinfold (mm); Suprailiac: thickness of suprailiac skinfold (mm); Sum of skinfolds: the sum of the three skinfold thickness measurements - triceps, subscapular and suprailiac skinfolds (mm); % of fat: percentage of body fat

Table 2 – Mean values of the distribution of lipids, blood pressure, BMI, central body fat, physical and sedentary activities according to gender, age group and skin color

Variable	Gender			Age Group			Skin Color		
	Male	Female	α	Child	Adolescent	α	White	Black	α
TC	154±1	162±1	S	164±1	154±1	S	160±1	150±2	S
LDL-c	90±1	97±1	S	100±1	90±1	S	95±1	89±2	S
HDL-c	45±0.4	47±0.4	S	47±0.4	47±0.4	NS	47±0.4	45±0.7	S
SBP	111±1	109±1	S	105±0.5	113±0.5	S	109±0.6	113±1	S
DBP	68±0.5	69±0.5	NS	66±0.4	70±0.4	S	68±0.5	70±1	S
BMI	19±0.1	19±0.1	NS	17±0.1	20±0.1	S	19±0.1	19±0.3	NS
Subscapula	10±0.2	13±0.2	S	10±0.2	13±0.2	S	12±0.2	12±0.4	NS
Suprailiac	13±0.3	17±0.3	S	13±0.3	17±0.3	S	15±0.4	15±0.7	NS
% of fat	10±0.3	23±0.3	S	14±0.4	20±0.4	S	18±0.4	17±0.8	NS
WHR	0.8±0.003	0.7±0.004	S	0.8±0.003	0.7±0.004	S	0.8±0.006	0.8±0.003	NS
MET	708±26	555±22	S	759±28	540±21	S	621±19	720±50	S
Sedentary	4±0.1	4±0.1	NS	3±0.1	4±0.1	S	4±0.2	4±0.1	NS
TV/Video	3±0.1	3±0.1	NS	3±0.1	3±0.1	NS	3±0.1	3±0.1	NS

TC: total cholesterol (mg/dl); LDL-c: low density lipoprotein (mg/dl); HDL-c: high density lipoprotein (mg/dl); SBP: systolic blood pressure (mmHg); DBP: diastolic blood pressure (mmHg); BMI: body mass index; Subscapula: thickness of the subscapular skinfold (mm); Suprailiac: thickness of the suprailiac skinfold (mm); % of fat: percentage of body fat; WHR: waist hip ratio; MET: unit of resting metabolic rate; Sedentary: hours/day spent on sedentary activities; TV/Video: hours/day spent watching TV and/or videos

NHLBI/NIH (Table 5), once again one third (32.9%) of these students that presented elevated levels of total cholesterol (> 170 mg/dl) were classified in the range of moderate to serious risk to develop atherosclerotic disease in adulthood, as well as close to one third (32.4%) in relation to those with elevated levels of LDL-c (> 105 mg/dl).

The results revealed that 28.1% of the participants spent more than 5.5 hours on sedentary activities, 22.6% presented low levels of physical activity expressed as energy expenditure (located in the lower MET quartile), and 68.5% were described by themselves or their parents/ guardians as less active than their counterparts who were considered much more active (31.5%). Generally speaking, the results show an average of 4 hours per day spent on sedentary activities; 2.8 hours watching TV and 0.3 hours playing video or computer games. The mean energy expenditure (MET/day) was 627.8.

The majority of the students presented dietary habits characterized by the consumption of high fat foods. In relation to the group of fruits, vegetables and fibers, 64.8% presented an intake classified as "very inadequate", 35.0% an inadequate intake and 0.0% reported and adequate intake of these macronutrients. A little more than one quarter (26.7%) ate potato chips or popcorn almost every day (> five days per week), 14.5% three to four days per week and 22.8% one to two days per week. Roughly one quarter (25.9%) ate snack foods almost every day (> five days per week), 18.0% three to four days per week and almost one third (31.5%) one

Table 3 – Mean values of the distribution of lipids, blood pressure, BMI, central body fat, physical and sedentary activities according to social-economic level and type of school

Variable	Social-Economic Level			Type of School		
	AB	**CDE**	α	**Private**	**Public**	α
TC	164±1	154±1	S	165±1	156±29	S
LDL-c	97±1	92±1	S	96±1	93±25	NS
HDL-c	49±0.4	45±0.4	S	50±0.4	45±10	S
SBP	110±0.6	110±0.7	NS	108±0.7	110±0.5	S
DBP	68±0.5	68±0.4	NS	67±0.6	69±0.4	NS
BMI	19±0.1	19±0.1	NS	20±0.2	19±0.1	S
Subscapula	12±0.2	12±0.2	NS	11±0.3	12±0.2	NS
Suprailiac	16±0.3	14±0.3	S	16±0.4	15±0.3	S
% of fat	18±0.4	18±0.4	NS	18±0.5	18±0.3	NS
WHR	0.8±0.004	0.8±0.003	NS	0.8±0.005	0.8±0.003	NS
MET	544±25	693±23	S	492±31	673±20	S
Sedentary	4±0.1	4±0.1	NS	4±0.2	4±0.1	NS
TV/Video	2.6±0.1	2.8±0.1	S	2±0.1	3±2	NS

TC: total cholesterol (mg/dl); LDL-c: low density lipoprotein (mg/dl); HDL-c: high density lipoprotein (mg/dl); SBP: systolic blood pressure (mmHg); DBP: diastolic blood pressure (mmHg); BMI: body mass index; Subscapula: thickness of the subscapular skinfold (mm); Suprailiac: thickness of the suprailiac skinfold (mm); % of fat: percentage of body fat; WHR: waist hip ratio; MET: unit of resting metabolic rate; Sedentary: hours/day spent on sedentary activities; TV/Video: hours/day spent watching TV and/or videos

Table 4 – Distribution of total cholesterol serum levels and lipoprotein fractions according to the clinical cut-points (*)

Lipids	Desirable		Borderline		Elevated	
	Reference Values (mg/dl)	Sample Distribution (%)	Reference Values (mg/dl)	Sample Distribution (%)	Reference Values (mg/dl)	Sample Distribution (%)
Total Cholesterol	< 170	921 (67.1)	170-199	351 (25.6)	≥ 200	100 (7.3)
LDL-cholesterol	< 110	1022 (74.6)	110 -129	244 (17.8)	≥ 130	100 (7.3)
HDL-cholesterol	< 10 years: > 40 10-19 years: > 35	1138 (83.0)				

(*) These cut-points were determined by consensus and guidelines: Brazilian Cardiologist Society (<http://www.cardiol.br/>), National Heart, Lung, and Blood Institute (<http://www.nhlbi.nih.gov/health/prof/heart/index.htm>)

Table 5 – Distribution of total cholesterol serum levels and lipoprotein fractions in accordance with the risk scale (*) to develop atherosclerotic disease in adulthood

Lipids	Level of Risk to Develop Atherosclerosis					
	Slight Risk		Moderate Risk		Serious Risk	
	Reference Values (mg/dl)	Sample Distribution (%)	Reference Values (mg/dl)	Sample Distribution (%)	Reference Values (mg/dl)	Sample Distribution (%)
Total Cholesterol	155 to 169	273.0 (19.9)	170 to 184	215.0 (15.7)	≥ 185	236 (17.2)
LDL-cholesterol	95 to 104	189.0 (13.8)	105 to 119	242.0 (17.7)	≥ 120	201.0 (14.7)

(*) National Cholesterol Education Program (NHBLI, USDHHS). Report of the expert panel on detection, evaluation, and treatment of high blood cholesterol in adults. Washington, DC: Government Printing Office, 1988; NIH publication no. 88-2925

to two days per week. More than one third (37.5%) ate French fries one to two days per week, 17.9% three to four days per week and 14.3% almost every day (> five days per week). A little more than one half (58.3%) ate candies and chewing gum almost every day (> five days per week), 14.7% three to four days per week and 13.7% one to two days per week. Roughly one third (32.9%) drank regular soft drinks almost every day (> five days per week), and another third (32.8%) one to two days per week, while one fifth (21.0%) three to four days per week and the majority (86.6%) at least once a week. Almost one half (48.0%) ate fruits and vegetables every

day, 22.8% two to three days per week and 11.1% four to six days per week.

Prevalence rates were 8.4% for overweight, 3.1% for obesity, and 11.5% for excess weight (BMI > 85th percentile).

Participants with a regular intake of very high-fat foods and very low levels of fruits, vegetables and fibers did not present any significant differences when compared to those with intakes of high-fat foods and low levels of fruits, vegetables and fibers in relation to low levels of HDL-c, elevated levels of total cholesterol and LDL-c, elevated systolic or diastolic blood pressure and central body fat distribution variables, except the subgroups of subscapular and suprailiac skinfold thickness measurements in children. (Table 6).

The chance of a student with a physical activity level located in the 1st interval or lower quartile – Q_1 of the calorie expenditure distribution and also classified as "less active" (calorie expenditure < 100 MET/day) to have high cholesterol (>200 mg/dl) is 3.80 times higher than the chance of another student classified as "more active" located in the upper quartile – Q_4 (calorie expenditure > 964 MET/day) (Table 6). A student located in the 4th interval (upper quartile – Q_4) of the subscapular skinfold thickness distribution classified in quartiles has 3.68 times more chances to have high cholesterol than another student located in the 1st interval (lower quartile – Q_1) of this skinfold (Table 6). In relation to LDL-c, the chance of a student with central body fat distribution, that is, located in the 4th interval (upper quartile – Q_4) of the "sum of skinfold thickness measurements", to have elevated levels of LDL-c (>130 mg/dl) is 3.29 times higher than the chance of another student located in the 1st interval for this variable (Table 6). In regard to HDL-c, the chance of a student with a BMI value lower than the 85th percentile to have "desirable levels of HDL-c" is 2.20 times higher than the chance of another student with excess weight (> 85th percentile) (Table 6). Further, the chance of a student located in the 1st interval of the "waist – hip ratio" classified in quartiles to have "desirable levels of HDL-c" is 2.45 times higher than the chance of another student located in the 4th interval of this quotient when both are in the last interval of the sum of skinfold measurements (Table 6).

Students with excess weight (BMI > 85th percentile) presented 3.60 times more chances to have high systolic blood pressure and 2.70 times more chances to have high diastolic blood pressure (> 90th percentile) (Table 4). Also, students enrolled in public schools presented 3.95 times more chances to have a systolic blood pressure above the 90th percentile than those enrolled in private schools (Table 6).

Students with "excess weight" presented 1.99 times more chances to be located in the higher social-economic classes (AB) than those with a BMI < 85th percentile;

1.86 times more chances to be male and 1.78 times more chances to be "less active than the others" when compared with females and those that are considered to be "more active than the others". However, the age group (child) only had a significant association with "excess weight" when the skin color variable was included in the regression model (Table 6).

There were more female students from the higher social-economic classes (AB) with a body fat percentage in the upper quartile (Q4) of their distribution than male students. Compared to a student that is "more active than the others", the less active was estimated to have 1.18 times more chances to be in the upper quartile of the distribution of the percentage of body fat (Table 6).

With the exception of dark skinned children, more female students were located in the upper quartile of the distribution of subscapular skinfold thickness than male students. Children with dietary habits classified as "very inadequate consumption of fruits, vegetables and fibers" presented 1.18 times more chances to present subscapular skinfold thickness values in the upper quartile of their distribution compared to those that presented an "inadequate intake". Students considered "less active than the others" presented 1.23 times more chances to be located in the upper quartile of the distribution of this skinfold than those who are more active (Table 6).

Once again, more female students were found to have suprailiac skinfold thickness measurements in the upper quartile of their distribution than male students. Children with a diet classified as "very inadequate intake of fruits, vegetables and fibers" presented 1.18 times more chances to present suprailiac skinfold thickness values in the upper quartile of their distribution compared to those who presented an "inadequate intake." Participants who were "less active than the others" presented 1.25 times more chances to be located in the upper quartile of the distribution of this skinfold than those who were more active (Table 6).

Participants from the social-economic group AB had 1.22 times more chances to present values of the sum of the three skinfold measurements studied located in the upper quartile of their distribution than those from the lower social-economic classes (groups CDE). Consistent with the other variables indicative of central body fat distribution, participants who were "less active than the others" presented 1.23 times more chances to be located in the upper quartile of the distribution of this variable than those who were more active. The female participants also presented higher values for this variable than the males (Table 6).

There were more male students with waist-hip ratios (WHR) located in the upper quartile of their distribution than females. Students located in the upper quartile of the distribution of WHR did not present any significant differences compared to those located in the lower quartile, in relation to the adiposity, and physical and

Table 6 – Odds ratio (logistic regression) for cardiovascular risk factors[1] in children and adolescents

Variable	Ratio	Odds	95% Confidence Interval	
			Lower	Higher
Elevated Total Cholesterol (> 200mg/dl)				
Subscapular skinfold thickness	Q_4 / Q_1	3.68	2.09	6.46
Energy expenditure (MET)[2]	Q_1 / Q_4	3.80	1.54	9.40
Elevated LDL-c (> 130mg/dl)				
Sum of skinfolds[3]	Q_4 / Q_1	3.29	1.89	5.74
Desirable HDL-c[4] level				
Body Mass Index	<85 Ptile *vs* >85 Ptile[5]	2.20	1.44	3.35
Waist – Hip Ratio	Q_1 / Q_4	2.45	1.06	5.68
Elevated Systolic Blood Pressure (>90 percentile)				
Type of School	private vs. public	3.95	1.80	8.71
Body Mass Index	>85 Ptile vs. <85 Ptile	3.60	2.23	5.78
Elevated Diastolic Blood Pressure (>90 percentile)				
Body Mass Index	>85 Ptile vs. <85 Ptile	2.70	1.85	3.95
Elevated Body Mass Index (>85 percentile)				
Sex	male vs. female	1.86	1.31	2.65
Age Group	Child vs. adolescent	1.98_{Wht}	1.01	3.87
		2.38_{Dark}	0.86	6.59
		9.24_{Blk}	2.50	34.30
Social-Economic Class	(AB) vs. (CDE)[6]	1.99	1.40	2.83
Physical Activity	(- Others) vs. (+ Others)[7]	1.78	1.28	2.48
Elevated Body Fat Percentage (Upper Quartile)				
Sex	female vs. male	Child: 4.24_{Wht}	2.94	6.13
		2.81_{Dark}	1.99	3.98
		3.54_{Blk}	2.74	4.57
		Adolescent: 6.47_{Wht}	4.70	8.92
		4.30_{Dark}	3.17	5.82
		5.40_{Blk}	4.44	6.57
Social-Economic Class	(AB) vs. (CDE)	1.22	1.10	1.36
Physical Activity	(- Others) vs. (+ Others)[7]	1.18	1.06	1.31
Subscapular skinfold thickness (Upper Quartile)				
Sex	female vs. male	Child: 1.72_{Wht}	1.27	2.32
		1.16_{Dark}	0.87	1.56
		1.43_{Blk}	1.18	1.75
		Adolescent: 2.00_{Wht}	1.54	2.60
		1.35_{Dark}	1.05	1.75
		1.67_{Blk}	1.45	1.93
Fruits, Vegetables & Fibers	Very inadequate vs. inadequate[8]	Child: 1.18	1.01	1.38
		Adolescent: 1.03	0.92	1.15
Physical Activity	(- Others) vs. (+ Others)[7]	1.23	1.13	1.35
Suprailiac skinfold thickness (Upper Quartile)				
Sex	female vs. male	Child: 1.44_{AB}	1.19	1.75
		1.27_{CDE}	1.07	1.49
		Adolescent: 1.67_{AB}	1.44	2.95
		1.47_{CDE}	1.31	1.65
Fruits, Vegetables & Fibers	Very inadequate vs. inadequate[8]	Child: 1.18	1.01	1.37
		Adolescent: 1.02	0.92	1.13
Physical Activity	(- Others) vs. (+ Others)[7]	1.25	1.14	1.37
Sum of skinfolds – triceps+ subscapular + suprailiac (Upper Quartile)				
Sex	female vs. male	Child: 1.45	1.25	1.67
		Adolescent: 1.76	1.59	1.95
Social-Economic Class	(AB) vs. (CDE)	1.22	1.10	1.36
Physical Activity	(- Others) vs. (+ Others)[7]	1.23	1.13	1.35
Waist-Hip Ratio (Upper quartile)				
Sex	male vs. female	Child: 1.75	1.51	2.02
		Adolescent: 2.09	1.88	2.32

Q1 = lower quartile (or interval) of the distribution of the independent variables; Q4 = upper quartile (or interval) of the distribution of the independent variables; 1 serum lipid levels, blood pressure, excess weight (overweight and obesity) and central body fat distribution (dependent variables) – in bold and highlighted. The other variables are the independent ones; 2 resting metabolic rate (1 MET=1Kcal/Kg/h); 3 triceps + subscapular + suprailiac skinfolds; 4 desirable levels of HDL-c: up to 10 years of age = > 40 mg/dl; 10 to 18 = >35 mg/dl; 5 percentile; 6 higher social-economic class (AB), versus lower social-economic class (CDE); 7 less (physically) active than the other students versus more active than the other students; 8 very inadequate consumption of fruits, vegetables and fibers versus inadequate consumption (according to the Block score)

sedentary activity variables (Table 6).

No significant differences were observed in a multivariate analysis between the groups for other variables.

DISCUSSION

Consistent with other studies, we found higher serum lipid levels in the female participants[15,16] with an increase roughly between the ages of nine and eleven. However, unlike other studies[15], we found that the white students had higher levels of TC, LDL-c, and HDL-c than the black students. Higher levels of serum lipids, overweight, obesity and central body fat distribution were found among the students from the upper social-economic classes and enrolled in private schools, as frequently occurs in countries in epidemiological transition.

When compared with the results of the Lipid Research Study[16], there was a wide discrepancy in the positive and negative values for the mean values of serum lipids which in most cases was not statistically significant. Despite the presence of a lipid profile that is harmful to health and similar to and at times even more alarming than that of the North American population regarding the figures found for risk of development of atherosclerotic disease, these figures are still lower than those reported in the cities of New York and Bogalusa, with figures of slight risk between 28% and 33%, moderate risk between 17% and 22%, and serious risk between 20% and 30%[17].

For the comparison of results, we chose the studies conducted in the cities of Rio Acima – MG[18] and Bento Gonçalves – RS[19], because their methodology was similar to ours. Using identical design and methodology, we replicated the Belo Horizonte Heart Study in the city of Florianópolis – SC[20,21], thus facilitating the comparison of the results found in Florianópolis with those of the main study from Belo Horizonte.

In regard to the prevalence of elevated levels of cholesterol and lipoprotein fractions, the students from Belo Horizonte presented lower rates of elevated levels of total cholesterol and LDL-c than those found in the cities of Rio Acima[18], Bento Gonçalves[19] and Florianópolis[20,21], and higher rates of undesirable levels of HDL-c than those of Bento Gonçalves[19] and Florianópolis[20,21].

After adjustment for other variables, significant odds ratio were found for desirable HDL-c levels in individuals with "normal weight", similar to the results of the Bogalusa Heart Study[22]. Also, as described in this North American cohort[22], an inverse relation between desired HDL-c levels and the WHR was demonstrated in this Brazilian study (Table 6).

In agreement with other population studies[23], we did not find significant differences in the diastolic blood pressure readings for males and females, but adolescents presented significantly higher values in relation to children and blacks in relation to whites. Significant differences were found between the values of elevated systolic blood pressure for black male adolescents when compared to white female children and public school students, however, no difference was found for social-economic classes (Table 3). In the present sample, 12% of the students presented higher than normal blood pressure readings (systolic and/or diastolic > 90th percentile). This prevalence of high blood pressure was lower than that found in another Brazilian sample by Perone et al (15%)[24] and the same as found in the city of Florianópolis (12%)[20,21].

As was expected, and similar to the results found by Nielsen et al[25] (OR=3.99), our students with "excess weight" (BMI > 85th percentile) presented more chances to have elevated (> 90th percentile) systolic or diastolic blood pressure than those with "normal weight" (BMI < 85th percentile) (Table 6). The public school students presented more chances to have high systolic blood pressure than those enrolled in private schools, whereas no significant differences were observed between the extreme quartiles of the distribution of adiposity and high blood pressure variables (Table 6). This odds ratio was higher than those found by Styne (2.40)[26] and close to that verified for systolic blood pressure levels in developing countries (4.00)[27].

Our prevalence rates for overweight (8.4%), obesity (3.1%) and excess weight were lower than the rates for Brazil as a whole, several countries in Latin America, and the United States[28,29]. Data collected from another source one year before our study and representative of Brazil also showed the same prevalence for overweight, but higher rates for obesity and excess weight[30]. In Florianópolis, found higher prevalence rates for overweight, obesity, and excess weight were found in a sample of 1,050 students between the ages of six and eighteen[20,21]. Compared to another study conducted five years earlier with students between the ages of six and eighteen in Belo Horizonte[31], with the same design and methodology and researchers as this study, our results indicate a clear 13% increase trend during this period in the rates for overweight and obesity in this population group.

As was expected, participants with excess weight and those with central body fat presented higher systolic and diastolic blood pressure readings than those with "normal weight" and no central body fat (Table 6). The lack of a significant association between WHR and the majority of the variables studied could be explained by a larger increase in the shoulder circumference compared to abdominal circumference during the growth cycle.

In the present study, black male children enrolled in public schools and from lower social-economic classes (CDE), presented higher values of energy expenditure (MET), when compared to white female adolescents enrolled in private schools and from higher social-economic classes (Tables 2 and 3). Adolescents were more sedentary than children and those from lower social-economic classes spent more time watching television

than those from the higher classes (Tables 2 and 3). There were more participants in this study that spent long periods of time on sedentary activities (28% > 5.5 hr/day) than recorded for the world population (17% > fifteen years of age)[32], less than in the Brazilian population as a whole (50%-79% > twelve years of age) but similar to the adolescent subgroup of the Brazilian population (76% > 5.5 hr/day)[33,34]. Compared to North Americans (3.5 hr/day)[35] and another Brazilian sample (5 hr/day),[36] our students, including the adolescents, spent less time watching television (2.8 hr/day). The results from the study arm conducted in the state of Santa Catarina[20,21] showed a higher percentage of students with little physical activity (very low levels of calorie expenditure, MET/day = 40%) compared to those in Belo Horizonte (lower quartile calorie expenditure, MET/day = 22.8%).

Both the comparative scale of physical activity and energy expenditure levels indicated low levels of these variables and were more frequently found in those with excess weight than those with "normal weight". Similar to the findings of other authors[25], we found significant odds ratios for excess weight (BMI > 85th percentile) and increased skinfold thickness measurements for low levels of physical activity (Table 4). In agreement with Kemper et al[37] (OR = 0.81), we found that physical activity has a protective effect against excess weight (OR = 0.61). Unlike other studies[38], our students with excess weight did not spend more hours watching television than those with normal weight levels.

Our findings were similar to those in Florianópolis regarding the consumption of foods affecting cardiovascular health. Thus, while 88.4% of the Belo Horizonte students consumed foods high in saturated fat and not one participant reported an adequate intake of fruits, vegetables and fibers, these values in Florianópolis were 79% and 0.3%[20,21]. In Dennison et al's study[39], just as in the present study, participants with excess weight did not present higher energy intake than their controls.

Consistent with other studies[39], we found that participants with excess weight ate fruits, vegetables and fibers more frequently than those with normal weight levels or underweight. It is possible that the participants with excess weight and their parents exaggerated when reporting fruit and vegetable intake and under reported the intake of high fat foods due to the concepts of "healthy and unhealthy foods" that are promoted by various media and health professionals.

As reported in other studies, we identified among the students a cluster of risk factors for developing metabolic syndrome[40]. We verified that practically one in every five participants (19.3%) presented a cluster of four cardiovascular risk factors in the same individual: elevated total cholesterol levels (> 200 mg/dl), BMI > 85th percentile, systolic blood pressure > 90th percentile, diastolic blood pressure > 90th percentile.

The lack of a significant association between dietary habits and other variables could be partially due to attenuation caused by the low accuracy of data regarding dietary habits and physical activity.

CONCLUSIONS

The majority of the students presented dietary habits considered harmful to health, characterized by the consumption of alarming quantities of junk food, foods with high levels of saturated fat and low fruit, vegetable and fiber intakes. Many students presented very low levels of physical activity, long periods of time spent on sedentary activities, mainly watching television and more than half of the participants in the sample were individuals considered "much less active than the others." We found a disturbing rate of "excess weight" and central body fat distribution, which together with patterns of low levels of physical activity/ a sedentary lifestyle were associated with high blood pressure, elevated levels of total cholesterol and LDL-c as well as low HDL-c levels.

Acknowledgements

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