CARDIOVASCULAR RISK FACTORS, NON-HDL CHOLESTEROL, AND OVERWEIGHT AMONG ADOLESCENTS: CLINICAL AND SOCIODEMOGRAPHIC ASPECTS

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Abstract: The objective of this study was to estimate the prevalence ratio of increased non-HDL

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cholesterol with cardiovascular risk factors in a representative sample of adolescents from public schools. This is a descriptive and cross-sectional study, carried out with adolescents aged between 10 and 16 years from public schools in Montes Claros, northern Minas Gerais, Brazil. The proportion of adolescents classified as overweight (31.4%) did not differ significantly between genders and was significantly higher among younger adolescents (47.6%) compared to all other age groups. The prevalence of central obesity was also higher in adolescents aged 10-11 years, as well as metabolic syndrome and hypertriglyceridemia, but without significant difference. The adjusted prevalence ratio for LDLc was 1.71 (95% CI 1.68-1.73; $p < 0.00$), indicating that an increase in each unit of non-HDL cholesterol increases the probability of high LDLc by 71%. It was also evidenced that adolescents with high non-HDL cholesterol have a prevalence of 1.14 times more hypertriglyceridemia, adjusted for gender and age group. The prevalence of non-HDL cholesterol was high among adolescents, as well as cardiovascular risk factors, in this sense, effective school programs for health promotion and regular physical activity are needed.

Keywords: HDL-Cholesterol; Overweight; Cardiovascular Risk Factors.

Introduction

The increase in overweight in adolescence around the world is alarming, with this increasing the risks for cardiovascular diseases (CVD) and others such as dyslipidemia, type 2 diabetes mellitus (DM2) and metabolic syndrome (MS). These diseases increase morbidity and mortality, reduce quality of life, and present high economic costs for their treatments (Farias-Junior et al., 2021).

In recent years, researchers have been looking for simple markers to assess cardiovascular (CV) risk in children and adolescents, encouraging its early identification in the population to intervene in order to improve quality of life and reduce the risk of CVD in adulthood. LDL (low-density lipoprotein) cholesterol is an excellent CV marker, and studies show non-HDL cholesterol predicting

CV events in a simple and low-cost way in adults (NCEP, 2002; Boekholdt et al., 2012).

It is calculated by subtracting HDLc (high-density lipoproteins) from total cholesterol (TC), does not require the measurement of LDLc levels and is not influenced by the concentration of triglycerides (TG) (NCEP, 2002). Non-HDL cholesterol reflects the concentrations of atherogenic lipoproteins and includes all cholesterol present in the particles of lipoproteins considered potentially atherogenic - LDLc, very low-density lipoproteins (VLDLc), intermediate-density lipoproteins (IDL), and lipoprotein-A - and excludes HDLc, which is considered anti-atherogenic (NCEP, 2002).

The etiology of CVD is multifactorial, and may result from the biological characteristics of the individual and the socioeconomic, environmental, cultural, and urbanization conditions of the environment in which he or she is inserted (Lancarotte et al., 2020; WHO, 2021). In addition, several behaviors, considered behavioral risk factors for cardiovascular health, have been associated with the development of CVD (Regis et al., 2016). Among these factors, unhealthy eating habits, physical inactivity, tobacco use, and alcohol consumption stand out (NCEP, 2002).

In Brazil, there are no studies that show the accumulation of behavioral risk factors for CVD among adolescents, so there is still no knowledge about the extent to which these young people are exposed to the development of CVD. However, national studies conducted in urban areas have shown a high prevalence of behavioral risk factors for CVD among adolescents, with physical inactivity and inadequate consumption of fruits and vegetables being the most prevalent risk behaviors (Malta et al., 2014; Heyward; Stolarczyk, 2000; Onis et al., 2007), reported by about 60% (Zimmet et al., 2007) and 80% (Stergiou; Yiannes; Rarra, 2006) of young people, respectively. Other risk behaviors, such as alcohol and tobacco use, have also been frequently observed in this age group (NHBPEPWGH, 2004), reaching the mark of 21% of reports of alcohol experimentation (Malachias et al., 2016) and 18.5% of tobacco experimentation (Guedes; Lopes; Guedes, 2005. This scenario is worrisome, since many of these behaviors are maintained after adolescence, having a negative impact on the health of individuals in adult life (NHBPEPWGH, 2004).

Knowledge of the prevalence of each isolated factor provides only a partial view of the problem, considering that behavioral risk factors often occur simultaneously and that the concomitant presence of these behaviors can be even more harmful to health (Back et al., 2005). In this sense, the objective of the present study was to estimate the prevalence ratio of increased non-HDL cholesterol with risk factors for VC in a representative sample of adolescents from public schools in Montes Claros, northern Minas Gerais, Brazil.

Methodology

This is a descriptive and cross-sectional study, carried out with adolescents aged between 10 and 16 years from public schools in Montes Claros, northern Minas Gerais, Brazil. It is part of the research project entitled "Influence of a physical activity program on adolescents at cardiovascular risk".

The sample selection process was based on probabilistic clusters. The sample size was established to estimate the parameters of the population with a prevalence of 0.50, which ensured a larger sample size. A confidence interval (CI) of 95% and a precision level of 5% were established. The correction was made for the finite population and correction for drawing effect, adopting a deff equal to 1.5. A 10% increase was also established to compensate for possible non-responses and losses.

The sample was stratified into four regions (north, south, east and west), consisting of the 63 state public schools in the city of Montes Claros (MG) in Brazil, with a total population of 77833 students. The clusters were selected at two levels: schools and school level (primary and secondary education). The sample weight was calculated by the product of the inverse of the probabilities of inclusion in each stage of sample selection and was calibrated considering the estimates of the population of adolescents enrolled in schools located in the geographic strata considered by gender and age group. The sample weight of the northern region was 140 units of the population, represented by the Uk unit of the sample, the south 109 Uk, the east 145 Uk and the west 97 Uk.

Subsequently, the adolescents were selected in each school, with a draw based on enrollment number, gender and age stratification, adopting simple random sampling. In the refusal to participate, the previous one on the enrollment list was replaced. In this way, the study provided the same chance of participation to adolescents. Each student received a manual of instructions and procedures for data collection.

For this study, 634 adolescents (249 men and 385 women) who met the inclusion criteria were evaluated, and adolescents who had any physical disability that made it impossible to assess weight, height, waist circumference (WC) and blood collection were excluded. Pregnant women were also excluded; adolescents with significant inflammatory, infectious, renal, hepatic and hematological diseases; used medications that influence the metabolic and hemodynamic profile; adolescents without signing the Informed Consent Form by their guardians.

Data collection was carried out by a multiprofessional team in August 2016. The team was properly calibrated, with the kappa coefficients for the application of the questionnaires being 0.99 (inter-examiner) and 0.98 (intra-examiner) and for anthropometric and hemodynamic evaluations of 1.0 and 0.9, respectively.

A questionnaire was applied to identify the participants: age, gender, educational and socioeconomic level, presence of obesity and other hereditary family diseases, medications used, smoking and alcohol consumption, as well as religion and ethnicity. Age was categorized into the following groups: 10-11 years, 12-13 years, 14-15 years, and 16 years.

Weight was measured with an electronic scale (Líder, Araçatuba, São Paulo, Brazil, model P150M), with a capacity of 150 kg and a precision of 50 g. Height was measured with a portable stadiometer (Alturexata, Belo Horizonte, Minas Gerais, Brazil) with a limit of 2 m and a precision of 0.1 cm. Weight was measured in an anthropometric position, with the head placed in the Frankfurt plane and distributed on both feet. For height, the measurement point was produced with a steel rod that reached the vertex at the end of deep breathing (Heyward; Stolarczyk, 2000). Both were measured barefoot and with the least amount of clothing possible. Nutritional status classification was based on BMI (weight (kg)/height2 (m2)) according to the WHO BMI tables for gender and age (Onis et al., 2007). The cut-off points were: Z-score ≥ -2 and ≤ 1 (normal); Z-scores > 1 and ≤ 2 (overweight); Z-score > 2 (obesity). For some statistical analyses, BMI was categorized as normal and overweight (overweight and obesity).

WC was assessed by the mean of two measurements with a flexible and inextensible tape measure (Sanny, São Bernardo do Campo, São Paulo, Brazil), with a limit of 2 m and a precision of 0.1 cm. The measurement point used was the midway between the lower border of the last rib and the upper border of the iliac crest. It was determined with the adolescent standing, arms at the sides of the body, feet together, after a normal exhalation (Heyward; Stolarczyk, 2000). The cutoff point for central obesity was WC ≥ the 90th percentile (p 90), for gender and age, according to the IDF (Zimmet et al., 2007).

Blood pressure (BP) was measured with an automatic oscillometric sphygmomanometer model Omron 705-IT, validated for adolescents (Stergiou; Yiannes; Rarra, 2006). It was measured with the subject sitting and feet on the floor, after 5 minutes of rest, the right arm supported and at the level of the heart (NHBPEPWGH, 2004). The mean value of the two measurements was recorded with an interval of 3 minutes. SAH was defined as systolic and/or diastolic BP ≥ p 95 (for age, gender, and height) and prehypertension as systolic and/or diastolic BP ≥ p 90 and < p 95 or BP values ≥ 120/80 mmHg, according to the recommendations of the 4th Task Force for children and adolescents (Malachias et al., 2016).

Habitual physical activity (PA) was self-reported using the IPAQ (International Physical Activity Questionnaire) short version with nine questions, validated for Brazilian adolescents (Guedes; Lopes; Guedes, 2005). For the PA level, the categorization when necessary was performed at the following levels: inactive (sedentary, irregularly active A and B) and active (active and very active).

Blood samples for the biochemical tests were collected at the school itself, by venipuncture with disposable needles and syringes after a 12-hour fast, by a specialized blood collection team. The biochemical parameters were carried out in a single laboratory according to the quality standards in force and required for their qualification. All the methods used were from Bioquímica LabTeste and the analyses were carried out by LabTeste's Lab Max Pleno automated equipment.

Blood glucose (BG) was analyzed with the God-Trinder enzymatic assay method and was established as a cutoff value for hyperglycemia ≥ 100 mg/dL (Zimmet et al., 2007). Insulin (INS) was measured using chemiluminescence immunoassay and hyperinsulinemia was established if ≥ 20mU/L (Back et al., 2005; Bloch et al., 2015). The IR was determined by the formula HOMA-IR = (GLI X 0.0555 X INS) / 22.5, adopting a HOMA-IR value ≥ 3.16 (Keskin et al., 2005).

For total cholesterol (TC), triglycerides (TG) and uric acid, the Trinder enzymatic assay method was used and in the analysis for HDL cholesterol (HDLc) the colorimetric enzymatic method was used. LDL cholesterol (LDLc) was calculated using the Friedewald equation: LDLc = TC - (HDLc + TG / 5), participants with TG > 400 mg/dL being excluded due to the impossibility of calculation. Non-HDL cholesterol was calculated using the formula CT - HDLc. Dyslipidemia was defined by the presence of at least one of the following parameters: TC ≥ 170 mg/dL, HDLc ≤ 45 mg/dL, LDLc ≥ 110 mg/dL, non-HDL cholesterol ≥ 120 mg/dL or TG ≥ 90 mg/dL (Faludi et al., 2017). Adolescents with uric acid ≥ 5 mg/dL for females and ≥ 6 mg/dL for males were classified as hyperuricemia (Ferraz; Delgado,1988).

To create the database and statistical analysis, the SPSS program (Statistical Package for Social Science), version 20 (IBM, Chicago, IL, USA) was used, with a statistically significant level of 5% being considered for all analyses.

The characterization of the sample was expressed by descriptive statistics through percentages. The Kolmogorov-Smirnov test was used to assess the normality of continuous variables, which was evident for all variables. Analysis of variance (ANOVA) with weighting was used to determine the differences in quantitative variables according to gender and age group, described through means ± standard error (SE). The association between metabolic, hemodynamic, anthropometric changes and PA level was determined using the Chi-square test for a complex sample, which were described with their percentages and 95% CI, by gender and age group.

Poisson regression was performed with sample weighting (forward stepwise method), considering changes in non-HDL cholesterol as the dependent variable in the model, and the PR was calculated with its 95% CI adjusted for gender and age group, with robust variance. The following independent variables were defined: BMI, WC, MS, systolic and diastolic BP, GLI, INS, RI, LDLc, TG, uric acid and PA level.

The investigation was approved by the Research Ethics Committee of Unimontes (State University of Montes Claros) under number 1,503,680. Adolescents who agreed to participate by signing the Assent Form and whose guardians signed the Free and Informed Consent Form participated.

Results

The study population consisted of 634 adolescents aged between 10 and 16 years, 60.8% of whom were female, with a mean age of 13.8 ± 1.7 years. For the defined age group, 41.5% were between 14-15 years old. The general characteristics of the population that make up the sample are described in Table 1, showing that 26.2% of the adolescents studied and lived in the eastern region of the city. The majority (82.2%) declared a monthly family income of up to 3 minimum wages. Only 1.4% reported smoking and 6.5% consumed alcohol. Obesity was identified in 12.1%. According to IPAQ (14), the majority of adolescents had an active and very active level of PA (53%), with a sedentary lifestyle being present in 11.4% of participants.

Table 1. Sociodemographic characterization of adolescents.

	Variables	Sample % (n = 634)
Region	North	22,3 (120)
	South	25,9 (179)
	East	26,2 (136)
	West	25,6 (199)
Education	5-6º year	19,4 (125)
	7-8º year	26,1 (166)
	9-1º year	47,9 (297)
	2º year	6,5 (46)

Ethnicity	Brown	57,8 (365)
	Whites	18,6 (118)
	Blacks	17,4 (110)
	Others	6,2 (41)
Monthly family income	Up to 3 minimum wages	82,2 (517)
	From 3 to 10 minimum wages	13,0 (87)
	More than 10 minimum wages	4,8 (30)
Own home	No	15,6 (103)
	Yes	84,4 (531)
Smoking	No	96,6 (613)
	Yes	3,4 (21)
Alcoholism	No	93,5 (593)
	Yes	6,5 (41)
Nutritional status	Normal weight	68,4 (430)
	Overweight	19,5 (126)
	Obesity	12,1 (78)
	Overweight	31,4 (204)
Level of physical activity	Sedentary	11,4 (72)
	Irregularly active B	35,5 (226)
	Irregularly active A	0 (0)
	Active	40,1 (256)
	Very active	12,9 (80)

Source: study data.

Table 2 shows the ANOVA for the dependent variables by gender with their means and SE. Statistical differences were observed for BMI, GLI, INS, RI and uric acid. Significant differences in means were higher in females for BMI, INS and IR. There was no significant difference for non-HDL cholesterol.

Table 2. Anthropometric, hemodynamic and metabolic description of adolescents by gender.

Variáveis	Total average (TA)	Average Genre (AG)		
		Feminine	Masculine	p Value
Age (years)	13,8 (0,0)	14,0 (0,1)	13,6 (0,1)	0,002*
BMI (Kg/m²)	21,0 (0,2)	21,3 (0,2)	20,6 (0,3)	0,038*
WC (cm)	71,5 (0,4)	70,7 (0,5)	72,2 (0,6)	0,066
SBP (mmHg)	113,4 (0,6)	113,4 (0,7)	113,4 (0,9)	0,957
DBP (mmHg)	67,2 (0,5)	67,8 (0,6)	66,6 (0,7)	0,199
Blood glucose (mg/dL)	81,2 (0,3)	80,3 (0,4)	82,1 (0,5)	0,004*
Insulin (mU/L)	8,0 (0,4)	9,1 (0,5)	7,0 (0,6)	0,008*
RI	1,6 (0,1)	1,9 (0,1)	1,4 (0,1)	0,023*

CT (mg/dL)	153,2 (1,1)	154,4 (1,4)	152,0 (1,8)	0,282
HDLc (mg/dL)	47,4 (0,4)	48,2 (0,6)	46,6 (0,7)	0,075
LDLc (mg/dL)	87,7 (1,0)	87,5 (1,3)	88,0 (1,6)	0,782
Not HDL (mg/dL)	105,8 (1,2)	106,2 (1,5)	105,3 (1,8)	0,704
TG (mg/dL)	94,2 (1,7)	96,8 (2,2)	91,6 (1,7)	0,128
Auric (mg/dL)	4,6 (0,0)	4,2 (0,0)	5,0 (0,1)	0,000*

Analysis of variance with weighting SE, standard error; BMI, body mass index; WC, waist circumference; SBP, systolic blood pressure; DBP, diastolic blood pressure; IR, insulin resistance; TC, total cholesterol; HDLc, HDL cholesterol, LDLc, LDL cholesterol; Not HDL; non-HDL cholesterol; TG, triglycerides; Auric, uric acid.

Table 3 shows the prevalence and associations of metabolic, hemodynamic, anthropometric and PA changes according to age group. The proportion of adolescents classified as overweight (31.4%) did not differ significantly between genders and was significantly higher in the youngest (47.6%) compared to all other age groups. The prevalence of central obesity (high WC if ≥ p 90) was also higher in adolescents aged 10-11 years, as well as MS and hypertriglyceridemia, but without a significant difference.

Table 3. Anthropometric, hemodynamic, metabolic profile and physical activity level of adolescents by age group.

Variables	Age range % (CI 95%)				
	10-11 years	12-13 years	14-15 years	years	p Value
Sample	13,5 (9,0-19,9)	27,3 (25,8-28,8)	41,5 (34,3-49,0)	17,7 (14,3-21,7)	0,00
Excess weight[1]	47,6 (27,0-69,0)	38,8 (18,5-64,0)	23,7 (17,6-31,1)	25,6 (17,6-35,5)	0,01
WC high (≥ p90)	15,4 (4,1-43,5)	14,8 (4,7-37,8)	4,9 (2,8-8,2)	13,5 (4,0-37,1)	0,10
Metabolic syndrome[2]	5,8 (2,9-11,1)	4,5 (1,4-13,1)	1,9 (1,1-3,4)	3,2 (0,5-19,5)	0,27
SBP (≥ p95)	15,1 (10,2-21,8)	12,5 (8,7-17,5)	17,6 (14,4-21,2)	13,4 (8,1-21,2)	0,15
DBP (≥ p95)	6,8 (6,0-7,7)	6,6 (1,6-23,2)	6,4 (4,3-9,6)	8,1 (5,9-11,0)	0,73
Blood glucose (≥100 mg/dL)	1,4 (0,0-31,7)	1,6 (0,1-29,2)	1,2 (0,1-11,5)	1,9 (0,3-12,8)	0,95
Insulin (≥ 20 mU/L)	2,7 (0,1-49,4)	4,4 (1,7-11,0)	1,6 (0,4-6,1)	3,6 (1,2-10,6)	0,48
RI (≥ 3,16)	7,7 (1,9-26,1)	10,2 (6,8-14,9)	5,1 (1,8-13,6)	6,3 (3,9-9,9)	0,30
CT (≥ 170 mg/L)	28,2 (18,7-40,1)	30,1 (19,8-43,0)	23,3 (14,7-34,8)	27,3 (12,5-49,8)	0,27
HDLc (< 45 mg/dL)	44,5 (37,9-51,2)	48,2 (28,9-68,1)	42,8 (32,6-53,7)	39,8 (19,6-64,2)	0,57

LDLc (≥ 110 mg/dL)	21,3 (8,9-42,7)	21,3 (10,4-38,6)	14,1 (9,2-21,2)	21,4 (9,6-41,2)	0,18
Not HDL (≥120mg/dL)	28,1 (15,0-46,4)	31,6 (19,1-47,6)	23,7 (13,3-38,8)	27,4 (12,6-49,8)	0,31
TG (≥ 90 mg/dL)	56,9 (24,4-84,4)	49,2 (37,9-60,5)	38,9 (32,3-45,9)	43,9 (23,5-66,6)	0,29
Auric (mg/dL)[3]	9,3 (5,7-14,7)	19,3 (11,5-30,5)	17,6 (8,5-32,8)	20,2 (7,5-44,2)	0,38
Sedentary	16,8 (10,2-26,5)	14,2 (9,5-20,7)	9,4 (2,9-26,3)	7,6 (1,8-27,6)	0,41
Irregularly active B	36,5 (15,8-63,9)	37,3 (22,5-54,9)	34,6 (19,7-53,3)	34,1 (24,9-44,7)	
Active	41,5 (25,2-60,0)	37,4 (29,3-46,3)	39,7 (30,4-49,9)	44,3 (32,6-56,6)	
Very active	5,1 (1,1-21,0)	11,0 (2,3-40,0)	16,3 (12,9-20,4)	14,0 (7,4-24,9)	

Chi-square test for complex sample. CI, confidence interval; WC, waist circumference; SBP, systolic blood pressure; DBP, diastolic blood pressure; IR, insulin resistance; TC, total cholesterol; HDLc, HDL cholesterol, LDLc, LDL cholesterol; Not HDL; non-HDL cholesterol; TG, triglycerides; Auric, uric acid[1] Excess weight = overweight and obesity (Z score > 1 for gender and age); [2] Metabolic syndrome = WC ≥ p 90 plus two changes: TG ≥ 150 mg/dL; HDLc < 40 mg/dL; fasting blood glucose ≥ 100 mg/dL; SBP/DBP ≥ 130/85 mmHg and diagnosis for ≥ 16 years old similar to adults; [3] ≥ 5 mg/dL for females and ≥ 6 mg/dL for males

Table 4 describes the crude and adjusted PR with respective 95% CI for altered non-HDL cholesterol (≥ 120 mg/dL) according to the independent variables. The adjusted PR for LDLc was 1.71 (95% CI 1.68-1.73; p < 0.00), indicating that an increase in each unit of non-HDL cholesterol increases the probability of high LDLc by 71%. It was also shown that adolescents with high non-HDL cholesterol have a 1.14 times higher prevalence of hypertriglyceridemia, adjusted for gender and age group. In the Poisson regression, non-HDL cholesterol was a predictor of changes in BMI, and its impact on the chance of changes in uric acid was also identified.

Table 4. Final Poisson regression model of high non-HDL cholesterol in adolescents from public schools in Montes Claros (MG) – Brazil.

Variables		Gross PR (95% CI)	Adjusted PR (95% CI)	P Valeu
Overweight [1]	Sim	1,03 (1,01 - 1,05)	1,03 (1,01 - 1,05)	< 0,00
	Não	1	1	
EC alta (≥ p90)	Sim	0,99 (0,98 - 1,01)	0,97 (0,94 - 0,99)	< 0,00
	Não	1	1	
LDLc (≥ 110 mg/dL)	Sim	1,70 (1,68 - 1,73)	1,71 (1,68 - 1,73)	< 0,00
	Não	1	1	
TG (≥ 90 mg/dL)	Sim	1,14 (1,12 - 1,15)	1,14 (1,12 - 1,15)	< 0,00
	Não	1	1	
Auric (mg/dL)[2]	Sim	1,07 (1,05 - 1,09)	1,06 (1,05 - 1,08)	< 0,00
	Não	1	1	

Model adjusted for gender and age group. The goodness of fit of the final model was assessed using the Deviance test. PR, prevalence ratio; CI, confidence interval; WC, waist circumference; LDLc, LDL cholesterol; TG, triglycerides; Auric; uric acid. [1] Excess weight = overweight and obesity (Z score > 1 for gender and age); [2] ≥ 5 mg/dL for females and ≥ 6 mg/dL for males

Discussion

In this study, we assessed the prevalence ratio of increased non-HDL cholesterol and CV risk factors in a representative sample of adolescents from public schools. In this sense, CVDs are important causes of mortality in adulthood throughout the world and the Encouraging a healthy lifestyle in adolescence is essential to reduce mortality, increase life expectancy and improve the quality of life of this population in the future. The impact of current lifestyle habits, such as high intake of high-calorie foods and a sedentary lifestyle, increase the prevalence of excess weight in adolescence as demonstrated in this study (31.4%), which was higher than the results of ERICA (Estudo de Riscos Cardiovascular in Adolescents) in Brazil (25.5%) which was carried out in adolescents aged 12 to 17 years (Bloch et al., 2016). In accordance with ERICA, overweight was more prevalent in younger people (47.6%).

The majority of the population analyzed (68.8%) was between 12 and 15 years of age, probably due to difficulties in collecting blood in the afternoon. In agreement with the last Demographic Census of 2010 (21), the majority of adolescents declared themselves mixed race (57.8%) and Catholic (56.9%), and in the last census 63% of adolescents aged between 10-17 years they also declared themselves Catholics.

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Central obesity was observed in 10.5% (95%CI 4.5-22.7) of adolescents, with a higher prevalence being identified in younger people (15.4%; 95%CI 4.1-43.5), with no difference significant for gender and age group. A similar result was observed in a study carried out in São Paulo with children and adolescents aged eight to 18 years in which there were no differences between the sexes in the prevalence of excess central adiposity (Bloch et al., However, the study used waist circumference to discriminate excess of central adiposity, however, there is a lack of literature on studies that used the subscacular skinfold to discriminate excess central adiposity, which makes it difficult to compare the results found.

The average WC was 71.5 cm (SE = 0.4), with higher averages in males (72.2 cm; SE 0.6; p = 0.06). The averages are in accordance with ERICA in Brazil (72.2 cm) (Kuschnir et al., 2016). These findings may demonstrate that, in the same country, the factors associated with excess body adiposity may vary. The lack of association between sociodemographic and lifestyle factors with excess central and general adiposity in male adolescents in the present study can be explained in part because male adolescents are more active than female adolescents, contributing to combating excess adiposity (Stergiou; Yiannes; Rarra, 2006).

There are several recommendations for physical activity in adolescents, there are around 50 national and international guidelines available for consultation29, of which 22 included recommendations to reduce sedentary behavior and three for sleep 29. Unfortunately, only a small proportion of the global population meets the current recommendations for physical activity (Ferraz; Delgado, 1988). For adolescents, even physical activity of lower intensity and duration can promote health benefits, but with increasing intensity, additional gains can be obtained. Possible justification for why boys had greater chances of Having peripheral adiposity when not physically active may result from the physical activities and sports preferred by male adolescents, generally football and running, as these are activities that involve large muscle groups, so they can be considered activities that may not directly impact peripheral adiposity. . Evidence shows that physical activity of moderate to vigorous intensity is inversely associated with adiposity in adolescents32, in addition to reducing risk factors for chronic diseases33, improving quality of life34, and strengthening muscles and bonés (Faria-Neto et al., 2016; IBGE, 2021).

The adjusted PR for LDLc was 1.71 (95% CI 1.68-1.73; $p < 0.00$), indicating that an increase in each unit of non-HDL cholesterol increases the probability of high LDLc by 71%. Changes in plasma lipids and their lipoproteins are associated with increased cardiovascular risk. Elevations in cholesterol associated with low-density lipoprotein (LDLc) are closely correlated with increased cardiovascular risk, regardless of age (Stergiou; Yiannes; Rarra, 2006). Although the clinical manifestation of atherothrombotic events usually occurs after the fourth decade of life, premature exposure to a hyperlipidemic environment can lead to lipid deposition in the arterial wall in the first weeks after conception16. Autopsy data reveal that high LDLc and reduced levels of cholesterol associated with high-density lipoprotein (HDLc) are associated with coronary atherosclerosis in adolescents and young adults (Back et al., 2005). Therefore, cardiovascular prevention measures must be initiated in childhood and adolescence, and for this, it is necessary to identify the presence of risk factors in this population.

In short, lipid alterations are frequent in Brazilian adolescents. Lifestyle interventions are key to improving this outlook and are usually effective in the short term. The data suggest that, although prevention strategies are planned nationally, it is essential that regional differences are recognized so that these strategies can be properly implemented (Faria-Neto et al., 2016).

Finally, it is worth highlighting that the influence of sex on physical activity has been the subject of several studies that affirm that females are less active when considering: lower levels of parental education, reflecting a lack of support and encouragement for this practice; lower socioeconomic status, resulting in less access to activities with higher energy expenditure; and a female preference for individual and light activities. However, a Brazilian study that analyzed the prevalence of insufficient physical activity among adolescents did not observe a difference between the sexes (Jesenery et al., 2023).

Conclusion

The results indicate that the prevalence of non-HDL cholesterol was high among the adolescents analyzed, the other biochemical, metabolic and biochemical indicators were also altered. In this sense, effective school programs for health promotion and regular physical activity are needed.

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