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Dyslipidemias and Related Factors in Brazilian Adolescents from Rural and Urban Areas

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Abstract

This study aimed to evaluate the prevalence of dyslipidemias and related factors, in Brazilian adolescents from rural and urban areas. This is a cross-sectional study with 182 adolescents aged 10 to 13 years, students, residing in the rural and urban area of Brazil; grouped according to age, gender and socioeconomic class. Sexual maturation, physical activity, blood pressure, nutritional status and body composition were evaluated. Total cholesterol, LDL, HDL and serum triglycerides were dosed. The food frequency questionnaire was applied, quantifying energy, carbohydrates, proteins, lipids, full fat and fibers. Bivariate and multiple analyses were carried out, by logistic regression. It was verified that 84.6% (n = 154) adolescents presented some lipid profile alteration. There was no difference in the lipid profile between adolescents for residence place. However, as for gender, it was noticed that girls presented higher levels of total cholesterol and HDL ($p < 0.05$). In addition, adolescents with excess weight and body fat showed lower HDL and higher triglycerides values compared with eutrophic and with those with appropriate body fat percentage ($p < 0.05$). In the multiple analyses, it was observed that gender and signs of sexual maturation were associated with total cholesterol; fiber intake remained associated with HDL and signs of sexual maturation with LDL ($p < 0.05$). For triglycerides the related factors were gender, nutritional status and protein intake ($p < 0.05$). The elevated prevalence of dyslipidemias found between adolescents from rural and urban areas reinforces the importance of monitoring these alterations and information as for the related risk factors, with programs for correction of changeable factors.

Keywords

Dyslipidemias, Adolescents, Lifestyle, Puberty

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1. Introduction

Cardiovascular diseases (CVD) represent one of the main causes of morbimortality in Brazil and in the world [1]. It is treated as a multifactorial disease caused by the interaction of genetic factors, excess weight and body fat, high arterial blood pressure, dyslipidemias, inadequate eating habit, sedentarism and tobaccoism [2] [3].

The probability of CVD incidence is proportional to the number of risk factors [4]. Dyslipidemias stand out as determining factors of these diseases, being a great public health concern [5]-[7]. They are characterized by abnormal concentrations of lipid or lipoproteins serum levels [8], sometimes identified in young individuals as children and adolescents [1].

In growth and developmental stages, the influences of sexual hormones must also be considered, as they are responsible for physiologically increasing lipid serum levels, especially in early puberty [2].

The importance of tracking the risk factors in childhood and adolescence for planning early interventions stands out, aiming at the maintenance of the identified risk situation in adult life [7]. Besides, as these are resulting of multifactorial etiology, there might be differences according to the characteristics of the studied population, such as the area of residence, urban or rural [9].

The present study aimed to evaluate the prevalence of dyslipidemias and related factors, in Brazilian adolescents residing in rural and urban areas.

2. Methodology

2.1. Study Delineation

This is an observational cross-sectional study with 182 public school adolescent aged 10 to 13 years, from rural and urban areas of Viçosa (MG, Brazil). The adolescents reside in the school area (rural or urban) and had not received nutritional follow-up in the last six months.

Initially, all students from the rural area in the interest age group (n = 132) were contacted; however, 110 were eligible, out of which 91 (82.7%) participated in the study. Considering age, gender and socioeconomic class, these students were grouped with those residing in the urban area at 1:1 ratio, totalizing 182 adolescents to the final sample.

The project was approved by the Research Ethics Committee of the Universidade Federal de Viçosa, MG, Brazil (process number 054/2011) and the parents/caregivers signed a free and informed consent term.

2.2. Socioeconomic Evaluation

For grouping and socioeconomic classification, the questionnaire of the Brazilian Association of Research Companies [10] which considers the presence of consumer goods and education level of the head of family was used. To help with the grouping of adolescents from rural and urban areas, classes B and C1 and C2, D and E were grouped together.

2.3. Evaluation of Physical Activity Practice

The short version [11] of the International Physical Activity Questionnaire (IPAQ) was applied categorizing adolescents as inactive (sedentary and irregularly active) and active (active and very active).

2.4. Anthropometrical and Physical Composition Evaluation

According to techniques recommended by the World Health Organization (WHO) [12], weight was verified in a Kratos® electronic scale with 150 kg capacity and 50 g precision (Cotia, SP, Brazil), and the stature was evaluated, in duplicate, using an Alturexata® vertical anthropometer, 2 meters extension (Belo Horizonte, MG, Brazil), using the average of obtained values as the individual's stature. From the weight (in kilogram) and stature (in meters) measures, the body mass index (BMI) was calculated, classified by age and gender, according to the anthropometrical references of the WHO [13], using z-scores, calculated in the software WHO Antroplus.

The body composition was estimated (BARBOSA, 2006), using equipment Dual X-ray Absorptiometry (DEXA), obtaining body fat percentage data (BF%), classified according to Lohman [14].

2.5. Blood Pressure

The blood pressure was checked in a digital automatic inflation appliance, recommended by the Brazilian Cardiology Society (Sociedade Brasileira de Cardiologia), following the recommendations of the Brazilian Society of Hypertension (Sociedade Brasileira de Hipertensão) [15]. The definition of the blood pressure percentile was carried out considering age, gender and adolescent stature percentile, evaluated by WHO [13], classifying bordering values as unhealthy also.

2.6. Evaluation of Sexual Maturation

During the anthropometrical evaluation, sexual maturation was characterized, observing the presence of secondary sexual characteristics such as axillary hair, in boys and girls, facial hair, in boys and development of breasts and menarche, in girls [16]. According to this evaluation, sexual maturation signs were classified as present or absent.

2.7. Dietetic Evaluation

The frequent food questionnaire was applied with adolescents in the presence of parents/caregivers, using domestic measure utensils to help in the portioning. The preparations were detailed, standardizing the recipes [17]. Dietetic analyses were carried out using Diet Pro 5.5i software (Viçosa, MG, Brazil), quantifying energy, carbohydrates, lipids, trans fat and fibers.

The caloric intake was compared with the estimate energy requirement (EER) value, classifying adolescents as above or below this value. For evaluation of carbohydrates and lipid consumption, the recommendation of the AMDR (Acceptable Macronutrient Distribution Ranges) [18] was considered. For protein, the cut point 1 g/kg weight [19], trans fat, up to 7% of the total energetic value [2] and the AI (Adequate Intake) value for fibers [18] were adopted.

2.8. Biochemical Evaluation

The biochemical evaluation was carried out after 12 hours of fast, dosing total cholesterol (TC), HDL (High Density Lipoprotein), LDL (Low Density Lipoprotein) and triglycerides. For characterization of the lipid profile, the recommendations of the Sociedade Brasileira de Cardiologia (Brazilian Society of Cardiology) [2] were used, considering as unhealthy values classified as bordering and increased for total cholesterol, LDL and triglycerides, as well as reduced values for HDL. Individuals who presented alteration in at least one of the mentioned parameters were considered dyslipidemia bearers.

2.9. Statistical Analyses

The database was analyzed in duplicate using Microsoftware Excel, Epi Info 6.04, Sigma Statistic for Windows and Stata 9.1 programs. The Kolmogorov-Sminorv test was carried out to check the normality of data, parametric or non-parametric tests for paired samples, comparison and correlation and Chi-square test to verify associations.

The odds ratio (OR) and respective 95% confidence intervals for associations between dependent (total cholesterol, HDL, LDL and triglycerides) and independent (sociodemographic condition, signs of sexual maturation, nutritional status, physical fat and lifestyle) variables were estimated.

Variables which in bivariate analysis were associated with dependent variables with significance level lower than 0.20 were included in the multiple logistic model. A model was prepared for each studied variable, maintaining independent variables that presented association with the dependant variable with significance level lower than 0.05 in the final model.

3. Results

The sampling was constituted by 182 adolescents from rural and urban areas, 62.6% (n = 114) boys, aged 10.02 to 13.95 years, with median and mean ± SD of 11.13 and 11.42 ± 1.0 years, respectively.

Regarding the lipid profile, the most altered parameters between adolescents were mean values for total cholesterol and LDL (**Figure 1**), with overall mean of 161.1 ± 28.9 and 95.3 ± 25.8 mg/dL, respectively. Median values (minimum - maximum) for HDL and triglycerides were 50.0 (23.0 - 117.0) and 64.0 (14.0 - 248.0) mg/dL, respectively. It was verified that 84.6% (n = 154) adolescents presented some lipid profile alteration.

When total cholesterol, HDL, LDL and triglycerides levels were compared between adolescents, no difference was found according to the residence place. However, when gender was considered, girls presented higher

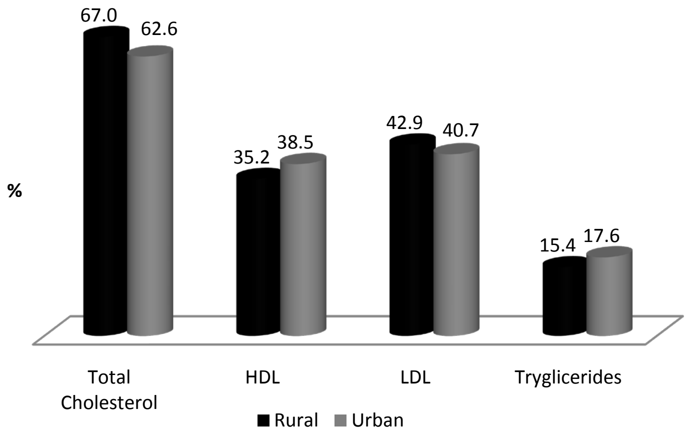

Figure 1. Lipid profile of Brazilian adolescents residing in rural and urban areas.

total cholesterol and HDL levels (**Table 1**).

Of the evaluated individuals, 21.4% (n = 39) were classified as excess weight and 33.5% (n = 61) as excess body fat. These adolescents presented lower HDL and higher triglycerides values comparing with eutrophic adolescents with appropriate body fat percentage. Besides, those with excess body fat presented higher total cholesterol and LDL serum levels (**Table 1**).

It is emphasized that both for rural and urban area adolescents, means and medians of the total cholesterol values were higher than 150 mg/dL, both for nutritional status and body fat in adequate or excessive conditions (**Table 1**).

Table 2 presents results of bivariate analyses for total cholesterol, HDL, LDL and triglycerides levels concerning sociodemographic, sexual maturation, physical activity, nutritional status, body fat, blood pressure and dietetic intake characteristics.

Altered total cholesterol was associated with gender and signs of sexual maturation. Male adolescents presented lower probability of alteration in this parameter (OR, odds ratio, 0.47; IC, interval confidence 95%: −1.4 - 0.15; p = 0.02). Presence of sexual maturation signs represented protection regarding the altered total cholesterol (OR: 0.33; IC 95%: 0.13 - 0.79; p = 0.01) (**Table 2**).

Regarding the HDL fraction, it was associated with age and signs of sexual maturation variables. Adolescents with age above median (11.1 years) were more protected as for this alteration (OR: 0.45; IC 95%: 0.24 - 0.83; p = 0.01). The presence of sexual maturation signs showed 76% less chance of low HDL values [(1 - 0.24)*100]. In addition, gender (p = 0.14) and lipid intake (p = 0.08) variables were included in the multiple analysis (**Table 2**).

As for the LDL fraction, association was observed with gender and fiber intake. Male adolescents presented twice as high probability of altered LDL (IC 95%: 1.05 - 3.88; p = 0.03) and those with fiber intake below the recommended level also had more chance of alteration in this parameter (OR: 1.96; IC 95%: 1.06 - 3.63; p = 0.03). Additionally, physical activity (p = 0.15), nutritional status (p = 0.12) and energetic intake (p = 0.09) variables were included in the multiple analysis.

Altered triglyceride was associated with gender, nutritional status, body fat percentage, protein and full fat intake. Male adolescents presented 56% less chance of alteration in this parameter [(1 - 0.44)*100]. Excess weight and body fat increased the chances for this biochemical alteration (OR: 3.15; IC 95%: 1.37 - 7.20; p = 0.006 and OR: 2.97; IC 95%: 1.24 - 7.10; p = 0.01, respectively). Both protein and saturated fat intake above the recommended levels were associated with protection (OR: 0.17; IC 95%: 0.07 - 0.44; p < 0.001), (OR: 0.35: IC 95%: 0.14 - 0.87; p = 0.02), respectively. In addition, physical activity (p = 0.13) and energetic intake (p = 0.19) were included in the multiple analysis.

It was verified that gender (p = 0.03) and sexual maturation signs (p = 0.02) showed association with total cholesterol in the multiple analyses.

Regarding HDL, fiber intake was the variable that maintained associated with it; adolescents with fiber intake below the recommended level presented 1.97 times higher chance to have alteration in this biochemical parameter (**Table 3**).

Table 1. Comparison of lipid profile according to place of residence, gender, nutritional status and body fat of adolescents from Brazil.

	Total cholesterol (mg/dL)*	HDL (mg/dL)**	LDL (mg/dL)*	Triglycerides (mg/dL)**
	Mean ± SD Median (Min - Max)	Mean ± SD Median (Min - Max)	Mean ± SD Median (Min - Max)	Mean ± SD Median (Min - Max)
Area of residence				
Rural	162.1 ± 30.5 161.0 (92.0 - 234.0)	52.5 ± 15.5 51.0 (23.0 - 117.0)	95.8 ± 24.4 93.6 (35.0 - 166.6)	69.1 ± 36.1 60.0 (25.0 - 228.0)
Urban	160.1 ± 27.3 162.0 (99.0 - 210.0)	50.2 ± 12.0 49.0 (29.0 - 106.0)	94.9 ± 23.4 95.6 (46.2 - 140.4)	74.7 ± 36.1 68.0 (14.0 - 248.0)
p	0.66	0.21	0.82	0.19
Gender				
Girls	166.7 ± 28.7 168.5 (92.0 - 234.0)	53.2 ± 12.5 52.0 (23.0 - 97.0)	97.8 ± 27.7 100.8 (35.0 - 166.6)	78.2 ± 39.1 66.5 (30.0 - 228.0)
Boys	157.7 ± 28.6 158.0 (99.0 - 224.0)	50.2 ± 14.5 46.5 (29.0 - 117.0)	93.9 ± 23.3 91.7 (46.2 - 154. 8)	68.1 ± 33.8 63.0 (14.0 - 248.0)
p	**0.04**	**0.04**	0.27	0.08
Nutritional status				
Eutrophic and low weight	160.1 ± 29.3 160.0 (92.0 - 224.0)	53.2 ± 15.5 51.0 (29.0 - 117.0)	94.0 ± 23.0 90.2 (35.0 - 154. 8)	64.2 ± 25.0 60.5 (25.0 - 167.0)
Excess weight	166.1 ± 30.5 166.0 (107.0 - 234.0)	45.5 ± 8.7 45.0 (23.0 - 66.0)	100.9 ± 26.9 103.0 (47.4 - 166.6)	98.3 ± 51.6 94.0 (27.0 - 248.0)
p	0.29	**0.01**	0.14	**<0.001**
Body fat				
Ideal and low	157.8 ± 29.7 158.0 (92.0 - 224.0)	52.8 ± 13.8 52.0 (29.0 - 106.0)	92.6 ± 23.4 89.8 (35.0 - 154. 8)	62.2 ± 23.5 60.0 (14.0 - 139.0)
Excess	167.6 ± 26.1 159.0 (107.0 - 234.0)	48.5 ± 13.6 46.0 (23.0 - 117.0)	100.8 ± 24.0 102.2 (47.4 - 166.6)	91.3 ± 47.5 84.0 (25.0 - 248.0)
p	**0.03**	**0.02**	**0.02**	**<0.001**

SD, Standard Deviation; Med, Median; Min, Minimum; Max, Maximum; HDL, High Density Lipoprotein; LDL, Low Density Lipoprotein. [a*]Paired t-test; [a**]Wilcoxon's test; [b*]Student t-test; [b**]Mann Whitney's test $p < 0.05$.

Table 2. Prevalence of alterations in lipid profile and *gross odds ratio* (95% interval confidence) according to sociodemographic, sexual maturation signs, nutritional status, body fat and lifestyle variables of rural and urban adolescents from Brazil.

	Total Cholesterol			HDL			LDL			Triglycerides		
	Altered (%)	Gross OR (IC 95%)	p	Altered (%)	Gross OR (IC 95%)	p	Altered (%)	Gross OR (IC 95%)	p	Altered (%)	Gross OR (IC 95%)	p
Área												
Rural	61 (67.0)	1.0		32 (35.2)	1.0		39 (42.9)	1.0		14 (15.4)	1.0	
Urban	57 (62.6)	1.21 (0.65 - 2.23)	0.53	35 (38.5)	0.86 (0.47 - 1.58)	0.64	37 (40.7)	1.13 (0.62 - 2.05)	0.67	16 (17.6)	0.35 (0.38 - 1.86)	0.69
Gender												
Girls	52 (76.5)	1.0		18 (26.5)	1.0		34 (50.0)	1.0		16 (23.5)	1.0	
Boys	66 (57.9)	0.47 (−1.4 - 0.15)	**0.02**	49 (43.0)	2.02 (1.05 - 3.88)	**0.03**	42 (36.8)	0.63 (0.34 - 1.16)	0.14	14 (12.3)	0.44 (0.20 - 0.97)	**0.04**
Age												
≤11.1 years	63 (69.2)	1.0		31 (34.1)	1.0		47 (51.6)	1.0		18 (19.8)	1.0	
>11.1 years	55 (60.4)	0.67 (0.36 - 1.25)	0.21	36 (39.6)	1.26 (0.69 - 2.31)	0.44	29 (31.9)	0.45 (0.24 - 0.83)	**0.01**	12 (13.2)	0.61 (0.27 - 1.36)	0.23
Sexual maturation signs												
Absent	108 (68.4)	1.0		56 (35.4)	1.0		72 (45.6)	1.0		27 (17.1)	1.0	
Present	10 (41.7)	0.33 (0.13 - 0.79)	**0.01**	11 (45.8)	1.54 (0.64 - 3.66)	0.33	4 (16.6)	0.24 (0.08 - 0.76)	**0.01**	3 (12.5)	0.69 (0.19 - 2.48)	0.57

Continued

Physical atividade												
Yes	96 (65.7)	1.0		50 (34.3)	1.0		63 (43.2)	1.0		21 (14.4)	1.0	
No	22 (61.1)	0.81	0.60	17 (47.2)	1.71	0.15	13 (36.1)	0.72	0.41	9 (25.0)	1.98	0.13
		(0.38 - 1.73)			(0.82 - 3.59)			(0.34 - 1.54)			(0.81 - 4.80)	
Nutritional status												
Eutrophic and low weight	91 (63.6)	1.0		49 (34.3)	1.0		54 (37.8)	1.0		15 (10.5)	1.0	
Excess weight	27 (69.2)	1.19	0.57	18 (46.2)	1.20	0.55	22 (56.4)	1.60	0.12	15 (38.5)	3.15	**0.006**
		(0.64 - 2.20)			(0.65 - 2.20)			(0.87 - 2.91)			(1.37 - 7.20)	
Body fat %												
Low and Adequate	72 (59.5)	1.0	0.66	40 (33.1)	1.0	0.53	45 (37.2)	1.0		10 (8.3)	1.0	
Excess	46 (75.4)	1.14		27 (44.3)	1.21		31 (50.8)	1.21	0.53	20 (32.8)	2.97	**0.01**
		(0.62 - 2.10)			(0.66 - 2.21)			(0.66 - 2.21)			(1.24 - 7.1)	
Arterial blood pressure												
Normal	115 (65.0)	1.0		66 (37.3)	1.0		75 (42.4)	1.0		30 (16.9)	1.0	
Altered	3 (60.0)	0.80	0.81	1 (20.0)	0.42	0.44	1 (20.0)	0.44	0.49	-	-	-
		(0.13 - 4.96)			(0.04 - 3.04)			(0.04 - 4.40)				
Energetic Intake												
Below	53 (63.8)	1.0		36 (43.4)	1.0		33 (39.8)	1.0		17 (20.5)	1.0	
Above	65 (65.7)	1.08	0.80	31 (31.3)	0.59	0.09	43 (43.3)	1.26	0.54	13 (13.1)	0.58	0.19
		(0.58 - 1.99)			(0.32 - 1.09)			(0.66 - 2.18)			(0.26 - 1.29)	
Carbohydrate intake												
Adequate	96 (66.7)	1.0		53 (36.8)	1.0		63 (43.8)	1.0		22 (15.3)	1.0	
Below	22 (18.7)	0.73	0.35	14 (20.9)	0.87	0.70	13 (17.1)	1.05	0.88	8 (26.7)	1.08	0.85
		(0.37 - 1.41)			(0.44 - 1.71)			(0.55 - 2.02)			(0.46 - 2.56)	
Protein Intake												
Below	17 (68.0)	1.0		11 (44.0)	1.0		10 (40.0)	1.0		11 (44.0)	1.0	
Above	101 (64.3)	0.84	0.72	56 (35.7)	0.70	0.42	66 (42.0)	1.11	0.81	19 (12.1)	0.17	**0.00**
		(0.34 - 2.09)			(0.30 - 1.65)			(0.47 - 2.63)			(0.07 - 0.44)	
Lipid intake												
Adequate	70 (64.2)	1.0		41 (37.6)	1.0		40 (36.7)	1.0		16 (14.7)	1.0	
Above	48 (65.8)	1.06	0.83	26 (35.6)	0.91	0.78	36 (49.3)	1.7	0.08	14 (19.2)	1.37	0.42
		(0.57 - 1.99)			(0.49 - 1.69)			(0.92 - 3.11)			(0.62 - 3.03)	
Saturated fat intake												
Adequate	16 (55.2)	1.0		12 (41.4)	1.0		12 (41.4)	1.0		9 (31.0)	1.0	
Above	102 (66.6)	1.62	0.24	55 (35.9)	0.79	0.58	64 (41.8)	1.04	0.92	21 (13.7)	0.35	**0.02**
		(0.72 - 3.63)			(0.35 - 1.78)			(0.46 - 2.33)			(0.14 - 0.87)	
Fiber intake												
Adequate	55 (63.2)	1.0		25 (32.5)	1.0		35 (40.2)	1.0		13 (14.9)	1.0	
Below	63 (66.3)	1.14	0.66	42 (44.2)	1.96	**0.03**	41 (43.2)	1.08	0.79	17 (17.9)	1.24	0.59
		(0.62 - 2.10)			(1.06 - 3.63)			(0.59 - 1.96)			(0.56 - 2.73)	

HDL, High Density Lipoprotein; LDL, Low Density Lipoprotein; OR, Odds Ratio; IC, Interval Confidence. Values in bold represent $p < 0.05$.

Table 3. Multiple analysis final results of association between sociodemographic, sexual maturation signs, nutritional status, body fat, lifestyle conditions and serum lipid profile of rural and urban adolescents from Brazil.

	Total Cholesterol		HDL		LDL		Triglycerides	
	OR (IC 95%)	p	OR (IC 95%)	p	OR (IC 95%)	p	OR (IC 95%)	p
Gender								
Girls	1.0						1.0	
Boys	**0.46**	**0.03**	-	-	-	-	**0.41**	**0.04**
	(0.23 - 0.91)						**(0.17 - 0.97)**	
Sexual maturation signs								
Absent	1.0		-	-	1.0		-	-
Present	**0.36**	**0.02**			**0.24**	**0.01**		
	(0.15 - 0.88)				**(0.1 - 0.8)**			
Nutritional status								
Eutrophic and low weight							1.0	
Excess weight	-	-	-	-	-	-	**3.34**	**0.01**
							(1.38 - 8.09)	
Protein intake								
Below							1.0	
Above	-	-	-	-	-	-	**0.18**	**<0.001**
							(0.07 - 0.50)	
fiber intake								
Adequate			1.0					
Below	-	-	**1.96**	**0.03**	-	-	-	-
			(1.1 - 3.6)					

OR, Odds Ratio; IC, Interval Confidence. Values in bold represent $p < 0.05$.

As for LDL, adolescents presenting sexual maturation signs, showed 76% lower alteration chances comparing with those who did not present these signs [(1 - 0.24)*100] (**Table 3**).

Factors independently associated with triglycerides alterations were gender ($p = 0.04$), nutritional status ($p = 0.01$) and protein intake above the recommended level ($p < 0.001$) (**Table 3**).

It is worth emphasizing that gender and sexual maturation were associated in two of the elaborated models (**Table 3**).

4. Discussion

The prevalence of dyslipidemia found in this study was elevated, similar to a study with children and adolescents with excess weight, residing in Campina Grande city (PB, Brazil), in which 85.3% exhibited dyslipidemia [1].

Although students from Pernambuco (PE, Brazil) aged 10 to 14 years demonstrated inferior prevalence, more than half (63.8%) [20] presented at least one lipid profile alteration. In this sense, investigations on this risk factor between adolescents are relevant, as they represent a disturbing reality.

The absence of lipid profile difference in adolescents, according to area of residence observed in the present study, suggests that other factors inherent to this life stage could be involved with this lipid alteration However, in a study comparing the prevalence of dyslipidemias between 3121 Mexican students aged 12 to 16 years residing in rural and urban areas, higher prevalence was more frequent in adolescents of the rural area ($p < 0.001$) [9].

The differences between studies can be due to the area of Viçosa (MG, Brazil) having atypical rural population comparing with other places, with rural population representing only 6.8% the total population [21]. Moreover, the studies were carried out in different countries, with age groups of different stages of adolescence.

The fact that girls presented higher lipid serum levels than boys might be related to sexual hormone alterations due to growth and development, especially in the initial stage of adolescence [2].

In this sense, in a study carried out with children and adolescents from Pernambuco, only total cholesterol and triglycerides levels were more elevated in girls ($p = 0.03$ and $p = 0.04$, respectively) [5]. In Mexico, adolescent girls presented higher serum levels of total cholesterol, LDL, triglycerides and HDL than those of boys [9]. Similar result was found between American adolescents aged 12 to 19 years, for the two last mentioned parameters [22]. However, some studies did not identify differences in the lipid profile between genders [6] [20] [23].

Excess weight is an important risk factor for the development of cardiovascular alterations, predisposing individuals to the increase in total cholesterol, LDL, and triglycerides serum levels and to HDL reduction [24].

In the present study, excess weight represented higher chance of triglycerides alteration. Likewise, Pereira *et al.* [25] evaluated children and adolescents aged 2 to 19 years in rural and urban areas of Itapetininga (SP, Brazil) and verified that individuals with excess weight presented greater risk of total cholesterol and triglycerides increase. Conversely, in the study of Grillo *et al.* [6], obesity resulted in 3.27 higher risk for HDL alteration, not significant for the other evaluated lipid parameters. This demonstrates the close relation between excess weight and dyslipidemias.

In addition, Romaldini *et al.* [26] studied the risk factors for atherosclerosis in 109 children and adolescents with family history of premature coronary artery disease and identified lipid alterations in 57.1% (16/28) of those with excess weight (obese and overweight) and in 32% (26/55) of those with normal or low weight. Adolescents with excess weight presented twice higher chances (IC 95% = 1.16 - 6.81) of dislipidemia, however there was no association between dyslipidemia and family income, parental schooling and practice of physical activity variables.

Likewise, when evaluating clinical-metabolic alterations in obese and non obese adolescents grouped according to gender, color, age, sexual maturation stage and schooling, lower HDL levels and superior triglycerides levels among obese adolescents were observed [24].

In Tunisia, the prevalence of hypercholesterolemia among school children with excess weight was superior comparing with eutrophic children (14.6% and 7.1%, respectively, $p < 0.001$). Moreover, girls presented more total cholesterol and LDL alterations ($p < 0.001$) [7].

The sexual maturation process described by biological alterations may influence individual [16] lipid and lipoprotein blood levels [2]. Considering this variable in the lipid profile evaluation of 1846 urban Mexican adolescents aged 12 to 16 years, it was identified that during advancing of the pubertal stage, evaluated by self-evaluation according to Tanner, boys were negatively associated with total cholesterol, LDL and triglycerides [27].

It should be emphasized that besides the biological influence in question, adolescents presenting puberty signs experience higher environment interference in the definition of habits, including eating and physical activity and this will influence the lipid profile [20]. However a limitation of this study was not considered sexual maturation of the annealing of the sample.

The present study reinforces the importance of dietetic factors as determinant of plasmatic lipids, having in mind that inadequate fiber intake was associated with HDL, and proteins above the recommended level, with triglycerides.

In a study with adolescents aged 12 to 19 years who participated in the *National Health and Nutrition Examination Survey* (NHANES) 1999-2002, it was verified that to each increase in the amount of fiber intake, there was a 20% reduction in the incidence of metabolic syndrome, which corresponds to the set of cardiovascular risk factors, including dyslipidemias (adjusted OR = 0.83, IC 95% 0.68 - 1.00 and $p = 0.043$) [22].

Protein ingestion above the recommended level reduced the risk of triglycerides alteration. The opposite was expected, given that the main sources of proteins in the diet are foods of animal origin which also have higher amounts of fat in their composition. However, the source of ingested protein was not investigated in this study.

The modern lifestyle characterized by inadequate offer of caloric foods, with high contents of full fat, trans fat, cholesterol, simple carbohydrates and salt, may lead to an increased consumption and consequently to the development of risk factors like excess weight, high arterial blood pressure, diabetes and dyslipidemias [3].

5. Conclusions

The elevated prevalence of dyslipidemias found between adolescents of urban and rural areas reinforces the importance of monitoring this alteration in early ages. It is necessary to consider the influence of sexual maturation and gender, besides planning actions for adjustment of the nutritional status and the adopted lifestyle habits.

Actions taken during childhood and adolescence allow the reduction in the incidence of cardiovascular disease and its consequences in adulthood, favoring the promotion of health of these individuals at all stages of life.

Conflict of Interest

The authors declare that there is no conflict of interest.

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Abbreviations

CVD: Cardiovascular Diseases
IPAQ: International Physical Activity Questionnaire
WHO: World Health Organization (WHO)
DEXA: Dual X-ray Absorptiometry
EER: Estimate Energy Requirement
AMDR: Acceptable Macronutrient Distribution Ranges
AI: Adequate Intake
HDL: High Density Lipoprotein
LDL: Low Density Lipoprotein
OR: Odds Ratio
IC: Interval Confidence
SD: Standard Deviation
MED: Median
MIN: Minimum
MAX: Maximum