Original Article

Serum Lipids in School Kids and Adolescents from Florianópolis, SC, Brazil - Healthy Floripa 2040 Study

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Objective

To determine the distribution of serum lipids in children and adolescents of Florianopolis, Santa Catarina State, Brazil. To determine the association between undesirable levels for total cholesterol (>170 mg/dL) and others coronary heart disease risks factors.

Methods

A questionnaire, physical examination and blood analyses were collected from randomized sample from school kids aged range from 7 to 18 years old.

Results

1,053 students participated, aged between 7 and 18 years old. They presented a total cholesterol mean of 162±28 mg/dl, triglyceride mean of 93±47 mg/dl, HDL-cholesterol mean of 53±10 mg/dl, LDL-cholesterol mean of 92±24 mg/dl and non-HDL cholesterol mean of 109±26 mg/dl. The TC/HDL and LDL/HDL mean rates were, respectively, 3.1±0.6 and 1.8±0.5. Findings showed that private school children, 10 years old or less, girls and black children had higher lipids values. Overall findings suggest that the best logistic regression model which explained abnormal total cholesterol levels included: obesity, stroke and heart attack familial history, feminine gender, age of 10 years old or less and overweight body image determined on inspection.

Conclusion

In comparison to international literature, our results, showed intermediated total cholesterol, lower LDL-cholesterol and non-HDL-cholesterol and higher HDL-cholesterol. Therefore, primary prevention programs are needed to be carrying out, especially among overweight children and adolescents so to prevent ischemic heart disease as adulthood.

Key words

child, adolescent, lipids, atherosclerosis, risk factors

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Atherogenesis is a process that starts in the early stages of life[1]. A great number of anatomicopathological studies already showed the presence of initial lesions of atherosclerosis on the arterial wall of individuals in their first year of life[2,3]. Atherosclerotic disease (AD) is one of the main causes of morbidity and mortality among adults all over the world[4], with a trend of in affecting younger people in developing countries[4,5]. In Latin America, this disease is responsible for about 20 to 35% from total mortality, being one of the main causes of expenses in Health in most countries in the region[6,7]. In the 1980s, approximately 50% of deaths due to coronary disease in Brazilian capitals occurred before 65 years of age[8].

Observational studies show that cholesterol levels in children are directly associated to the prevalence of coronary disease in adults from the same region[9,10]. Such observation is in accordance with the tracking phenomenon, states that which there is a strong trend that children remain in the same cholesterol percentiles until adulthood[11-16]. Besides, this data, the risk factors for atherosclerotic disease tend to have during (clustering effect) in individuals, by the process of growth and development[17].

The prevalence of dyslipidemias in childhood and adolescence varies between 24 and 33%[18-22] with a progressive increase of those rates along the years in some countries (especially in those that suffered occidentalization of habits)[23,24] and a decrease especially in countries that instituted prevention programs[25]. Given the important causal relation between LDL and atherosclerosis, demonstrated in recent clinical assays, and the precociousness with which atherosclerotic vascular lesions settle, it is important to understand the lipidic profile of children and adolescents, so to planning preventive health actions.

In the present study, the distribution of serum concentrations of total cholesterol, LDL-cholesterol, HDL-cholesterol and triglycerides, non-HDL fraction, and CT/HDL and LDL/HDL cholesterol relationships was determined in children and adolescents from Florianópolis (SC) schools, as well as the associations between lipids and other atherosclerosis risk factors.

Methods

A random sample of infants and adolescents enrolled in public and private schools from Florianópolis, SC, was analyzed.

The sample was calculated by using the EPI-INFO® program, version 6,04B (CDC, Atlanta, USA and WHO, Geneva, Switzerland - 1997), based on a population estimated in 71,000 school children in the year 2001, taking for granted a sampling error of 3.5% and taking a 10% reference prevalence rate for the least prevailing risk factor (hypertension) and a confidence interval of 95%. A sample of 570 pupils resulted from that. For the purpose of stratification (age ranges from 7 to 10 years old, from 11 to 14 years old and from 15 to 18 years old), there was an increase of 36%, which reached to a total of 775 infants.

Private and public schools of Florianópolis were listed and then assorted, regarding to the proportion of enrolled pupils in each group. From the schools, two classes per school from each group were assorted, amounting about 180 children per institution, in addition of two substitute classes per group and per school. According to data from Secretaria Municipal de Educação (Municipal Education Secretariat), 97% of infants and adolescents between 7 and 18 years old were enrolled and studying.

An extensively, structured, previously validated questionnaire was used, regarding biological and social variables, which characterized the sample and identified atherosclerotic disease risks. The variables shown in this study emphasize lipidic associations. Physical exam consisted in weighing, height measurement, two blood pressure measurements with a 30-minute interval and a 3rd measurement if values were higher than percentile 95 for age and sex. Triceps and subscapular skinfolds and abdominal and pelvic perimeters were also measured. From those data, body mass index (BMI = weight/height^2) and triceps-to-subscapular and waist-to-hip abdominal/pelvic rates were calculated.

Serum lipids were analyzed with blood collected in schools, with no fasting samples, and transported under refrigeration to the laboratory. Total cholesterol and triglycerides were determined by using an enzymatic method (SHOD-PAP, Merck®) and HDL-cholesterol directly determined, after precipitation of other lipoproteins[26]. LDL-cholesterol was calculated by employing the formula of Friedewald[27]. Criteria defined by III Diretrizes Brasileiras Sobre Dislipidemias e Diretriz de Prevenção da Aterosclerose da Sociedade Brasileira de Cardiologia (3rd Brazilian Guidelines on Dyslipidemias and Guideline for the Prevention of Atherosclerosis of Brazilian Cardiology Association)[28] were used as abnormality criteria for lipids and lipoproteins, the Study from Navarra[29], for total cholesterol/HDL and LDL/HDL rates, and Bogalusa Study[30], for non-HDL. Values of lipids or their relations that were considered non normal values, were classified as non-desirable.

For the purpose of families economic classification, the Critério de Classificação Econômica Brasil (Brazil Economic Classification Criterion), from Associação Brasileira de Pesquisas de Mercado (ABIPEME)[31], was used.

Continuous variables were introduced as means and standard deviation, and percentages. For the comparison among means the t-test of Student and ANOVA (for more than two groups) were used, which is considered as statistically significant if $p<0.05$. The description of variables was carried out with EPI-INFO 6.04 B software and Microsoft Excel® 2002 software.

The association between total cholesterol and previously determined variables was determined through a theoretical model, by using the χ^2 test with significance level (α) of 5%. Continuous variables were categorized to allow for bivariate and multivariate analysis. Logistic regression was carried out to assess the association between hypercholesterolemia (total cholesterol >170 mg/dL) and factors as overweight or obesity, sedentary lifestyle, diet, abdominal obesity, educational level of parents and social class, by using the SPSS® program, version10.0.5, Chicago, USA.

After completion of data collection of the whole sample the schools were again visited for a new measurement of blood pressure in children who showed values higher than percentile 95 for age, sex and height in the first exam, and all parents and responsible people were contacted when inconsistent and incomplete data were detected in the questionnaires. After that stage, new telephone interviews were carried out from a sample of 5% of pupils, in order to certify on the fidelity of data. At that verification, no significant difference was detected.

Informed consent and protocol were submitted and approved by the Comitê de Ética em Pesquisa com Seres Humanos (Ethics Committee in Research with Human Beings) da Federal University from Santa Catarina.

Results

One thousand, two hundred and twenty-two (1,222) individuals were invited to participate in the study, and 1,053 of them agreed on participating in. The analyzed sample represented 1.5% from the total of individuals from Florianópolis within the age range from 7 to 18 years old.

From the 1,053 participating children and teenagers, 620 (59%) were female. The scholar distribution in age groups was: a) 7 to 10 years old: 28.4%; b) 11 to 14 years old: 37.8%; c) 15 to 18 years old: 33.8%.

Distribution regarding the type of school was among 706 (67%) individuals, in public schools and 347 (33%), in private schools. Concerning the socioeconomic class, there was a prevalence of class C pupils (35%). The average concentration of serum lipids and other indexes in this sample are displayed in table I.

Table II shows the main lipid comparisons between genders and between the two types of education institution attended by the scholars.

Female individuals showed higher concentrations of total cholesterol and LDL-cholesterol, and those who attended private schools showed higher levels of cholesterol, triglycerides and HDL-cholesterol. Lipidic distribution per age range is displayed in table III. A trend to higher levels is observed up to 10 years of age and a decrease of cholesterol, triglycerides, non-HDL-cholesterol and HDL-cholesterol from that age. There is a similar phenomenon concerning TC/HDL and LDL/HDL relations.

Table I – Distributions of means (mg/dL), standard deviations (SD), confidence interval of 95% (CI 95%) and percentiles of lipids, lipoproteins and relations among lipoproteins in school children betwen 7 and 18y o in Florianópolis y. 2001

Lipids and relations	mean±SD (mg/dL)	CI 95% (mg/dL)	P95 (mg/dL)	P5 (mg/dL)
Total Cholesterol	162±28	160 - 164	214	-
HDL-cholesterol (mg/dL)	53±10	52 - 54	-	38
Triglycerides (mg/dL)	93±47	108 - 111	183	-
LDL-Cholesterol (mg/dL)	89±24	89 - 92	133	
Non-HDL Cholesterol (mg/dL)	109±26	108 - 111	156	-
TC/HDL	3.1±0.6	-	4.2	-
LDL/HDL	1.8±0.5	-	2.6	-

P95: percentile 95; P5: percentile 5.

Table II – Comparison of serum concentration of lipids (mg/dL) among genders and type of school in Florianópolis, 2001.

	Total Cholesterol (mg/dL)	Triglycerides (mg/dL)	HDL-cholesterol (mg/dL)	LDL-cholesterol (mg/dL)
Female (n=620)	164±28	91±43	53±10	92±23
Male (n=433)	159±28	96±52	52±10	88±25
p	0.0022	0.09	0.11	0.0075
Private (n=2)	166±28	103±51	55±10	91±25
Public (n=4)	160±29	88±44	52±9	90±24
p	0.015	<0.001	<0.001	0.73

Table III – Distribution of means and standard deviations of lipids in children and adolescents, according to age range. Florianópolis, 2001.

Age	n	TC (mg/dL)	HDL (mg/dL)	LDL (mg/dL)	TGC (mg/dL)	non-HDL (mg/dL)	TC/HDL	LDL/HDL
7-10	299	166±29	53±10	92±24	108±55	113±27	3.2±0.6	1.8±0.5
11-14	398	159±27	52±9	89±24	87±43	107±26	3.1±0.6	1.7±0.5
15-18	356	162±28	54±10	91±24	88±41	108±25	3.1±0.6	1.7±0.5
Total	1053	162±28	53±10	91±24	93±47	109±26	3.1±0.6	1.7±0.5
p*		0.005	0.018	0.238	0.0001	0.007	0.052	0.014

*p for tendency. TC- total cholesterol; TG- triglycerides; HDL and LDL- high and low density lipoproteins; non-HDL- non-HDL cholesterol.

Figure 1, shows level distributions of lipids and lipoproteins found in the sample, classified as non-desirable from cardiovascular risk point of view. It is observed that, depending on the type of lipid, the non-desirable level rate may reach up to 22%, in the case of triglycerides. The relations between total cholesterol/HDL and LDL/HDL are presented in undesirable levels in 27% and 18% of pupils, respectively.

Logistic regression using of all theoretical model pre-defined variables, was corried out in a non-conditional way. Such model was significant (Hosner-Lemeshow test with p=0.16). Confusion variables were excluded to increase model consistency, so to arrive to a model that explains the highest number of cases studied.

When correlation total cholesterol to other analyzed variables, the model that was best adjusted (table IV), in which family history of early acute myocardial infarction, mother's educational level, social class, physical activity, color of skin, and waist-to-hip ratio, regarded as confusion factors, were excluded. Such model explained 64.1% of studied cases, with maximum verisimilitude test of 0.828. Regarding to cases resulting in desirable levels (TC <170 mg/dL), the model was able to support 95.5% of the cases.

Table IV - Coefficients and respective values of p in multivariate analysis between abnormal total cholesterol (>170 mg/dL) and dependent variables that showed statistical significance in bivariate analysis. Florianópolis, 2001.

Variable	Coefficient b	p
Obesity	0.319	0.001
FH of death due to AMI	-0.370	0.011
Female sex	0.265	0.049
Family history of CVA	0.255	0.097
Age lower than 10 years old	-0.122	0.147
Body image defined by the physician	-0.009	0.292

Discussion

The present study determined serum lipid distribution in a representative sample of school children and teenagers from Florianópolis, as well as the association of high total cholesterol with other variables. It is necessary to emphasize that more than 95% of children and teenagers from Florianópolis were regularly enrolled in schools, which made such sample very representative of the city universe this age group.

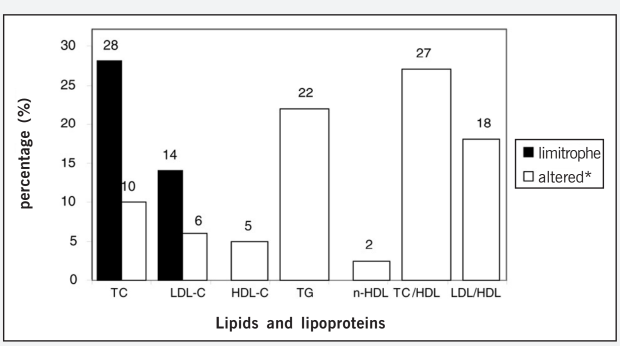

Fig. 1 – Percentage of individuals with lipids, lipoproteins and the relations among them, with non-desirable values. Florianópolis, 2001.

Serum lipid and lipoprotein levels suffer deep changes during growth and development, with two expressive increase stages in their levels, up to the 2nd year of life and during sexual maturation[32]. There is also an expressive increase of LDL-cholesterol in puberty, especially among white boys[19,33,34].

The means of total cholesterol per age range in this sample are similar to data from national and international studies. Compared to Brazilian data, Florianópolis shows higher values than those from Belo Horizonte[21], especially among children older than 10 years old.

Few data are found in the literature for LDL-C means (often shown as medians, as in Bogalusa Study[33] or non-determined as in that from 26 countries[34]). Compared to Belo Horizonte study[21], pupils from Florianópolis showed lower values of that lipoprotein, especially among 10 yo children. Concerning HDL-cholesterol, the values from this sample were intermediate between Belo Horizonte[21] and the meta-analysis from 26 countries[34], showing a prevalence of higher values among children older than 14 years old.

The comparison of triglyceride concentration was impaired, when compared to because non fasting samples were collected in Belo Horizonte[21]. Data from Florianópolis showed higher triglyceride values, especially among children and teenagers.

By observing the means of lipoproteins and considering their distribution among different age ranges, children and teenagers in this sample showed a more favorable lipidic profile, except to triglycerides. So, the lipidic profile of this sample is similar to that from 26-country meta-analysis children[34], which also included populations with low prevalence of cardiovascular disease.

Important national and international epidemiological studies on lipid distribution among children and teenagers show high levels of all lipoproteins and lipids among female sex individuals, regardless of age or color of the skin[24,35]. In this work, we have verify the same difference, except to triglycerides, higher levested among boys, which was also evidenced in Belo Horizonte study[21].

American data show that low income social classes show higher levels of serum lipids, which is a fact explained due to higher rates of sedentary lifestyle and overweight or obesity[36,37].

Similarly this study, higher levels of serum lipids were found in private schools, especially due to increase of TC and HDL-cholesterol. Higher lipids and lipoproteins levels in private schools were also verified in other Brazilian cities[21,22,38,39]. That may be due to by the fact that in Brazil there are more overweight or obese children in higher classes, and mostly studying in private schools.

Perhaps in Brazil, middle-class has been suffering the same process experienced by the American middle-class in the 1960s, in which the higher income was reflected in a calorie and saturated fat "richer" diet. Currently in the United States of America (USA), that trend reversed, as people holds better and easy acess to health information, which means, higher income classes do more exercise, eat less, smoke less and have lower mortality rates caused by cardiovascular disease[36,38,40,41].

Studies all over the world have demonstrated that the average of total cholesterol is in proportion with to coronary disease prevalence in the studied region. Such data reinforce the preoccupation on reducing the population average levels of cholesterol, a decreas attempting in the frequency of atherosclerosis complications[9,10]. By comparing mortality rates due to atherosclerosis complications and the respective means of total cholesterol among children from 4 Brazilian cities, and data from the sample [Bento Gonçalves (227/100,000, 167 mg/dL) (22), Campinas (223/100,000, 160 mg/dL) (39), Belo Horizonte (222/100,000, 158 mg/dL) (21) and Florianópolis (224/100,000, 162 mg/dL)] (42), it is observed that, like other countries, in Brazil the two indexes are close related.

Therefore criteria to determine whether a child or teenagers has risk to develop coronary disease in adulthood is been estabilished. In Brazil, Sociedade Brasileira de Cardiologia – Brazilian Cardiology Association - (SBC)[28], like the USA, at the National Education Program on Cholesterol[43], defined desirable levels of lipids for children and teenagers, as well as limitrophe and altered values. Results obtained are uncomparable with the literature available, as there is a great variety of criteria defining ideal lipid levels in different age ranges. However, by using SBC criteria, approximately one fifth of scholars from Florianópolis showed one or more lipidic fractions on levels defined as undesirable.

The relation between dyslipidemia and other cardiovascular risk factors in chilhood aims at establishing rules for the lipid dosage in that age range. Currently, the recommendation for cholesterol measurement is limited to infants with family history of hypercholesterolemia or early coronary disease[43]. Moreover, such practice show low sensitivity to detect higher risk individuals, as demonstrated in international and national studies[22]. For that reason, the study of associations of lipidic levels with other independent variables has clinical importance to detect dyslipidemic infants and adolescents in a more efficient and less costly way.

Multivariate analysis in this sample defined a model to forecast the presence of hypercholesterolemia (total cholesterol >170 mg/dL). It included the following variables: obesity, family history of death due to acute myocardial infarction (AMI), gender, family history of cerebrovascular accident (CVA), age under 10 years old and overweight body image, defined by the physician. Such model explained 64% of the studied cases, especially concerning desirable level cases (cases with total cholesterol <170 mg/dL were explained in 95.5%).

In national studies, such as Bento Gonçalves[22] and Belo Horizonte[21], higher values of total cholesterol are verified in private schools, unlike most of American studies, in which lower social class infants are more obese and sedentary[36,40,41]. In this study there was a similar behavior in the analysis of total cholesterol association with social class. A strong association between the two risk factors in bivariate analysis was verified, which was probably explained by the higher prevalence of overweight in high social class (A1, A2, B1 and B2) children. Such association is unlikely when obesity is isolated. That phenomenon is very complex and may be related with educational, cultural and genetic factors. Futher studies are needed a greater to determine the real cause for such difference.

It is known that physical activity is one of determinant factors for the decrease of coronary disease risk in adults[44]. The effect of physical activity on childhood dyslipidemia is far from being completely understood, as there are conflicting data on whether the effect is mediated by weight control induced by energetic waste and if the response is the same between boys[45] and girls[45-52]. In this work, a relation between physical activity and dyslipidemia was only evidenced in bivariate analysis, and its effect disappeared when the multivariate analysis was carried out, in accordance with agreeing on some international studies[45,50].

The cause of that behavior seems to come from the difficulty of measurement of physical activity at childhood. Another possibility is that infants are often sent to regular physical activity practice and are supervised for weight excess treatment, being obesity clearly associated to dyslipidemia in childhood[45,50]. Although the direct relation between sedentary lifestyle and dyslipidemia was not proven, stimulation to physical activity is maybe one of the most important measures for the prevention of coronary disease since infancy, as it may promote weight control, which is hard to achieve with only caloric restriction diet[50,53].

In Florianópolis sample, overweight was the most strongly risk factor to associated dyslipidemia, which was in accordance with most studies[54-60], but not similar to Gerber[22] findings, in Bento Gonçalves. The association between body mass and dyslipidemia has many metabolic causes: resistance to insulin, hyperinsulinemia, hyperglycemia, increase of cholesterol ester-transferrer protein, secreted by adipocytes, among others[61]. Body weight control is an efficient measure in dyslipidemia control, with decrease of LDL-C and increase of HDL-C, especially among girls[55].

There was a strong association between obesity diagnosed at inspection (body image of obesity and overweight diagnosed by the physician) and body mass index in the sample studied. Suggesting a populational level clinical importance, as the impression of excess of weight may guide the need for the collection of children lipidic profile. According to some studies in children, which have demonstrated that abdominal obesity can help predict dyslipidemia[57,62-64].

The struggle against children obesity must be faced as a Public Health priority, as it brings many short- and long-term consequences, both physical and emotional ones, which makes it more and more necessary, as a progressive increase of its prevalence[65] has been seen all over the world. Acquisition of healthy life habits during childhood (weight control, physical activity and proper nutrient and caloric diet specific for the age) increases the chances for the maintenance of such habits in adult life, and probably reduces the risk of early chronic-degenerative diseases[66]. Bogalusa Study demonstrated that dyslipidemia at infancy can be a risk factor for adult obesity. It reveals that the complete understanding on the interconnection among risk factors for coronary disease at infancy and their behavior during growth and development is far from being concluded[67].

There is much controversy on how family history (FH) determines dyslipidemia risk. Such interaction seems to be multifactor, in which cultural, genetic and environmental factors are interconnected. Such behavior differs according to the age and sex of the children and parenthood[68-71]. A negative association between history of death due to coronary disease and total cholesterol was found. Besides memory bias, occasional change of life habits in families with positive history of death can be explained due to cardiovascular disease, may be tools preventing to disease.

As opposed to international studies, no association between dyslipidemia and early coronary event history was found. Such data reinforce somehow the findings in the work from Bento Gonçalves[22], where 2/3 of infants with dyslipidemia did not have an early history of coronary disease, and from Bogalusa Study, which demonstrated the possibility of the currently used criterion not having the sensitivity and the specificity to forecast dyslipidemia in infants[72].

Whenever bivariate and multivariate analyses of certain associations were confronted, it is evidenced that the masking effect is some variables may accured when there analyzed separately from the set of involved factors. That occurred in this study, especially with the variables of physical activity, waist-to-hip ratio, mother's educational level, skin color and social class. After determination of the independent effect of each variable, it was noted that variables as obesity, family history and female were, in fact, determinants of previously found associations.

Concluding, this epidemiological inquiry, with a representative sample of scholar infants and adolescents from Florianópolis, established the distribution of lipid and lipoprotein concentrations and their associations with other variables of cardiovascular risk. Overweight revealed as being the strongest associated risk factor to hypercholesterolemia. Measures aiming the body weight control in childhood and adolescence may have an important impact on cardiovascular diseases in the future of that population.

References

1. Francoso LA, Coates V. Anatomicopathological evidence of the beginning of atherosclerosis in infancy and adolescence. Arq Bras Cardiol 2002; 78: 131-42.
2. Berenson GS, Srinivasan SR, Bao W, Newman WP, 3rd, Tracy RE, Wattigney WA. Association between multiple cardiovascular risk factors and atherosclerosis in children and young adults. The Bogalusa Heart Study. N Engl J Med 1998; 338: 1650-6.
3. McGill HC Jr., McMahan CA, Herderick EE, et al. Effects of coronary heart disease risk factors on atherosclerosis of selected regions of the aorta and right coronary artery. PDAY Research Group. Pathobiological Determinants of Atherosclerosis in Youth. Arterioscler Thromb Vasc Biol 2000; 20: 836-45.
4. Levi F, Lucchini F, Negri E, La Vecchia C. Trends in mortality from cardiovascular and cerebrovascular diseases in Europe and other areas of the world. Heart 2002; 88: 119-24.
5. Kanitz MG, Giovannucci SJ, Jones JS, Mott M. Myocardial infarction in young adults: risk factors and clinical features. J Emerg Med 1996; 14: 139-45.
6. Nicholls ES, Peruga A, Restrepo HE. Cardiovascular disease mortality in the Americas. World Health Stat Q 1993; 46: 134-50.
7. Valiente S, Abala C, Avila B, Monckeberg F. Patologia nutricional en America Latina e Caribe. Arch Latinoam Nutr 1988; 38: 15-9.
8. Chor D, da Fonseca MJ, de Andrade CR. Doenças cardiovasculares. Comentários sobre a mortalidade precoce no Brasil. Arq Bras Cardiol 1995; 64: 15-9.
9. Knuiman JT, Hermus RJ, Hautvast JG. Serum total and high density lipoprotein (HDL) cholesterol concentrations in rural and urban boys from 16 countries. Atherosclerosis 1980; 36: 529-37.
10. Schulpis K, Karikas GA. Serum cholesterol and triglyceride distribution in 7767 school-aged Greek children. Pediatrics 1998; 101: 861-4.
11. Lauer RM, Lee J, Clarke WR. Factors affecting the relationship between childhood and adult cholesterol levels: the Muscatine Study. Pediatrics 1988; 82: 309-18.
12. Tan F, Okamoto M, Suyama A, Miyamoto T. Tracking of cardiovascular risk factors and a cohort study on hyperlipidemia in rural schoolchildren in Japan. J Epidemiol 2000; 10: 255-61.
13. Porkka KV, Viikari JS, Taimela S, Dahl M, Akerblom HK. Tracking and predictiveness of serum lipid and lipoprotein measurements in childhood: a 12-year follow-up. The Cardiovascular Risk in Young Finns study. Am J Epidemiol 1994; 140: 1096-110.
14. Porkka KV, Viikari JS. Tracking of serum lipids in children; association with the absolute lipid level—the cardiovascular risk in young Finns study. J Clin Epidemiol 1995; 48: 221-8.
15. Boulton TJ, Magarey AM, Cockington RA. Tracking of serum lipids and dietary energy, fat and calcium intake from 1 to 15 years. Acta Paediatr 1995; 84: 1050-5.
16. Boreham C, Twisk J, Neville C, Savage M, Murray L, Gallagher A. Associations between physical fitness and activity patterns during adolescence and cardiovascular risk factors in young adulthood: the Northern Ireland Young Hearts Project. Int J Sports Med 2002; 23(Suppl 1): S22-6.
17. Freedman DS, Khan LK, Dietz WH, Srinivasan SR, Berenson GS. Relationship of childhood obesity to coronary heart disease risk factors in adulthood: the Bogalusa Heart Study. Pediatrics 2001; 108: 712-8.
18. Lerman-Garber I, Sepulveda-Amor JA, Tapia-Conyer R, et all. Cholesterol levels and prevalence of hypercholesterolemia in Mexican children and teenages. Atherosclerosis 1993; 103: 195-203.
19. Lauer RM, Connor WE, Leaverton PE, Reiter MA, Clarke WR. Coronary heart disease risk factors in school children: the Muscatine study. J Pediatr 1975; 86: 697-706.
20. Ucar B, Kilic Z, Colak O, Oner S, Kalyoncu C. Coronary risk factors in Turkish schoolchildren: randomized cross-sectional study. Pediatr Int 2000; 42: 259-67.
21. Ribeiro RQC. Epidemiologia das dislipidemias em escolares [dissertação]. Belo Horizonte: Universidade Federal de Minas Gerais, 2000.
22. Gerber ZR, Zielinsky P. Fatores de risco de aterosclerose na infância. Um estudo epidemiológico. Arq Bras Cardiol 1997; 69: 231-6.
23. Hakeem R, Thomas J, Badruddin SH. Urbanisation and coronary heart disease risk factors in South Asian children. J Pak Med Assoc 2001; 51: 22-8.
24. Morrison JA, James FW, Sprecher DL, Khoury PR, Daniels SR. Sex and race differences in cardiovascular disease risk factor changes in schoolchildren, 1975-1990: the Princeton School Study. Am J Public Health 1999; 89: 1708-14.
25. Porkka KV, Raitakari OT, Leino A, et al. Trends in serum lipid levels during 1980-1992 in children and young adults. The Cardiovascular Risk in Young Finns Study. Am J Epidemiol 1997; 146: 64-77.
26. Rifai N, Warnick GR, Dominiczack MH. Handbook of lipoprotein testing. Washington; 1997.
27. Friedewald WT, Levy RI, Fredrickson DS. Estimation of the concentration of low-density lipoprotein cholesterol in plasma, without use of the preparative ultracentrifuge. Clin Chem 1972; 18: 499-502.
28. III Diretrizes brasileiras sobre dislipidemias e diretriz de prevenção da aterosclerose do Departamento de Aterosclerose da Sociedade Brasileira de Cardiologia. Arq Bras Cardiol 2001; 77(S III): 1-48.

29. Elcarte R, Villa I, Sada J, Gasco M, Oyarzabal M, Sola A.? Cuál es la mejor definición de hiperlipidemia en la edad infanto-juvenil? An Esp Pediatr 1993; 38: 317-22.
30. Srinivasan SR, Myers L, Berenson GS. Distribution and correlates of non-high-density lipoprotein cholesterol in children: the Bogalusa Heart Study. Pediatrics 2002; 110: e29.
31. Associação Nacional de Empresas de Pesquisa. Critério de Classificação Econômica Brasil [on-line]. São Paulo; [citado Fev 2003]. Disponível em: URL: http://www.anep.org.br
32. Bertrais S, Balkau B, Charles MA, et al. Puberty-associated differences in total cholesterol and triglyceride levels according to sex in French children aged 10-13 years. Ann Epidemiol 2000; 10: 316-23.
33. Frerichs RR, Srinivasan SR, Webber LS, Berenson GR. Serum cholesterol and triglyceride levels in 3,446 children from a biracial community: the Bogalusa Heart Study. Circulation 1976; 54: 302-9.
34. Brotons C, Ribera A, Perich RM, et al. Worldwide distribution of blood lipids and lipoproteins in childhood and adolescence: a review study. Atherosclerosis 1998; 139: 1-9.
35. Pietro Albino L, Arroyo Diez J, Vadillo Machota JM, Mateos Montero C, Gallan Rebollo A. Prevalencia de hiperlipidemia en niños y adolescentes de la Provicnia de Caceres. Rev Esp Salud Publica 1998; 72: 343-55.
36. Van Lenthe FJ, Boreham CA, Twisk JW, Strain JJ, Savage JM, Smith GD. Socio-economic position and coronary heart disease risk factors in youth. Findings from the Young Hearts Project in Northern Ireland. Eur J Public Health 2001; 11: 43-50.
37. McGill HC, Jr. Nutrition in early life and cardiovascular disease. Curr Opin Lipidol 1998; 9: 23-7.
38. Dressler WW, Dos Santos JE, Viteri FE, Gallagher PN, Jr. Social and dietary predictors of serum lipids: a Brazilian example. Soc Sci Med 1991; 32: 1229-35.
39. Moura EC, de Castro CM, Mellin AS, de Figueiredo DB. Perfil lipídico em escolares de Campinas, SP, Brasil. Rev Saúde Pública 2000; 34: 499-505.
40. Batty GD, Leon DA. Socio-economic position and coronary heart disease risk factors in children and young people. Evidence from UK epidemiological studies. Eur J Public Health 2002; 12: 263-72.
41. Brunner E, Shipley MJ, Blane D, Smith GD, Marmot MG. When does cardiovascular risk start? Past and present socioeconomic circumstances and risk factors in adulthood. J Epidemiol Community Health 1999; 53: 757-64.
42. Ministério da Saúde [BR]. Datasus. Informações de saúde. Estatísticas vitais [on-line]. Brasília; [citado Fev 2003]. Disponível em: URL: http://tabnet.datasus.gov.br/tabnet.tabnet.htm#IndicSaude.
43. American Academy of Pediatrics. National Cholesterol Education Program: Report of the Expert Panel on Blood Cholesterol Levels in Children and Adolescents. Pediatrics 1992; 89(3 Pt 2): 525-84.
44. Third Report of the National Cholesterol Education Program (NCEP) Expert Panel on Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults (Adult Treatment Panel III) final report. Circulation 2002; 106: 3143-421.
45. Raitakari OT, Taimela S, Porkka KV, et al. Associations between physical activity and risk factors for coronary heart disease: the Cardiovascular Risk in Young Finns Study. Med Sci Sports Exerc 1997; 29: 1055-61.
46. Katzmarzyk PT, Malina RM, Bouchard C. Physical activity, physical fitness, and coronary heart disease risk factors in youth: the Quebec Family Study. Prev Med 1999; 29(6 Pt 1): 555-62.
47. Boreham C, Twisk J, van Mechelen W, Savage M, Strain J, Cran G. Relationships between the development of biological risk factors for coronary heart disease and lifestyle parameters during adolescence: The Northern Ireland Young Hearts Project. Public Health 1999; 113: 7-12.
48. Boreham C, Twisk J, Murray L, Savage M, Strain JJ, Cran G. Fitness, fatness, and coronary heart disease risk in adolescents: the Northern Ireland Young Hearts Project. Med Sci Sports Exerc 2001; 33: 270-4.
49. Guillaume M, Lapidus L, Bjorntorp P, Lambert A. Physical activity, obesity, and cardiovascular risk factors in children. The Belgian Luxembourg Child Study II. Obes Res 1997; 5: 549-56.
50. Hager RL, Tucker LA, Seljaas GT. Aerobic fitness, blood lipids, and body fat in children. Am J Public Health 1995; 85: 1702-6.
51. Harrell JS, Gansky SA, Bradley CB, McMurray RG. Leisure time activities of elementary school children. Nurs Res 1997; 46: 246-53.
52. Tolfrey K, Campbell IG, Batterham AM. Exercise training induced alterations in prepubertal children's lipid-lipoprotein profile. Med Sci Sports Exerc 1998; 30: 1684-92.
53. Eisenmann JC, Womack CJ, Reeves MJ, Pivarnik JM, Malina RM. Blood lipids in young distance runners. Med Sci Sports Exerc 2001; 33: 1661-6.
54. Anavian J, Brenner DJ, Fort P, Speiser PW. Profiles of obese children presenting for metabolic evaluation. J Pediatr Endocrinol Metab 2001; 14: 1145-50.
55. Srinivasan SR, Myers L, Berenson GS. Rate of change in adiposity and its relationship to concomitant changes in cardiovascular risk variables among biracial (black-white) children and young adults: The Bogalusa Heart Study. Metabolism 2001; 50: 299-305.
56. Chu NF, Rimm EB, Wang DJ, Liou HS, Shieh SM. Clustering of cardiovascular disease risk factors among obese schoolchildren: the Taipei Children Heart Study. Am J Clin Nutr 1998; 67: 1141-6.
57. Freedman DS, Dietz WH, Srinivasan SR, Berenson GS. The relation of overweight to cardiovascular risk factors among children and adolescents: the Bogalusa Heart Study. Pediatrics 1999; 103(6 Pt 1): 1175-82.
58. Lai SW, Ng KC, Lin HF, Chen HL. Association between obesity and hyperlipidemia among children. Yale J Biol Med 2001; 74: 205-10.
59. McMurray RG, Harrel JS, Levine AA, Gansky SA. Childhood obesity elevates blood pressure and total cholesterol independent of physical activity. Int J Obes Relat Metab Disord 1995; 19: 881-6.
60. Valverde MA, Vitolo MR, Patin RV, Escrivão MAMS, Oliveira FLC, Ancona-Lopez F. Investigação de alterações do perfil lipídico de crianças e adolescentes obesos. Arch Latinoam Nutr 1999; 49: 338-43.
61. Asayama K, Hayashibe H, Dobashi K, et al. Increased serum cholesteryl ester transfer protein in obese children. Obes Res 2002; 10: 439-46.
62. Daniels SR, Morrison JA, Sprecher DL, Khoury P, Kimball TR. Association of body fat distribution and cardiovascular risk factors in children and adolescents. Circulation 1999; 99: 541-5.
63. Freedman DS, Serdula MK, Srinivasan SR, Berenson GS. Relation of circumferences and skinfold thicknesses to lipid and insulin concentrations in children and adolescents: the Bogalusa Heart Study. Am J Clin Nutr 1999; 69: 308-17.
64. Owens S, Gutin B, Ferguson M, Allison J, Karp W, Le NA. Visceral adipose tissue and cardiovascular risk factors in obese children. J Pediatr 1998; 133: 41-5.
65. Chu NF. Prevalence and trends of obesity among school children in Taiwan—the Taipei Children Heart Study. Int J Obes Relat Metab Disord 2001; 25: 170-6.
66. Wright CM, Parker L, Lamont D, Craft AW. Implications of childhood obesity for adult health: findings from thousand families cohort study. Br Med J 2001; 323(7324): 1280-4.
67. Tershakovec AM, Jawad AF, Stouffer NO, Elkasabany A, Srinivasan SR, Berenson GS. Persistent hypercholesterolemia is associated with the development of obesity among girls: the Bogalusa Heart Study. Am J Clin Nutr 2002; 76:730-5.
68. Chen W, Srinivasan SR, Bao W, Berenson GS. The magnitude of familial associations of cardiovascular risk factor variables between parents and offspring are influenced by age: the Bogalusa Heart Study. Ann Epidemiol 2001; 11: 522-8.
69. Kardia SL, Haviland MB, Sing CF. Correlates of family history of coronary artery disease in children. J Clin Epidemiol 1998; 51: 473-86.
70. Ucar B, Kilic Z, Sonmez HM, Ata N, Ozdamar K. Relationships between the children and the parents for coronary risk factors. Pediatr Int 2001; 43: 611-23.
71. Youssef AA, Srinivasan SR, Elkasabany A, Chen W, Berenson GS. Trends of lipoprotein variables from childhood to adulthood in offspring of parents with coronary heart disease: the Bogalusa Heart Study. Metabolism 2001; 50: 1441-6.
72. Chen W, Srinivasan SR, Bao W, Wattigney WA, Berenson GS. The relationship of conjoint traits of dyslipidemias between young offspring and their parents in a community-based sample. Prev Med 1997; 26(5 Pt 1): 717-23.