Original Article

Cardiovascular Risk Factors in Adolescents with Different Levels of Energy Expenditure

Italo Quenni Araujo de Vasconcelos, Antonio Stabelini Neto, Luís Paulo Gomes Mascarenhas, Rodrigo Bozza, Anderson Zampier Ulbrich, Wagner de Campos, Renata Labronici Bertin

Universidade Federal do Paraná, Curitiba, PR - Brazil

Summary

Background: Physical inactivity in adolescence is related to body fat accumulation, which apparently can increase the probability of onset and development of metabolic changes.

Objective: To verify the predisposition to cardiovascular risk factors in adolescents with different levels of energy expenditure.

Methods: A total of 108 young men and 132 young women aged between 12 and 16 years were selected. Daily energy expenditure was obtained using the questionnaire proposed by Bouchard et al. The sample was previously divided according to the quartiles of energy expenditure (Kcal/kg/day) into three groups: sedentary (SG), moderately active (MG), and active (AG). The enzyme-colorimetric method was used to determine the total cholesterol (TC), HDL-C, and triglycerides (TG) levels. LDL-C was calculated using the Friedewald et al's formula. The one-factor analysis of variance was used for statistical analysis, considering $p<0.05$.

Results: For the male gender, significant differences were found between the groups for the TC variable (mg/dL); AG (121.56±19.15) was different from MG (142.70±27.65) and from SG (145.63±36.54). Likewise, MG was different from SG ($F=3.70$ and $p=0.03$). For the TG variable (mg/dL), AG (65.69±18.95) was different from MG (82.25±33.73) and from SG (97.44±45.95). Also, MG was different from SG ($F=3.40$ and $p=0.04$). For the female gender, no significant differences were found in relation to daily energy expenditure.

Conclusion: More active young men show lower TC and TG levels in comparison with their moderately active and sedentary peers. (Arq Bras Cardiol 2008;91(4):207-212)

Key words: Risk factors; energy metabolism; adolescent.

Introduction

Health researchers such as physicians, nutritionists, and physical educators have currently investigated the different factors that make up a desirable lifestyle for the pediatric population. Health is deemed one of the most important components, and is defined as a state of complete physical, mental and social well-being and not merely the absence of diseases[1].

In this sense, starting from the assumption that the habits adopted by adolescents may be further maintained during their adulthood, we should be aware of the main elements of lifestyle, especially when behavioral factors such as physical activity are analyzed.

Thereby, physical inactivity in adolescence is related to body fat accumulation, which apparently can increase the probability of the onset and development of metabolic changes such as hypercholesterolemia, hypertriglyceridemia and hypertension[2-4], thus representing an important factor of public health concern[5].

In adults, there is substantial evidence that physical inactivity is directly associated with the development of cardiovascular diseases and type-2 diabetes[6,7]; an inverse association is demonstrated between physical activity and metabolic changes[8]. However, this relation remains contradictory in young adults[9].

Considering that adolescence is a phase in which it is extremely easy to incorporate new habits into the lifestyle, early detection of risk factors for health becomes important in the sense of applying an efficient intervention strategy[10,11]. In view of these aspects, the objective of this study was to analyze the predisposition to cardiovascular risk factors in adolescents aged between 12 and 17 years with different levels of energy expenditure.

Mailing Address: Italo Quenni Araujo de Vasconcelos •
Rua Lamartini Babo, 201 - Castelo Branco - 86812-320 – Apucarana, PR - Brazil
E-mail: italo@ufpr.br
Manuscript received May 30, 2007; revised manuscript received July 17, 2007; accepted February 25, 2008.

Methods

Sample

The randomized sample was comprised of 240 adolescents (108 young men and 132 young women) aged between 12 and 16 years, from the city of São Mateus do Sul, State of Paraná, Brazil, retrieved from the database of the research project "Analysis of cardiovascular risk factors and immune system deficiency in adolescents attending public schools of São Mateus do Sul, PR" which is being conducted by the UFPR's Research Center on Exercise and Sports.

The sample size was calculated according to the following criteria: a) total number of young men and young women enrolled in the public school network; b) 95% confidence interval; c) sample error of 5% and prevalence of 20%[12]. The prevalence estimate was set at 20% considering that the distribution of risk factors found in other studies with young individuals shows values lower than 20%[2,13,14].

Initially, an "invitation letter" with information relative to the study and containing a short explanation of the objectives of the research and assessments to be carried out was sent to each school. Next, the adolescents were drawn by lot; of these, those who accepted to participate in the assessments received an informed consent form which was filled out by their parents or respective guardians, who gave their permission for participation in the study.

This study was approved by the Research Ethics Committee of *Universidade Federal do Paraná* according to resolution 196/96 of the National Health Council involving human research, process no. 018-06.

Instruments and procedures

Maturation stage

The method proposed by Tanner[15] was used for determination of the sexual maturation stage, which is divided from one to five. Stage one corresponds to the prepubertal level, and stage five, in the other extreme, to the final maturation process.

The test was administered as a self-assessment of the development of pubic hair as suggested by Martin et al[16] and Bojikian et al[17], who identified satisfactory agreement between this method and the physician's assessment, with $k = 0.61$ and $k = 0.53$ for the male and female gender, respectively.

Daily energy expenditure

The diary-record questionnaire developed by Bouchard et al[18] was used. It consists of a form where the activities performed in two days of the week and one day of the weekend, divided in 15-minute periods, are recorded. The activities are classified in a continuum involving nine categories that represent the mean energy expenditure of the activities performed. These categories are classified from one to nine. Category one is characterized by activities with lower energy expenditure (sleeping and resting in bed) and category nine, by activities with high calorie expenditure (intense manual work and sports competition).

Based on this information, the daily energy expenditure (DEE) divided by kilogram of body weight per day (kcal/kg/day) could be estimated, as well as the DEE by the mean of the three-day diary record. The questionnaire has a reproducibility of r=0.91 in individuals from 10 years of age[18].

In order to classify the individuals as regards DEE, the sample was divided into quartiles (Q) according to gender[8]. The discrimination of group formation according to the DEE (kcal/kg/day) and the cut-off points established are shown in Table 1.

Anthropometry

Total height was measured with a portable WCS stadiometer to the nearest 0.1 cm. Body mass was measured using a portable digital PLENNA scale to the nearest 100g. At the moment of assessment, the individuals were barefoot and wearing only light clothes[19].

The ratio weight (Kg) divided by square height (m) was used to obtain the values of body mass index (BMI)[20]. The adolescents' nutritional status was classified using the reference tables proposed by Anjos et al[21]: adequate ≥ 5th percentile and < 85th percentile; overweight ≥ 85th percentile and < 95th percentile; obesity ≥ 95th percentile.

Waist circumference (WC) was measured at the mean point between the lower rib and the iliac crest, at the moment of minimum respiration, using a SANNY flexible metal anthropometric tape measure with a 0.1-cm scale[22]. Waist circumference was classified according to the tables proposed by Fernandez et al[23], adopting measurements < 75th percentile as adequate values and measurements ≥ 75th percentile as increased values.

Blood pressure

Systolic (SBP) and diastolic blood pressure (DBP) were measured in the individual's left arm using a stethoscope and a mercury sphygmomanometer with scale up to 300 mmHg and variation of 2 mmHg placed at the level of the heart. Measurements were performed after the individual had remained sitting at rest for a period of at least five minutes.

The adolescents were initially classified by height according to the values proposed by the Centers for Disease Control[24]. The values obtained along with the chronological age were considered for the classification of blood pressure levels as desirable level (<90th percentile) and undesirable level (≥90th percentile), according to the consensus of The Fourth Report on the Diagnosis, Evaluation, and Treatment of High Blood Pressure in Children and Adolescents[25].

Table 1 – **Cut-off points established for the classification of subjects according to the DEE (kcal/kg/day)**

	SG	MG	AG
Male	<35.71	≥35.71 - <51.50	≥51.50
Female	<38.74	≥38.74 - <46.42	≥46.42

SG - sedentary group; MG - moderately active group; AG - active group

Biochemical variables

According to the Guidelines of the Brazilian Society of Cardiology (BSC)[5], the adolescents were advised to remain fasting for at least 12 hours, to avoid excessive consumption of fat, and not to drink alcoholic beverages three days prior to the test.

Total cholesterol (TC), HDL and triglyceride (TG) levels were analyzed by the automated colorimetric-enzyme method. LDL-C in mg/dL was calculated using the Friedewald et al's formula[26]: LDL-C= TC-HDL-TG/5. VLDL levels were calculated by the formula: VLDL= TG/5. Reference values adopted to define the lipid-lipoproteic profile of atherogenic risk are in accordance with the I Guideline on the Prevention of Atherosclerosis in Childhood and Adolescence[13] (Table 2).

Table 3 – **Sample characterization**

Variables	Male (n= 108)		Female (n= 132)	
	Mean	SD	Mean	SD
Age (years)	14.95	1.30	14.69	1.19
Height (cm)	167.24	8.33	159.81	6.79
Body mass (kg)	56.56	10.38	50.90	8.89
DEE (Kcal/kg/day)	43.18	6.98	42.40	5.71

Data treatment and statistical analysis

Descriptive statistics expressed as mean values and standard deviation was used for sample characterization. Frequency distribution was used for the classification of individuals according to the cut-off points adopted for each variable. One-factor analysis of variance (ANOVA) was used for comparison of the variables among the different DEE levels. Subsequently, the Tukey multiple comparison test was used to locate the differences found in ANOVA, with a significance level set at $p<0.05$. All procedures were performed in the SPSS 13.0 (Chicago, IL) statistical software.

Results

Sample characterization of the male and female groups with mean values and standard deviation of the decimal age, height, body mass, and DEE variables are shown in Table 3. Of the total sample, 7.7% of the adolescents were in stage two, 12.9% in stage three, 52.8% in stage four, and 26.6% in stage five of sexual maturation.

In view of the peculiarities of the population studied with respect to the biological characteristics, Table 4 shows the prevalence of subjects with desirable and undesirable values of anthropometric variables (BMI and WC), hemodynamic variables (SBP and DBP) and biochemical variables (TC, LDL-C, HDL-C and TG) corresponding to the cardiovascular risk factors.

Mean values and standard deviations for the young men in the SG, MG, and AG are shown in Table 5. Analysis of variance showed significant differences between the groups as regards energy expenditure in daily activities ($F=123.24$ and $p=0.0001$), thus demonstrating that the groups were heterogeneous with respect to the usual level of physical activities. Statistically significant differences were observed between the groups for TC and TG ($F=3.70$ and $p=0.03$; $F=3.40$ and $p=0.04$, respectively). No significant differences were found for the other variables.

Table 6 shows the mean values and standard deviations of the values presented by the young girls. Analysis of variance showed significant differences between the groups only for DEE ($F=123.24$ and $p=0.0001$). No significant differences were observed for the other variables.

Table 2 – **Reference values for lipid levels proposed for the age range from two to 19 years.**

Lipids	Desirable (mg/dL)	Borderline (mg/dL)	Increased (mg/dL)
Total cholesterol	<150	150-169	≥170
LDL-C	<100	100-129	≥130
HDL-C	≥ 45	---	---
TG	<100	100-129	≥130

Source: Brazilian Society of Cardiology[13].

Discussion

According to the prevalences shown in Table 4, we can observe that in relation to BMI the majority of young men and girls present adequate values of nutritional status, followed by a smaller proportion with overweight and obesity. However, the proportion of subjects with adequate values is lower when compared to the study conducted with adolescents in the State of Bahia[27], in which 90.4% of the young men and 94.1% of young women were found with adequate nutritional status.

As regards the hemodynamic variables, the majority of the adolescents, both males and females, presented desirable values. However, we should be concerned about the incidence of adolescents with undesirable DBP values, which are usually associated with excess weight and obesity[28,29]. Borderline blood pressure values in the present study are greater than those found in the study conducted in the city of Belo Horizonte by Ribeiro et al[28], who reported 12% of individuals with borderline or increased SBP or DBP values.

Guedes et al[2] presented a prevalence of undesirable SBP values of 9.7% for young women and 8.8% for young men; for DBP, the prevalences were 10.8% and 8.1% for young women and young men, respectively. The differences between the results may be due to the different cut-off points used for blood pressure.

The present study demonstrated a prevalence of hypercholesterolemia of 16.7% among boys and 13.8% among girls, different from that observed in Giuliano et al's study[14], which found 10% of increased values, whereas Guedes et al[2] found 5.6% of the young men and 12.9% of the young women

Table 4 – **Classification of cardiovascular risk indicators in the adolescents, expressed as percentage (%)**

Variables	Desirable		Borderline		Increased	
	Male	Female	Male	Female	Male	Female
BMI	72.2	87.1	16.7 *	7.6 *	11.1 †	5.3 †
WC	94.3	97.7	---	---	5.7 ‡	2.3 ‡
SBP	97.2	97.7	2.8 §	2.3 §	---	---
DBP	76.9	74.4	23.2 §	25.5 §	---	---
TC	64.9	66.6	19.4	19.7	15.7	13.7
LDL-C	77.8	80.7	19.4	16.2	2.8	3.1
HDL-C	39.8	50.8	60.2 //	49.2 //	---	---
TG	77.8	76.8	11.1	10.6	11.1	12.1

** adolescents with BMI values between ≥85th and <95th percentile; † adolescents with BMI values ≥95th percentile; ‡adolescents with WC ≥75th percentile; § adolescents with blood pressure values ≥90th percentile; / adolescents with HDL-C levels <45 mg/dL*

Table 5 – **Mean and standard deviation of the DEE variable and of the cardiovascular risk indicators in young men according to DEE**

Variables	SG (n= 27)	MG (n= 54)	AG (n= 27)	Overall (108)
DEE (Kcal/kg/dAY)	35.71±2.80	42.85±2.77a	51.50±3.05ab	43.22±6.25
BMI (kg/m2)	19.44±2.84	19.65±2.56	20.58±2.57	19.83±2.63
WC (cm)	67.22±7.50	68.19±6.63	69.81±6.06	68.35±6.68
SBP (mmHg)	96.62±16.42	99.63±13.39	98.00±12.22	98.49±13.76
DBP (mmHg)	73.00±10.85	72.66±10.49	72.37±9.41	72.67±10.17
TC (mg/dL)	145.63±36.54	142.70±27.65a	121.56±19.15ab	138.22±29.57
HDL-C (mg/dL)	41.13±7.82	43.03±8.19	42.06±10.55	42.32±8.64
LDL-C (mg/dL)	84.88±32.35	82.70±24.68	66.16±19.20	79.16±26.33
TG (mg/dL)	97.44±45.95	82.25±33.73a	65.69±18.95ab	81.91±35.69
VLDL-C (mg/dL)	19.40±9.30	18.76±12.83	13.18±3.74	17.54±10.59

Tukey contrasts: a - difference for SG; b - difference for MG.

with increased TC levels. However, the difference between the findings of the studies is due to the different cut-off points used for hypercholesterolemia, and we emphasize that the present research used the cut-off points suggested by the I Guideline on the Prevention of Atherosclerosis in Childhood and Adolescents[13].

As regards LDL-C, Giuliano et al's study[14] found a lower proportion of subjects with borderline (14%) and increased values (6%), as well as a lower incidence of undesirable HDL-C values (5%) in comparison with the present study. Thus, we should be concerned about the proportion of adolescents with undesirable LDL-C levels, which can lead to the development of cardiovascular risk factors such as hypertension, glucose intolerance and insulin-receptor deficiency[14,28-30].

In relation to TG levels, this study sample presented a lower prevalence of adolescents with increased values when compared to the sample of Giuliano et al's study[14], in which 22% of the subjects were found with undesirable values, thus indicating hypertriglyceridemia[31].

Accordingly, since the variables investigated in the prevalence analyses demonstrated cardiovascular risk status for part of the individuals, and aware of the benefits of physical activity on health status, we sought to verify the predisposition to these factors in adolescents with different levels of energy expenditure (Tables 5 and 6).

The analysis of variance showed that the anthropometric variables were not significantly different between the groups for both genders, possibly because the majority of the subjects

Table 6 – Mean and standard deviations of the DEE variable and of the cardiovascular risk indicators in the young women according to DEE

Variables	SG (n= 33)	MG (n= 66)	AG (n= 33)	Overall (132)
DEE (Kcal/kg/day)	36.55±1.69	41.88±2.27a	51.52±6.23ab	42.96±6.49
BMI (kg/m2)	19.19±2.58	20.29±3.31	20.33±2.16	20.03±2.90
WC (cm)	63.74±5.08	66.36±6.51	64.61±3.72	65.27±5.66
SBP (mmHg)	92.20±14.27	92.06±13.07	91.37±11.98	91.93±13.01
DBP (mmHg)	68.68±12.92	68.27±12.48	67.10±10.50	68.08±12.04
TC (mg/dL)	138.28±20.91	142.14±26.90	151.86±28.61	143.62±26.26
HDL-C (mg/dL)	44.00±13.93	46.26±14.54	47.03±15.83	45.89±14.64
LDL-C (mg/dL)	78.01±20.73	78.85±25.90	87.10±24.57	80.72±24.44
TG (mg/dL)	80.24±32.24	76.40±39.13	84.28±40.04	79.36±37.57
VLDL-C (mg/dL)	15.99±6.40	17.88±15.90	18.52±10.01	17.57±12.64

Tukey contrasts: a - difference for SG; b - difference for MG.

assessed had an adequate nutritional status.

As regards the biochemical variables, more physically active young men had lower values of total cholesterol and triglycerides when compared with those less active (moderately active and sedentary). Additionally, although not statistically significant, the mean values of the AG for the LDL-C and VLDL-C variables were lower than the mean values of the MG and SG. Thus, we can observe that a higher DEE in usual physical activities consequently contributes to the reduction of excessive values of plasma lipoproteins and lipids in male adolescents.

Corroborating these findings, Durstine & Haskell[32] observed that individuals physically active and engaged in aerobic training programs had lower total cholesterol and triglyceride levels when compared with their sedentary peers.

Additionally, in an intervention study, it was demonstrated that physical exercise is one of the major factors contributing to a desirable status of lipid and lipoprotein profiles and coronary diseases[33]. This is due to the physiological characteristics of physical exercises that improve the ability of the muscle tissue to perform fatty acid oxidation, in addition to stimulating the lipase enzyme activity in muscles, thus contributing to the decrease of plasma lipids and lipoproteins even in young individuals[32-34].

However, this situation was not observed among the young women, and no significant differences were found among the female groups classified by DEE for any of the cardiovascular risk indicators analyzed. This suggests that, for this sample, a higher DEE in itself did not lead to lower values of BMI, WC, blood pressure, and plasma lipids and lipoproteins in active female adolescents.

These results corroborate Guedes et al's study[2], in which the daily energy expenditure of female adolescents was not a determinant of reduction of the indicators corresponding to cardiovascular risk factors. Likewise, Sung et al[34] observed that six weeks of training were not enough to reduce TC and LDL-C levels in young female individuals.

Thus, the non-significant results of the present study lead us to believe that other factors such as puberty characteristics, family history of cardiovascular diseases, smoking, and alcohol use may influence the alteration of indicators corresponding to cardiovascular risk factors[2,30].

Therefore, due to the limitations of the present research, further studies with a greater number of participants being followed up in the mid- or long-term, or involving the administration of experimental treatment controlling the eating habits should be conducted with the purpose of providing a better diagnosis of the health status and its interrelations with behavioral aspects of the pediatric population.

In summary, a significant percentage of the adolescents in this sample was observed to present undesirable levels of BMI, WC, DBP, TC, LDL-C, HDL-C and TG, which demonstrates the need for adoption of intervention measures for these subjects. Considering the daily energy expenditure, the young men in the AG presented lower TC and TG levels when compared with their moderately active and sedentary peers.

Acknowledgements

To the adolescents who collaborated as research subjects and their respective guardians, as well as to the Departments of Education, Culture, Leisure and Health of the city of São Mateus do Sul, PR, for supporting this project.

Potential Conflict of Interest

No potential conflict of interest relevant to this article was reported.

Sources of Funding

There were no external funding sources for this study.

Study Association

This study is not associated with any graduation program.

References

1. World Health Organization. Working for health: an introduction to the WHO. Washington: WHO; 2007.
2. Guedes DP, Guedes JERP, Barbosa DS, Oliveira JA, Stanganelli LCR. Fatores de risco cardiovasculares em adolescentes: indicadores biológicos e comportamentais. Arq Bras Cardiol. 2006; 86 (6): 439-50.
3. Kim HM, Park J, Kim H, Kim DH, Park SH. Obesity and cardiovascular risk factors in Korean children and adolescents aged 10–18 years from the Korean National Health and Nutrition Examination Survey, 1998 and 2001. Am J Epidem. 2006 (8): 787-93.
4. Katzmarzyk PT, Srinivasan SR, Chen W, Malina RM, Bouchard C, Berenson GS. Body mass index, waist circumference, and clustering of cardiovascular disease risk factors in a biracial sample of children and adolescents. Pediatrics. 2004; 114: e198-205.
5. Sociedade Brasileira de Cardiologia. III Diretrizes Brasileiras sobre dislipidemias e diretriz de prevenção da aterosclerose do departamento de aterosclerose. Arq Bras Cardiol. 2001; 77 (supl. 3): 1-48.
6. Freedman D, Srinavasan S, Burke G. Relationship of body fat distribution in children and adolescents: the Bogalusa Heart Study. Am J Clin Nutr. 1987; 46: 403-10.
7. Ciolac EG, Guimarães GV. Exercício físico e síndrome metabólica. Rev Bras Med Esporte. 2004; 10 (4): 319-24.
8. Franks PW, Ekelund U, Brage S, Wong M, Wareham NJ. Does the association of habitual physical activity with the metabolic syndrome differ by level of cardiorespiratory fitness? Diabetes Care. 2004; 27 (3): 1187-93.
9. Eriksson J, Taimela S, Koivisto VA. Exercise and the metabolic syndrome. Diabetologia. 1997; 40: 125-35.
10. Sarni RS, Souza FIS, Schoeps DO, Catherino P, Oliveira MCP, Pessotti CFX, et al. Relação da cintura abdominal com a condição nutricional, perfil lipídico e pressão arterial em pré-escolares de baixo estrato socioeconômico. Arq Bras Cardiol. 2006; 87 (2): 153-8.
11. Mendes GA, Martinez TL, Izar MC, Amâncio OM, Novo NF, Matheus SC, et al. Perfil lipídico e efeitos da orientação nutricional em adolescentes com história familiar de doença arterial coronariana prematura. Arq Bras Cardiol. 2006; 86 (5): 361-5.
12. Luiz RR, Magnanini MMF. A lógica da determinação do tamanho da amostra em investigações epidemiológicas. Cad Saúde Pública. 2000; 8 (2): 9-28.
13. Sociedade Brasileira de Cardiologia. I Diretriz de prevenção da aterosclerose na infância e adolescência. Arq Bras Cardiol. 2005; 85 (supl 6): 1-36.
14. Giuliano ICB, Coutinho MSSA, Freitas SFT, Pires MMS, Zunino JN, Ribeiro RQC. Lípides séricos em crianças e adolescentes de Florianópolis, SC – Estudo Floripa Saudável 2040. Arq Bras Cardiol. 2005; 85 (2): 85-91.
15. Tanner JM. Growth and adolescence. Oxford: Blackwell Scientific Publication; 1962.
16. Martin RHC, Uezu R, Parra AS, Arena SS, Bojikian LP, Bohme MTS. Auto-avaliação da maturação sexual masculina por meio da utilização de desenhos e fotos. Rev Paul Ed Fis. 2001; 15 (2): 212-22.
17. Bojikian LP, Massa M, Martin RHC, Texeira CP, Kiss MAPD, Bohme MTS. Auto-avaliação puberal feminina por meio da utilização de desenhos e fotos. Rev Bras Ativ Fis Saúde. 2002; 7 (2): 24-34.
18. Bouchard CA, Tremblay C, Leblanc G, Lortie R, Savard R, Theriault GA. Method to assess energy expenditure in children and adults. Am J Clin Nutrition. 1983; 37: 461-7.
19. Docherty D. Measurement in pediatric exercise science. Champaign: Human Kinetics; 1996.
20. American College of Sports Medicine. Diretrizes do ACSM para os testes de esforço e sua prescrição. 6ª ed. Rio de Janeiro: Guanabara Koogan; 2003.
21. Anjos LA, Veiga GV, Castro IRR. Distribuição dos valores do índice de massa corporal da população brasileira até 25 anos. Rev Panam Salud Publica. 1998; 3 (3): 167-73.
22. Costa RF. Composição corporal: teoria e prática da avaliação. São Paulo: Manole; 2001.
23. Fernandez JR, Redden T, Pietrobelli A, Allison B. Waist circumference percentiles in nationally representative samples of African-American, European-American, and Mexican-American children and adolescents. J Pediatr. 2004; 145: 439-44.
24. Kuczmarski RJ, Odgen CL, Grummer-Strawn LM, Flegal KM, Guo SS, Wei R, et al. CDC growth charts: United States. Adv Data. 2000; 314: 1-27.
25. National High Blood Pressure Education Program Working Group on High Blood Pressure in Children and Adolescents. The fourth report on the diagnosis, evaluation, and treatment of high blood pressure in children and adolescents. Pediatrics. 2004; 114 (2 Suppl 4th Report): 555-76.
26. Friedewald WT, Levy RL, Fredrickson DS. Estimation of the concentration of low-density lipoprotein cholesterol in plasma without the use of preparative ultracentrifuge. Clin Chem. 1972; 18: 499-502.
27. Santos JS, Costa MCO, Nascimento Sobrinho CL, Silva MCM, Souza KEP, Melo BO. Perfil antropométrico e consumo alimentar de adolescentes de Teixeira de Freitas - Bahia. Rev Nutr Campinas. 2005; 18 (5): 623-32.
28. Ribeiro RQC, Lotufo PA, Lamounier JA, Oliveira RG, Soares JF, Botter DA. Fatores adicionais de risco cardiovascular associados ao excesso de peso em crianças e adolescentes: o estudo do coração de Belo Horizonte. Arq Bras Cardiol. 2006; 86 (6): 408-18.
29. Carneiro JRI, Kushni MC, Clemente ELS, Brandão MG, Gomes MB. Obesidade na adolescência: fator de risco para complicações clínico-metabólicas. Arq Bras Endocrinol Metabol. 2000; 44 (5): 390-6.
30. Gerber ZRSG, Zielinski P. Fatores de risco de aterosclerose na infância: um estudo epidemiológico. Arq Bras Cardiol. 1997; 69 (4): 231-6.
31. Schiavo M, Lunardelli A, Oliveira JR. Influência de triglicérides na concentração sérica de triglicérides. J Bras Patol Med Lab. 2003; 39 (4): 283-8.
32. Durstine JL, Haskell WL. Effects of exercise on plasma lipids and lipoproteins. Exerc Sport Sci Rev. 1994; 22: 477-521.
33. Ekelund LG, Haskell WL, Johnson JL, Whaley FS, Criqui MH, Sheps DS. Physical fitness as predictor of cardiovascular mortality in asymptomatic North American men: The Lipid Research Clinics Mortality Follow-Up Study. N Engl J Med. 1988; 319: 1379-84.
34. Sung RYT, Yu CW, Chang SKY, Mo SW, Woo KS, Lam CWK. Effects of dietary intervention and strength training on blood lipid level in obese children. Arch Dis Child. 2002; 86: 407-10.