Objective: To verify if there is an association between cardiometabolic risk factors and active daily commuting to school among children and adolescents.

Methods: A total of 1,743 schoolchildren aged 7 to 17 years old were evaluated in the city of Santa Cruz do Sul (RS). The way of commuting to school was investigated with a questionnaire, and the cardiometabolic risk factors analyzed were body mass index (BMI), waist circumference (WC), systolic (SBP) and diastolic (DBP) blood pressure, blood glucose, triglycerides, total cholesterol (TC) and fractions, LDL and HDL.

Results: The prevalence of active commuting among schoolchildren was 48.0% (95%CI 45.7–50.4), and it was associated, in the crude analysis, with blood glucose and LDL cholesterol levels. Passive schoolchildren had a 1.1 higher prevalence ratio of high glucose and LDL cholesterol levels. However, when sociodemographic variables were included in the model, these associations were not maintained.

Conclusions: The prevalence of active commuting in the sample studied is low and it was shown to have a crude association with glucose and LDL cholesterol levels in students. However, sociodemographic factors seem to influence these associations.

Keywords: Risk factors; Physical activity; Child; Adolescent.
INTRODUCTION

Insufficient levels of physical activity among children and adolescents have become increasingly prevalent across the globe, impacting the well-being and health of this population. Data from the National School Health Survey show that only 30.1% of Brazilian schoolchildren reach the recommended 300 weekly minutes of physical activity, while the South region reaches 36.3%.2

Active commuting to school, characterized by walking and/or pedaling to school, has been widely adopted as an effective strategy to increase the levels of daily physical activity of young people, helping to sustain an active lifestyle.3 This practice, however, can impact health positively and, consequently, help to prevent metabolic and cardiovascular diseases.4

Studies have shown a positive association of active commuting to work with physical fitness levels among adults5 and negative association with obesity indicators,5,6 triglyceride levels,5 blood pressure5,6 and insulin resistance indicators, besides being linked to an 11% reduction in cardiovascular risk.7

The national scientific literature brings studies conducted with Brazilian children and adolescents on the prevalence of active commuting to school and its association with socio-economic factors8-12 and with free time activities,11 obesity10,13 and blood pressure indicators.14 However, there are no studies addressing the association of active commuting with other cardiometabolic risk factors. This study, therefore, aims to search and identify any associations between cardiometabolic risk factors and active commuting to school among children and adolescents.

METHOD

This is a cross-sectional study that has been developed from the research database of the study “Evaluation of biochemical health indicators of schoolchildren using infrared spectroscopy, polymorphisms, oral health and lifestyle factors: a study in Santa Cruz do South – Phase II”. The project was approved by the Research Ethics Committee of the Universidade de Santa Cruz do Sul (protocol 3044-11). Participating schools received a copy of the research project and had their policy boards signing an acceptance letter. All students evaluated had their parents/legal guardians signing the free and informed consent form was sent for the selected students through the teaching staff. The free and informed consent form was sent for the selected students through the school prior to data collection, as well as a note to parents, explaining the procedures of data collection.

Nineteen schools participated: seven from the municipal network, ten from the state and two from the private network; being 14 in the urban area and five in the rural area; ten schools had only elementary education and nine had both primary and secondary education. Inclusion criteria were: being aged 7 to 17 years old and not presenting intellectual or cognitive deficiencies or limitations in order to understand and fill in the research instrument, or any physical limitations that could interfere in other evaluations. Schoolchildren who did not fill in the research instruments correctly, who for some reason did not perform any of the evaluations or from which blood samples could not be collected were excluded.

Regarding socio-demographic characteristics, participants under the age of ten were considered children and those aged ten or were classified as adolescents, according to World Health Organization (WHO) criteria.15 The socioeconomic level was classified according to ABEP16 which groups subjects into eight distinct economic classes (A1, A2, B1, B2, C1, C2, D and E). For the present study, these classes were regrouped in three: high economic classes (A1, A2, B1 and B2), intermediate classes (C1 and C2) and lower classes (D and E).
Information on how to get to school is part of a series of information contained in the survey completed by the schoolchildren during data collection. The questionnaire “Lifestyle, Health and Welfare – child/adolescente" by Barros and Nahas, was adapted by the researchers to meet the objectives of the project. As for commute to school, the question was: “How do you predominantly go to school (college)?”, with the following options: bus; on foot; car or motorcycle; bike; other (please specify). Answers were classified into active (walking, cycling or other form of movement requiring physical effort) or passive means of transportation (including alternatives such as bus, car, motorcycle, school bus, and other types of motor vehicle).

Body mass index (BMI) was determined by measuring body mass and height of schoolchildren, with classification based on the criteria suggested by the Centers for Disease Control and Prevention, according to sex and age: low weight (p≤5), normal weight (p≥5 and p≤85), overweight (p≥85 and p<95) and obesity (p>95). All four categories were grouped in two, that is, low/normal weight and overweight/obesity.

Waist circumference (WC) was measured using an inelastic metric tape with 1-mm resolution (Cardiomed®, Curitiba, Brazil), based on the narrower part of the trunk between the ribs and the iliac crest. Subsequently, the measure was classified according to criteria established by Taylor et al., considering circumference normal (percentile ≤75) or high (percentile >75), according to gender and age.

Blood pressure was measured by auscultation, with the student sitting and in rest of five minutes. A Sphygmomanometers for brachial perimeter and a stethoscope were placed on their left arm. Each device had three different sized cuffs so that researchers could select the most suitable for each arm circumference (pediatric, adolescent, and adult). Blood pressure was sorted based on percentiles for age, sex, and height, with percentile <90 considered normal, between 90 and 95 borderline, and above 95 hypertension (stages 1 and 2), according to the VI Brazilian Guidelines for Hypertension; these were then regrouped into two categories: normotensive and borderline/hypertensive.

In order to evaluate the biochemical indicators (blood glucose, triglycerides, total cholesterol — low density lipoprotein LDL and high-density lipoprotein HDL cholesterol), students in fasting and previous rest of 12 hours were submitted to standard blood collection from the brachial vein with vacutainer without serum additives. The blood samples were incubated at 37 °C for 15 minutes and then centrifuged at 2,500 rpm at the same time to obtain serum samples. These were subjected to glucose, triglycerides and HDL testing in the automated equipment Miura One® (ISE, Rome, Italy) using commercial DiaSys® kits (Diagnostic Systems, Germany). The Friedwald equation was used to determine LDL:21 LDL = CT-HDL− (Triglycerides/5).

CT, LDL, HDL and triglycerides were classified according to the National Heart, Lung, and Blood Institute, considering categories borderline/increased for CT, LDL and triglycerides, and acceptable and borderline/low for HDL. The American Diabetes Association protocol was used for glucose measurement, sorted as normal (up to 99 mg/dL), pre-diabetes (100-126 mg/dL), and diabetes (≥126 mg/dL).

Statistical analysis was performed in the Statistical Package for the Social Sciences (SPSS®) version 20.0 (IBM, Armonk, USA). Descriptive statistics were initially used to analyze the distribution of frequency of variables and respective 95% confidence intervals (95%CI). The chi-square test was applied to analyze the distribution of frequency of means of commuting to school according to sociodemographic factors, with significance level set at p≤0.05. Poisson regression was applied to test the association of commuting to school with cardiovascular risk factors, while crude and adjusted prevalence ratios with respective 95%CIs were calculated to estimate the extent of the associations’ effect. For the adjusted analysis, sociodemographic variables (such as gender, age group, school network, region of residence, and economic class) were included in the model. The level of significance was 5%.

RESULTS

In total, 1,963 students were evaluated. After applying the exclusion criteria, 220 (11.2%) participants were excluded from the sample due to data inconsistency, missing info or impossibility to collect blood samples. Thus, 1,743 students made up the final sample, of which 53.8% were females. Table 1 shows the sociodemographic characteristics of the sample and, Table 2, the frequency distributions of cardiometabolic risk factors.

The prevalence of active commuting to school among schoolchildren was 48.0% (95%CI 45.7–50.4), being higher for males (p=0.031), children aged seven to nine years (p=0.009), students of the State school network, living in the periphery, and from lower economic classes (p<0.001), according to data listed in Table 3.

In the crude analysis, active commuting was associated with risk factors for glucose and LDL cholesterol. Schoolchildren who go to school passively have 1.1 higher prevalence ratio (PR) for glucose levels (p=1.10, 95%CI 1.01–1.20) and high LDL cholesterol levels (PR 1.12; 95%CI 1.03–1.21). However, when adjusted for socioeconomic variables, these associations were not maintained (Table 4).
DISCUSSION

The main finding of this study is the association of passive commuting with glucose and LDL cholesterol levels: in the crude analysis, schoolchildren who passively commute to school have a 1.1 higher PR of increased levels. However, after analysis adjusted for socioeconomic factors, this relationship is not maintained.

The habit of actively commuting daily to school is an important source of daily activity and a relevant increase in physical activity levels.3 The effects of good levels of physical activity on glucose and lipid metabolism are well-evidenced already. It is known that exercise creates hormonal changes that activate the translocation of glucose transporter 4 (GLUT4) and thus increase glucose uptake regardless of the action of insulin.24 Physical exercise also helps increase glucose enzymatic activity in lipid metabolism, increasing the catabolism of triglycerides, while reducing the formation of LDL particles and increasing the production of HDL.25

Regarding the non-association between the way of commuting and anthropometric indicators, Heelan et al.23 have pointed out that active commuting does not seem to provide a sufficient amount of physical activity to reduce these effects, although it does help to raise the levels of this activity. On the non-association with blood pressure levels, Silva and Lopes10 have stated that the relation between blood pressure and physical activity in this age group has not been well established yet, and cross-sectional epidemiological studies do not allow observing cause and effect between such variables.

According to a previous literature review, other studies evaluating the association between commuting to school and the same cardiometabolic risk factors analyzed in this study in the Brazilian schoolchildren population are unknown. However, some studies address the association with some of the variables considered in this project. A study conducted with schoolchildren from João Pessoa, Paraíba, to evaluate the association of passive commuting with BMI, fat percentage and blood pressure reported association only with anthropometric indicators, BMI and fat percentage.19 This association with BMI was also investigated and seen among schoolchildren from Uruguaiana, Rio Grande do Sul,13 and Florianópolis, Santa Catarina.26

Table 1 Sociodemographic characteristics of schoolchildren included in the sample.

|               | n    | % (95%CI)   |
|---------------|------|-------------|
| Gender        |      |             |
| Males         | 806  | 46.2 (43.9–48.5) |
| Females       | 937  | 53.8 (51.5–56.1) |
| Age group     |      |             |
| Children (aged 7-9) | 454 | 26.0 (24.0–28.1) |
| Adolescents (aged 10-17) | 1,289 | 74.0 (71.9–76.0) |
| School network |      |             |
| Municipal     | 760  | 43.6 (41.1–46.1) |
| State         | 889  | 51.0 (48.5–53.4) |
| Private       | 94   | 5.4 (4.4–6.5) |
| Region        |      |             |
| Central       | 343  | 19.7 (17.8–21.7) |
| Periphery     | 768  | 44.0 (41.8–46.4) |
| Rural         | 632  | 36.3 (34.0–38.5) |
| Economic class|      |             |
| A and B       | 828  | 47.5 (45.2–49.8) |
| C             | 844  | 48.4 (46.1–50.9) |
| D and E       | 71   | 4.1 (3.2–5.0)  |

N: sample size; CI95%: 95% confidence interval.

Table 2 Characterization of way of commuting and cardiometabolic risk factors of schoolchildren included in the sample (n = 1,743).

| Commuting to school       | n    | % (95%CI)   |
|---------------------------|------|-------------|
| Active                    | 837  | 48.0 (45.7–50.4) |
| Passive                   | 906  | 52.0 (49.6–54.3) |
| BMI                       |      |             |
| Low/normal weight         | 1,236| 70.9 (68.8–73.1) |
| Overweight/obesity        | 507  | 29.1 (26.9–31.2) |
| WC                        |      |             |
| Normal                    | 1,400| 80.3 (78.4–82.3) |
| Increased                 | 343  | 19.7 (17.7–21.6) |
| SBP                       |      |             |
| Normal                    | 1,507| 86.5 (84.9–88.1) |
| Borderline/hypertension   | 236  | 13.5 (11.9–15.1) |
| DBP                       |      |             |
| Normal                    | 1,477| 84.7 (83.2–86.4) |
| Borderline/hypertension   | 266  | 15.3 (13.6–16.8) |
| Glucose levels            |      |             |
| Acceptable                | 1,430| 82.0 (80.1–83.8) |
| Pre-diabetes/diabetes     | 313  | 18.0 (16.2–19.9) |
| TG                        |      |             |
| Acceptable                | 900  | 51.6 (49.3–53.9) |
| Borderline/increased      | 843  | 48.4 (46.1–50.7) |
| TC                        |      |             |
| Acceptable                | 684  | 39.2 (37.1–41.5) |
| Borderline/increased      | 1,059| 60.8 (58.5–62.9) |
| LDL                       |      |             |
| Acceptable                | 991  | 56.9 (54.6–59.2) |
| Borderline/increased      | 752  | 43.1 (40.8–45.4) |
| HDL                       |      |             |
| Acceptable                | 1,457| 83.6 (81.8–85.3) |
| Borderline/low            | 286  | 16.4 (14.7–18.2) |

N: sample size; CI95%: 95% confidence interval; BMI: body mass index; WC: waist circumference; SBP: Systolic blood pressure; DBP: Diastolic blood pressure; TC: Total cholesterol; LDL: Low-density lipoprotein; HDL: High density lipoprotein.
### Table 3 Frequency distribution of way of commuting to school according to sociodemographic factors (n=1,743).

|                      | Active commuting | Passive commuting | p-value* |
|----------------------|------------------|-------------------|----------|
|                      | n                | % (95%CI)         | n        | % (95%CI) |
| Gender               |                  |                   |          |          |
| Male                 | 407              | 50.5 (46.9–53.9)  | 399      | 49.5 (46.1–53.1) |
| Female               | 430              | 45.9 (42.7–49.1)  | 507      | 54.1 (50.9–57.3) |
| Age group            |                  |                   |          |          |
| Children (aged 7-9)  | 240              | 52.9 (48.4–57.9)  | 214      | 47.1 (42.1–51.6) |
| Adolescents (aged 10-17) | 597      | 46.3 (43.8–49.1)  | 692      | 53.7 (50.9–56.2) |
| School network       |                  |                   |          |          |
| Municipal            | 338              | 44.5 (41.1–47.9)  | 422      | 55.5 (52.1–58.9) |
| State                | 485              | 54.6 (51.3–57.7)  | 404      | 45.4 (42.3–48.7) |
| Private              | 14               | 14.9 (8.5–22.3)   | 80       | 85.1 (77.7–91.5) |
| Region               |                  |                   |          |          |
| Central              | 112              | 32.7 (27.7–37.6)  | 231      | 67.3 (62.4–72.3) |
| Periphery            | 636              | 82.8 (80.2–85.4)  | 132      | 17.2 (14.6–19.8) |
| Rural                | 89               | 14.1 (11.6–16.9)  | 543      | 85.9 (83.1–88.4) |
| Economic class       |                  |                   |          |          |
| A and B              | 345              | 41.7 (38.5–45.0)  | 483      | 58.3 (55.0–61.5) |
| C                    | 454              | 53.8 (50.4–57.3)  | 390      | 46.2 (42.7–49.6) |
| D and E              | 38               | 53.5 (42.3–65.3)  | 33       | 46.5 (34.7–57.7) |

N: sample size; IC95%: 95% confidence interval. *Chi-square test, with statistical difference at p≤0.05.

### Table 4 Ratio of crude and adjusted prevalence of cardiometabolic risk factors related to school commuting among students included in the sample (n = 1,743).

| Way of commuting | Crude PR (95%CI) | p-value | Adjusted PR* (95%CI) | p-value |
|------------------|------------------|---------|----------------------|---------|
| BMI              |                  |         |                      |         |
| Active           | 1                | 0.485   | 1                    | 0.509   |
| Passive          | 0.97 (0.89–1.06) |         | 0.97 (0.89–1.06)     |         |
| WC               |                  |         |                      |         |
| Active           | 1                | 0.885   | 1                    | 0.816   |
| Passive          | 0.99 (0.91–1.08) |         | 0.99 (0.90–1.09)     |         |
| SBP              |                  |         |                      |         |
| Active           | 1                | 0.380   | 1                    | 0.690   |
| Passive          | 1.04 (0.96–1.13) |         | 1.02 (0.93–1.11)     |         |
| DBP              |                  |         |                      |         |
| Active           | 1                | 0.691   | 1                    | 0.863   |
| Passive          | 1.02 (0.94–1.10) |         | 1.01 (0.92–1.10)     |         |
| Glucose levels   |                  |         |                      |         |
| Active           | 1                | 0.033   | 1                    | 0.407   |
| Passive          | 1.10 (1.01–1.20) |         | 1.04 (0.95–1.14)     |         |
| TG               |                  |         |                      |         |
| Active           | 1                | 0.220   | 1                    | 0.363   |
| Passive          | 0.96 (0.89–1.03) |         | 1.04 (0.96–1.13)     |         |
| TC               |                  |         |                      |         |
| Active           | 1                | 0.127   | 1                    | 0.218   |
| Passive          | 1.06 (0.98–1.15) |         | 0.95 (0.88–1.03)     |         |
| LDL              |                  |         |                      |         |
| Active           | 1                | 0.006   | 1                    | 0.375   |
| Passive          | 1.12 (1.03–1.21) |         | 1.04 (0.96–1.13)     |         |
| HDL              |                  |         |                      |         |
| Active           | 1                | 0.906   | 1                    | 0.731   |
| Passive          | 0.99 (0.91–1.09) |         | 0.98 (0.90–1.08)     |         |

N: sample size; IC95%: 95% confidence interval; BMI: body mass index; WC: waist circumference; SBP: Systolic blood pressure; DBP: Diastolic blood pressure; TG: Triglycerides; TC: Total cholesterol; LDL: Low-density lipoprotein; HDL: High density lipoprotein.

*Adjusted for gender, age group, school network, region and economic class.
Among schoolchildren from Caxias do Sul, Rio Grande do Sul, it was found that active commuting to school was shown to increase the chance of high TC.\textsuperscript{27}

A study with Portuguese schoolchildren found a greater probability of students who actively commute to present better indexes for WC and HDL cholesterol than sedentary ones.\textsuperscript{4} A longitudinal study conducted in Denmark followed 334 children over six years and showed that those who used the bicycle as a means of transportation to school had a better cardiovascular risk profile. Students who, over time, started cycling to school, showed improved HDL cholesterol and glucose levels, as well as a reduced cardiovascular risk levels compared to those who did not use the bicycle.\textsuperscript{28}

In this study, the crude effect of commuting to school on glucose and LDL cholesterol levels was not confirmed in the analysis adjusted for sociodemographic variables. This loss of significance after adjustment indicates that glucose and LDL levels are influenced by sociodemographic factors. These environmental aspects interfere directly with lifestyle habits adopted and are decisive in the maintenance of health, since they influence opportunities of access to adequate environments for the practice of physical activity, health information and services, as well as the availability of food in the household and access to technologies, among others.\textsuperscript{29} These environmental factors, therefore, also directly impact in the choice of way of commuting, since it involves issues of accessibility and safety, which take into account aspects such as access to streets and sidewalks, lighting and safety on the way; public policies related to this issue should be encouraged.\textsuperscript{26} It is important to highlight some of the strengths of the present study, such as the sample, which represents the school population of the municipality. We also highlight the fact that the study was conducted and provided data from the population of a city in the countryside of the state, differing from most investigations conducted in capitals and large centers. This study is still innovative as it assesses the association between commuting to school and several cardiometabolic risk factors in the Brazilian population of children and adolescents, as no other studies analyzing the same variables have been found. Our findings contribute to the progress of knowledge in this area.

As weaknesses and limitations of the research, we highlight the fact that the way of commuting of the students was investigated through a self-referenced questionnaire, and also the fact that the analysis does not consider distance traveled or time spent in commuting. Also, as this is a cross-sectional study, it is not possible to determine a cause-and-effect association between variables, once it is not possible to determine the temporality of the events studied. Other physical and leisure activities practiced by schoolchildren have not been considered, and may also influence the parameters evaluated, since those who passively commute may have higher levels of physical activity or similar to those who actively commute to school, directly influencing their health parameters. However, a study with Portuguese schoolchildren adjusted the variable physical activity through accelerometry and observed that, although 75% of the sample commuted actively, 85% of schoolchildren were not sufficiently active. Among those who actively commuted to school, 86% took less than 15 minutes to get to school and only 13% took more than 15 minutes. Still, the results suggest that walking to school results in better WC and HDL levels, and may indicate that even short walks can play an important role in health.\textsuperscript{4}

Conclusion is that the prevalence of active commuting among schoolchildren is low; less than half of the sample go to school on foot or by bicycle. Active commuting to school showed a crude association with glucose and LDL cholesterol levels in schoolchildren, so active commuting seems to help reduce these levels. However, sociodemographic variables seem to interfere with this association, so further studies investigating these associations in the school population are needed.

Funding

Coordination for the Improvement of Higher Education Personnel (CAPES), Brazilian National Council for Scientific and Technological Development (CNPq) and Universidade de Santa Cruz do Sul (UNISC).

Conflict of interests

The authors declare no conflict of interests.

REFERENCES

1. Hatfield DP, Chomitz VR. Increasing children’s physical activity during the school day. Curr Obes Rep. 2015;4:147-56.
2. Brasil. Ministério do Planejamento, Orçamento e Gestão. Instituto Brasileiro de Geografia e Estatística (IBGE). Pesquisa nacional de saúde do escolar. Rio de Janeiro: IBGE; 2013.
3. Tudor-Locke C, Ainsworth BE, Popkin BM. Active commuting to school: an overlooked source of children’s physical activity? Sports Med. 2001;31:309-13.
4. Pizarro AN, Ribeiro JC, Marques EA, Mota J, Santos MP. Is walking to school associated with improved metabolic health? Int J Behav Nutr Phys Act. 2013;10:12.
5. Gordon-Larsen P, Boone-Heinonen JE, Sidney S, Sternfeld B, Jacobs DR, Lewis CE. Active commuting and cardiovascular disease risk: The CARDIA study. Arch Intern Med. 2009;169:1216-23.

6. Laverty AA, Mindell JS, Webb EA, Millett C. Active travel to work and cardiovascular risk factors in the United Kingdom. Am J Prev Med. 2013;45:282-8.

7. Hamer M, Chida Y. Active commuting and cardiovascular risk: a meta-analytic review. Prev Med. 2008;46:9-13.

8. Silva RJ, Lima NN, Queiroz DR, Pompliio RG, Freitas CM. Socio-demographic characteristics and active displacement in school adolescents. Rev Saude Pesq. 2014;7:383-8.

9. Rech RR, Rosa CO, Avrela PR, Halpern R, Costanzi CB, Bergmann ML, et al. Associated factors to children’s active commuting to school. Rev Bras Ativ Fis Saude. 2013;18:332-4.

10. Silva KS, Lopes AS. Excess weight, arterial pressure and physical activity in commuting to school: correlations. Arq Bras Cardiol. 2008;91:93-101.

11. Silva KS, Lopes AS, Silva FM. Walking to school and leisure time among children and adolescents from João Pessoa, PB. R Bras Ci e Mov. 2007;15:61-70.

12. Santos CM, Wanderley Júnior RS, Barros SS, Farias Júnior JC, Barros MV. Prevalence of physical inactivity and associated factors among adolescents commuting to school. Cad Saude Publica. 2010;26:1419-30.

13. Streb AR, Graup S, Bergmann ML, Bergmann GG. Overweight and commuting to school in adolescents from the city of Uruguaiana/RS, Brazil. Rev Bras Ativ Fis Saude. 2016;21:255-62.

14. Faul F, Erdfelder E, Buchner A, Lang AG. Statistical power analyses using G*Power 3.1: tests for correlation and regression analyses. Behav Res Methods. 2009;41:1149-60.

15. World Health Organization. Young people’s health – a challenge for society. Report of a WHO study group on young people and health for all. Geneva: WHO; 1986.

16. Associação Brasileira de Empresas de Pesquisa (ABEP). Critério de Classificação Econômica Brasil 2012. São Paulo: ABEP [cited 2012 Dec 02]. Available from: http://www.abep.org/criterio-brasil.

17. Barros MV, Nahas MV, editors. Medidas da atividade física: teoria e aplicação em diversos grupos populacionais. Londrina: Midiograf; 2003.

18. Centers for Disease Control And Prevention. National Center For Health Statistics (CDC/NCHS). CDC Growth Charts: United States 2000 [cited 2012 Dec 02]. Available from: https://www.cdc.gov/nchs/data/series/sr_11/sr11_246.pdf.

19. Taylor RW, Jones IE, Williams SM, Goulding A. Evaluation of waist circumference, waist-to-hip ratio, and the conicity index as screening tools for high trunk fat mass, as measured by dualenergy X-ray absorptiometry, in children aged 3–19 y. Am J Clin Nutr. 2000;72:490-5.

20. Sociedade Brasileira de Cardiologia, Sociedade Brasileira de Hipertensão, Sociedade Brasileira de Nefrologia. VI diretrizes brasileiras de hipertensão. Arq Bras Cardiol. 2010;95:1-51.

21. 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.

22. National Heart, Lung and Blood Institute (NHLBI). Expert panel on integrated guidelines for cardiovascular health and risk reduction in children and adolescents. Bethesda (USA): National Heart, Lung, and Blood Institute; 2012.

23. American Diabetes Association (ADA). Standards of medical care in diabetes – 2011. Diabetes Care. 2011;34:511-61.

24. Wilmore JH, Costill DV, Kuenen WL, editors. Fisiologia do esporte e do exercício. 2 ed. Barueri: Manole; 2001.

25. Prado ES, Dantas EH. Efeitos dos exercícios físicos aeróbio e de força nas lipoproteínas HDL, LDL e lipoproteína(a). Arq Bras Cardiol. 2002;79:429-33.

26. Benedet J, Assis MA, Calvo MC, Andrade DF. Overweight in adolescents: exploring potential risk factors. Rev Paul Pediatr. 2013;31:172-81.

27. Bergmann ML, Bergmann GG, Halpern R, Rech RR, Costanzi CB, Alli LR. Associated factors to total cholesterol: school based study in Southern Brazil. Arq Bras Cardiol. 2011;97:17-25.

28. Andersen LB, Wedderkopp N, Kristensen P, Moller NC, Froberg K, Cooper AR. Cycling to school and cardiovascular risk factors: a longitudinal study. J Phys Act Health. 2011;8:1025-33.

29. Organização Pan-Americana da Saúde. Doenças crônicas-degenerativas e obesidade: estratégia mundial sobre alimentação saudável, atividade física e saúde. Washington: OPAS; 2003.