Nutrición Hospitalaria
SENPE

Determinantes del estilo de vida asociado con el síndrome metabólico en adolescentes brasileños

Determinants of lifestyle associated with metabolic syndrome in Brazilian adolescents

10.20960/nh.02459

OR 2459

Determinants of lifestyle associated with metabolic syndrome in Brazilian adolescents

Determinantes del estilo de vida asociado con el síndrome metabólico en adolescentes brasileños

Raphael Gonçalves de Oliveira[1,2] and Dartagnan Pinto Guedes[1]

[1]Centro de Pesquisa em Ciências da Saúde. Universidade Norte do Paraná (UNOPAR). Londrina, Paraná. Brazil. [2]Centro de Ciências da Saúde. Universidade Estadual do Norte do Paraná (UENP). Jacarezinho, Paraná. Brazil

Correspondence: Raphael Gonçalves de Oliveira. Universidade Estadual do Norte do Paraná (UENP). Centro de Ciências da Saúde. Alameda Padre Magno, 841. Nova Alcântara. 86.400-000 Jacarezinho. Paraná, Brazil
e-mail: rgoliveira@uenp.edu.br

ABSTRACT

Background: metabolic syndrome (MetS) has been diagnosed in adolescents. However, it remains uncertain which determinants of lifestyle are independently associated with its occurrence.

Objective: to verify the association between lifestyle determinants (physical activity, sedentary behavior and food consumption) and MetS, by controlling demographic indicators and anthropometric nutritional status in a sample of adolescents from the southern region of Brazil.

Subjects and methods: a school-based cross-sectional study involving 1,035 adolescents (565 girls and 470 boys) aged 12 to 20 years. Anthropometric measurements were performed and a questionnaire was applied with structured questions. MetS was identified according to criteria proposed by the International Diabetes Federation. The data were treated using bivariate analysis and hierarchical multiple regression.

Results: the overall prevalence of MetS was equivalent to 4.5% (95% CI: 3.8 to 5.4). Multivariate analysis showed a significant association between MetS and age (OR = 1.34 [95% CI, 1.09 to 1.80]) and economic class (OR = 1.35 [95% CI: 1.08 to 1.86]). Among the determinants of lifestyle, high recreational screen time (OR = 1.32 [95% CI: 1.07 to 1.94]) and low fruit/vegetable intake (OR = 1.23 [95% CI: 1.01 to 1.87]) were independently associated with MetS. Likewise, obesity (OR = 1.62 [95% CI: 1.28 to 2.47]) was significantly associated with the outcome.

Conclusion: in view of the significant association with MetS, intervention strategies should be designed to reduce recreational screen time and encourage fruit/vegetable consumption, especially among older adolescents, with a high economic class and obesity status.

Key words: Metabolic diseases. Physical activity. Sedentary lifestyle. Feeding behavior. Young.

RESUMEN

Introducción: el síndrome metabólico (SMet) se ha diagnosticado en adolescentes, sin embargo, sigue siendo incierto qué determinantes del estilo de vida se pueden asociar de forma independiente con su ocurrencia.

Objetivo: verificar la asociación entre determinantes del estilo de vida (actividad física, comportamiento sedentario y consumo de alimentos) y SMet mediante el control de indicadores demográficos y el estado nutricional antropométrico en una muestra de adolescentes de la región sur de Brasil.

Sujetos y métodos: estudio transversal con 1.035 adolescentes (565 chicas y 470 chicos) de 12 a 20 años. Se midieron valores antropométricos y se aplicó un cuestionario con preguntas estructuradas. El SMet se identificó de acuerdo con los criterios propuestos por la International Diabetes Federation. Los datos fueron tratados mediante análisis bivariado y regresión múltiple jerarquizada.

Resultados: la prevalencia general de SMet fue del 4,5% [IC 95%: 3,8-5,4]. El análisis multivariado mostró una asociación significativa entre SMet y edad (OR = 1,34 [IC 95%: 1,09-1,80]) y clase económica (OR = 1,35 [IC 95%: 1,08-1,86]). Entre los determinantes del estilo de vida, el alto tiempo de pantalla en actividad recreativa (OR = 1,32 [IC 95%: 1,07-1,94]) y la baja ingesta de frutas/vegetales (OR = 1,23 [IC 95%: 1,01-1,87]) se asociaron de forma independiente con el SMet. Del mismo modo, la obesidad (OR = 1,62 [IC 95%: 1,28-2,47]) se asoció significativamente con el SMet.

Conclusión: en vista de la asociación significativa con el SMet, las estrategias de intervención deben diseñarse para reducir el tiempo de pantalla recreativo y fomentar el consumo de frutas y verduras, especialmente entre los adolescentes mayores, de clase económica más alta y obesos.

Palabras clave: Enfermedades metabólicas. Actividad física. Estilo de vida sedentario. Hábitos alimenticios. Joven.

INTRODUCTION

The diagnosis of metabolic syndrome (MetS) is understood as an important clinical resource to identify the risk of onset and development of cardiometabolic outcomes (1-3). MetS carriers are, respectively, two and five times more likely to present cardiovascular diseases and type II diabetes mellitus (1). MetS is identified when at least three of the following components are altered: abdominal fat, blood pressure, triglycerides, fasting plasma glucose, and HDL-cholesterol (1-3).

Although the cut-off points that define alterations in each component of MetS were initially proposed for use in adults, adaptations were proposed allowing the diagnosis to be made in the young population, and thus enabling intervention strategies delineated to minimize the possibility of occurrence of diabetes mellitus and cardiovascular diseases as early as possible (4-6).

In young people, the prevalence of MetS is naturally lower than in adults. Nevertheless, studies have shown proportions close to 5%, which in some cases may exceed 10%, depending on the demographic factors and diagnostic criteria adopted (7). In addition, nutritional status is capable of strongly impacting the prevalence of MetS. In a survey that gathered approximately 37 thousand Brazilian adolescents, the overall prevalence of MetS was equivalent to 2.6%; however, it reached 21.3% in obese youngsters (8).

In this perspective, investigating the factors associated with MetS in adolescents becomes relevant to knowledge in the area. Lifestyle-related determinants potentially associated with a higher risk of MetS are becoming increasingly frequent in adolescents, such as insufficient physical activity (9), a high time spent in sedentary activities (10) and inadequate dietary intake (11).

A meta-analysis study showed that adolescents with insufficient physical activity were 35% more likely to be diagnosed with MetS, while sedentary behavior, represented by recreational screen time, did not present a significant association. It should be considered that in both analyses limitations were identified, such as the practice of physical activity dichotomized in only two strata (low and high), when in order to present sufficient discriminatory capacity a minimum of three strata should be considered. In the case of sedentary behavior, only six studies were considered in the analysis, which does not allow for safe statements (12).

With regard to food consumption, the few studies that sought an association with MetS in adolescents found contradictory results (13-16). For example, the intake of sugary beverages increased the chances of presenting MetS by ten times (13), while consumption of soft drinks or fast food did not present a significant association (14). In addition, no associations were found between diet quality and MetS (15), whereas when investigating the consumption of different types of foods, an inverse association was identified only between fruit consumption and MetS (16).

Therefore, considering the importance of monitoring MetS from the earliest ages and the possibility of different factors influencing its diagnosis, the objective of the present study was to verify the association between lifestyle determinants (physical activity, sedentary behavior, and food consumption) and MetS, through control of demographic indicators and anthropometric nutritional status, in a sample of adolescents from southern Brazil.

METHODS

A cross-sectional survey was carried out in the city of Jacarezinho, Paraná, Brazil. The data collection extended from August to November 2014. The intervention protocols were approved by the Research Ethics Committee of the University of Paraná - UNOPAR (Opinion 1,302,963). All participants and their representatives signed a free and informed consent form.

Sample and selection of subjects

The reference population included adolescents of both sexes, between 12 and 20 years of age, enrolled in public and private elementary schools (6th to 9th grade) and high school (1st to 3rd year). The sample size was established assuming a 95% confidence interval, a sampling error of three percentage points, an increase of 10% to cover possible cases of losses and, as the sample planning involved conglomerates (school structure, sex, shift, and year of study), a delineation effect (deff) equivalent to 1.5 was added, initially providing a minimum sample of 1,000 participants. However, the final sample used in the data analysis was composed of 1,035 adolescents (565 girls and 470 boys).

The criteria adopted to exclude some adolescents drawn for the study were: a) refusal to participate in the study; b) non-confirmation by signing the free and informed consent form; c) any health problem that temporarily or permanently prevented participation in the study; d) the use of any type of medication that could induce changes in the study variables; e) being subjected to any type of specific diet; f) pregnancy; and g) non attendance at school on the day scheduled to begin data collection. In these cases, a new draw was carried out to recover any sample losses.

Data collection

Anthropometric measures (weight, height, and waist circumference) and other components used to identify MetS were collected, as well as a questionnaire consisting of items distributed in four sections: demographic aspects, food consumption, physical activity, and sedentary behavior. The questionnaire was applied at a single moment, individually for each adolescent in the place and time of the classes.

Regarding the demographic aspects, in addition to sex and age, information related to ethnicity, economic class, parental/guardian education, family structure, and eventual work activity were collected. The family economic class was identified according to the guidelines proposed by the National Association of Research Companies (17). Information on food consumption was obtained using food items from the Youth Risk Behavior Survey (YRBS), translated, adapted, and validated for use in the Brazilian young population (18). In this case, the adolescents answered how often they consumed fruits/vegetables and sugary/soft drink products, taking as a reference the week prior to data collection. From the frequency of consumption reported, the following indicators were considered: no consumption, consumption 1-4 days/week and consumption ≥ 5 days/week.

The Physical Activity Questionnaire for Adolescents (PAQ-A) was used to measure the practice of physical activity. This questionnaire was translated and validated for use in young Brazilians (19). The PAQ-A consists of eight questions structured and directed to different aspects of the practice of physical activity in the previous seven days. The response options are coded using an increasing scale of 1 to 5 points, and the physical activity practice score is computed through the arithmetic mean of the scores assigned to each question. Subsequently, specific cut-off points for sex and age were used based on the distribution of tertiles. Thus, adolescents with PAQ-A ≤ 1st tertile scores were classified as having low physical activity, those with scores between the 1st and 2nd tertile as moderately active, and adolescents with scores ≥ 2nd tertile as having high physical activity.

Sedentary behavior was considered through recreational exposure to high screen time, with structured questions about watching TV and using a computer, video game, tablet, and smartphone in a typical week. For the responses, a predefined questionnaire was made available, in which the adolescent indicated their option from six categories, with options between “none” to “≥ 5 hours/day”. The questions considered screen time equivalent to watching TV and using a computer, video game, tablet, and smartphone separately on weekdays and on weekends (Saturday and Sunday). Weighted means of the data on weekdays and weekends were used to identify the screen time per day reported by adolescents. Excessive screen time was defined by the combined use of TV and other screen devices for > 2 hours/day (20).

Regarding the anthropometric variables, measures of height, body weight, and waist circumference were performed according to a methodology described by the World Health Organization (WHO) (21). The body mass index (BMI) was calculated by the ratio between measurements of body mass in kilograms and height, expressed in square meters (kg/m^2). The nutritional status of adolescents was determined according to sex and age cut-off points proposed by the International Obesity Task Force (IOTF): low body weight, eutrophic, overweight, and obesity (22).

MetS was identified from the blood analysis of plasma lipids (triglycerides and HDL-C) and fasting blood glucose, resting blood pressure (systolic and diastolic), and abdominal fat accumulation (waist circumference), according to the criteria proposed by the International Diabetes Federation (IDF) (6). In this case, MetS is defined by the presence of a high waist circumference (< 16 years: both sexes ≥ percentile 90; ≥ 16 years: boys ≥ 90 cm and girls ≥ 80 cm) and at least two other compromised components: increased triglycerides (≥ 150 mg/dl), low HDL-C (< 16 years: both sexes < 40 mg/dl; ≥ 16 years: boys < 40 mg/dl and girls < 50 mg/dl), and altered blood pressure (systolic ≥ 130 mmHg or diastolic ≥ 85 mmHg).

Statistical analysis

Prevalences observed in the outcome of interest (MetS) according to demographic indicators, nutritional status and lifestyle determinants (physical activity, sedentary behavior, and food consumption) are presented together with the respective 95% confidence intervals (95% CI). To analyze the linearity of the associations between MetS and the set of independent variables, prevalence ratio calculations were used. Statistical differences among the strata under investigation were treated by the Chi-square test (χ^2). Subsequently, variables that indicated at least marginally significant associations ($p \leq 0.20$) in the bivariate analysis were selected to be included in the hierarchical multiple regression procedures. In this case, the variables were treated in blocks, and the demographic aspects (level one) were the first to be entered in the model, followed by the anthropometric nutritional indicators (level two) and, finally, the lifestyle determinants (level three). The retrograde procedure was adopted (backward), in which all the variables that presented statistical significance ($p < 0.05$) remained in the multivariate model. Data were processed in the Statistical Package for Social Science (SPSS), version 22.

RESULTS

Descriptive data characterizing the study sample are provided in table I. Girls represented 54.6% of the sample and the highest concentration of adolescents was between the ages of 12 and 15 years (56.6%). The majority of adolescents in the study were Caucasian (81.6%), living with their parents (70.2%), and reported not working (78.2%). Regarding the economic class and schooling of the parents/guardians, the proportions of adolescents were distributed proportionally in the strata considered. Furthermore, 21.6% of the adolescents demonstrated high body weight (overweight + obesity), approximately ⅓ were classified as low physically active (36.1%), and in each group of ten adolescents, seven reported staying > 2 hours in front of screen devices. Daily consumption of fruits and vegetables was reported by 24.9% of adolescents and 89.8% consumed sugary/soft drinks at least once a week. Regarding the individual components of MetS, decreased HDL-cholesterol was predominant (26.4%), while high fasting glycemia (4.4%) and high triglycerides (4.2%) were the least prevalent.

MetS prevalences with stratification for demographic indicators, anthropometric nutritional status, and lifestyle determinants are presented in table II. The overall prevalence was equivalent to 4.5% (95% CI: 3.8-5.4). The bivariate analysis showed that, from the list of variables considered, differences in MetS prevalence stratified by ethnicity, family structure and labor activity were not considered as marginally significant ($p \leq 0.20$).

Results of the hierarchical multiple regression are available in table III. In the case of demographic indicators, the final model confirmed significant associations between MetS, age and economic class, indicating greater exposure among older adolescents and those belonging to the higher economic class. Likewise, anthropometric nutritional status remained significantly associated with MetS, in which obese adolescents presented a 62% greater chance of the outcome (OR = 1.62 [95% CI: 1.28-2.47]). Among the determinants of lifestyle, recreational screen time and fruit/vegetable consumption remained associated with MetS.

DISCUSSION

The objective of the study was to provide information on the association between lifestyle determinants (physical activity, sedentary behavior and food consumption) and MetS, through the control of demographic indicators and anthropometric nutritional status, in a sample of adolescents from southern

Brazil. The main findings revealed an overall MetS prevalence of 4.5%. In addition, an independent association with MetS was found among: older adolescents, of higher economic class, who reported excessive screen time, with lower intake of fruits/vegetables, and who were obese.

Using the same diagnostic criteria (IDF), the prevalence of MetS observed in the current study was higher than that found in the young Brazilian population (4.5% *vs* 2.6%). However, when comparing the data of adolescents specifically from the interior of the southern region of Brazil, prevalences became similar (4.5% *vs* 4.1%) (8). When compared with international data, the prevalence of MetS identified in the present study is higher than that described in North American and European adolescents; however, it is lower than that found in adolescents from Asian countries (7). In this context, it is interesting to note that, in comparison to the diagnostic criteria proposed by the IDF, studies that use other criteria to diagnose MetS invariably present higher prevalences (7). This is due to the fact that the IDF diagnostic criteria have more rigorous cut-off points, in addition to considering the greater accumulation of abdominal fat as a compulsory risk component (6). However, the advantage of using the IDF diagnostic criteria is the possibility of minimizing possible false-positive cases in the diagnosis of MetS (23).

In line with previous findings (7,24-26), age and economic class were significantly associated with the presence of MetS in the adolescents of this study. A systematic review has shown that the prevalence of MetS increases in significant proportions in the young population with advancing age, presenting values ranging from 3% to 6% between the beginning and end of adolescence, respectively (7). Initially, the expected increase in blood pressure, triglycerides, fasting glycemia, and visceral fat deposits in more advanced stages of biological maturation (27) may explain the higher proportion of MetS among older adolescents.

With regard to economic class, the prevalence of MetS was positively associated with the highest stratum. Another study involving Brazilian youths identified a significant association in the same direction (24); however, data collected in other countries indicate an inverse relationship between economic class and the presence of MetS (25,26). The different criteria used to classify the economic strata and the interactions between family income and attributes of the socio-cultural context in which it is inserted can contribute to understanding these differences. For example, unlike young people living in developed countries/regions, high-income adolescents from developing countries, such as Brazil, tend to have a higher prevalence of obesity and, in turn, a higher cardiometabolic risk, in comparison with those of low economic classes (28).

The findings of the present study demonstrated a significant and independent association between obesity and MetS. Similar findings are found in the literature (14,16,29), which reinforces the hypothesis that anthropometric nutritional status is strongly associated with the risk of MetS. In this sense, studies have detected important associations between obesity and MetS from very young ages. Using a longitudinal design, among a set of biological and behavioral variables, it was observed that childhood obesity is the strongest predictor of MetS and other predisposing risk factors for cardiovascular diseases in early adulthood (30).

However, even assuming that there may be consensus regarding the impact of overweight and obesity on the increased risk for MetS, lifestyle determinants invariably present significant associations with cardiometabolic risk parameters in adolescents, regardless of excess body weight (31,32). In the present study, through the control of demographic indicators and anthropometric nutritional status, no significant association between physical activity and MetS was identified. It is possible this occurred as the variable physical activity was evaluated by self-report, which weakens the reliability of the data, since adolescents may present some difficulty in recalling levels of intensity, volume and frequency of everyday activities (33). This limitation was evidenced in a meta-analysis study which, when taking into account only the accelerometry technique for the measurement of physical activity, found three times higher chances of less physically active adolescents presenting MetS; however, in the analysis of subgroups, when considering only the use of self-report, the association disappeared (12).

Regarding sedentary behavior, the findings demonstrated that excessive recreational screen time was independently associated with MetS. Nevertheless, a fact that must be considered is the cut-off point used to define excessive screen time, typically recommended by current international guidelines and used in the present study; in particular, the cut-off point for excessive recreational screen time > 2 hours/day, proposed as the lowest risk for cardiovascular health (20), has shown a significant association with MetS in adults (34). Additionally, a study conducted in a representative sample of Brazilian adolescents also identified an independent association between recreational screen time ≤ 2 hours/day and lower cardiometabolic risk scores (32). However, it is worth highlighting a meta-analysis study, in which primary and sensitivity analyses based on this cut-off point did not reveal significant associations between recreational screen time and MetS in adolescents. In this case, the individual studies included in the meta-analysis that indicated significant associations assumed a cut-off point close to four hours/day (12).

Another finding from the present study was the independent association detected between fruit/vegetable consumption and MetS. It is important to highlight that this food habit remained significantly associated even after adjustments for potential confounding variables. The protection attributed to higher consumption of fruits/vegetables is consistent with evidence presented by other studies involving different experimental designs and statistical treatment (16,31). The food consumption pattern exerts an important influence on MetS through specific effects on the plasma lipid-lipoprotein profile, blood pressure, and body fat. Unlike diets in which fat-rich foods predominate, diets with higher fruit/vegetable consumption tend to have lower intake of simple carbohydrates and saturated fat, and a higher intake of complex carbohydrates and fibers, which are inversely related to altered glycemia and triglycerides, greater accumulation of abdominal fat, and high blood pressure, and positively with more favorable HDL-C, all known MetS components (35). On the other hand, in the case of consumption of sugary/soft drinks, in agreement with findings of some studies (14,16), but divergent from others (13), the significant association with MetS identified through bivariate analysis was not confirmed after adjustment for demographic indicators and anthropometric nutritional status.

One of the limitations of the study is that the research method employed to identify the determinants of lifestyle involved self-report, thus allowing possible memory bias. In addition, the transverse nature of the data does not allow inferences of causality in the association between MetS and the other variables. Finally, residual confounding caused by unidentified and unmeasured factors may potentiate eventual inaccuracies of the findings.

On the other hand, one of the strengths of the study is the simultaneous investigation of demographic indicators, anthropometric nutritional status and lifestyle determinants, which enabled adjustments in the final data analysis model, pointing to variables that were independently associated with MetS, and making it possible to plan and direct, personalized and more effective intervention actions. An additional strength of the study is the participation of a random and representative sample of adolescents aged 12 to 20 years who, together with the robustness of the procedures used in the data analysis, offer indications that the findings can be considered and generalized to other groups of young people with similar characteristics.

In conclusion, the present study identified that, due to the significant and independent association with MetS, intervention strategies should be designed to reduce recreational screen time and encourage daily consumption of fruits/vegetables in this population, with special attention to older adolescents, with a high economic class and excess body weight.

REFERENCES

1. Alberti KG, Eckel RH, Grundy SM, Zimmet PZ, Cleeman JI, Donato KA, et al. Harmonizing the metabolic syndrome: a joint interim statement of the International Diabetes Federation Task Force on Epidemiology and Prevention; National Heart, Lung, and Blood Institute; American Heart Association; World Heart Federation; International Atherosclerosis Society; and International Association for the Study of Obesity. Circulation 2009;120(16):1640-5.

2. Lam DW, LeRoith D. Metabolic syndrome. In: De Groot LJ, Beck-Peccoz P, Chrousos G, Dungan K, Grossman A, Hershman JM, et al. (eds.). Endotext. South Dartmouth (MA): MDText.com, Inc.; 2015. Available from: http://www.ncbi.nlm.nih.gov/books/NBK278936/

3. Kaur JA. Comprehensive review on metabolic syndrome. Cardiol Res Pract 2014;2014:943162.

4. Poyrazoglu S, Bas F, Darendeliler F. Metabolic syndrome in young people. Curr Opin Endocrinol Diabetes Obes 2014;21(1):56-63.

5. Cook S, Weitzman M, Auinger P, Nguyen M, Dietz WH. Prevalence of a metabolic syndrome phenotype in adolescents: findings from the third National Health and Nutrition Examination Survey, 1988-1994. Arch Pediatr Adolesc Med 2003;157(8):821-7.
6. Zimmet P, Alberti KG, Kaufman F, Tajima N, Silink M, Arslanian S, et al. The metabolic syndrome in children and adolescents - an IDF consensus report. Pediatr Diabetes 2007;8(5):299-306.
7. Friend A, Craig L, Turner S. The prevalence of metabolic syndrome in children: a systematic review of the literature. Metab Syndr Relat Disord 2013;11(2):71-80.
8. Kuschnir MC, Bloch KV, Szklo M, Klein CH, Barufaldi LA, Abreu GA, et al. ERICA: prevalence of metabolic syndrome in Brazilian adolescents. Rev Saude Publica 2016;50:11s.
9. De Moraes AC, Guerra PH, Menezes PR. The worldwide prevalence of insufficient physical activity in adolescents; a systematic review. Nutr Hosp 2013;28(3):575-84.
10. Tanaka C, Reilly JJ, Huang WY. Longitudinal changes in objectively measured sedentary behaviour and their relationship with adiposity in children and adolescents: systematic review and evidence appraisal. Obes Ver 2014;15(10):791-803.
11. Ochola S, Masibo PK. Dietary intake of schoolchildren and adolescents in developing countries. Ann Nutr Metab 2014;64(2):24-40.
12. Oliveira RG, Guedes DP. Physical activity, sedentary behavior, cardiorespiratory fitness and metabolic syndrome in adolescents: systematic review and meta-analysis of observational evidence. PLoS One 2016;11(12):e0168503.
13. Mohammadi SG, Mirmiran P, Bahadoran Z, Mehrabi Y, Azizi F. The association of dairy intake with metabolic syndrome and its components in adolescents: Tehran Lipid and Glucose Study. Int J Endocrinol Metab 2015;13(3):e25201.
14. Mehairi AE, Khouri AA, Naqbi MM, Muhairi SJ, Maskari FA, Nagelkerke N, et al. Metabolic syndrome among Emirati adolescents: a school-based study. PLoS One 2013;8(2):e56159.

15. Parker ED, Widome R, Nettleton JA, Pereira MA. Food security and metabolic syndrome in U.S. adults and adolescents: findings from the National Health and Nutrition Examination Survey, 1999-2006. Ann Epidemiol 2010;20(5):364-70.

16. Pan Y, Pratt CA. Metabolic syndrome and its association with diet and physical activity in US adolescents. J Am Diet Assoc 2008;108(2):276-86.

17. Associação Brasileira de Empresas de Pesquisa (ABEP). Critério de Classificação Econômica Brasil 2014. Available from: http://www.abep.org/criterio-brasil

18. Guedes DP, Lopes CC. Validation of the Brazilian version of the 2007 Youth Risk Behavior Survey. Rev Saúde Pública 2010;44(5):840-50.

19. Guedes DP, Guedes JERP. Medida da atividade física em jovens brasileiros: reprodutibilidade e validade do PAQ-C e do PAQ-A. Rev Bras Med Esporte 2015;21(6):425-32.

20. Expert Panel on Integrated Guidelines for Cardiovascular Health and Risk Reduction in Children and Adolescents; National Heart, Lung, and Blood Institute. Expert panel on integrated guidelines for cardiovascular health and risk reduction in children and adolescents: summary report. Pediatrics 2011;128(Suppl 5):S213-56.

21. World Health Organization (WHO). Physical status: the use and interpretation of anthropometry. Report of a WHO Expert Committee. Geneva: WHO Technical Report Series; 1995.

22. Cole TJ, Lobstein T. Extended international (IOTF) body mass index cut-offs for thinness, overweight and obesity. Pediatr Obes 2012;7(4):284-94.

23. Agudelo GM, Bedoya G, Estrada A, Patiño FA, Muñoz AM, Velásquez CM. Variations in the prevalence of metabolic syndrome in adolescents according to different criteria used for diagnosis: which definition should be chosen for this age group? Metab Syndr Relat Disord 2014;12(4):202-9.

24. Seki M, Matsuo T, Carrilho AJ. Prevalence of metabolic syndrome and associated risk factors in Brazilian schoolchildren. Public Health Nutr 2009;12(7):947-52.

25. MacPherson M, De Groh M, Loukine L, Prud'homme D, Dubois L. Prevalence of metabolic syndrome and its risk factors in Canadian children and

adolescents: Canadian Health Measures Survey Cycle 1 (2007-2009) and Cycle 2 (2009-2011). Health Promot Chronic Dis Prev Can 2016;36(2):32-40.

26. Puolakka E, Pahkala K, Laitinen TT, Magnussen CG, Hutri-Kähönen N, Tossavainen P, et al. Childhood socioeconomic status in predicting metabolic syndrome and glucose abnormalities in adulthood: the Cardiovascular Risk in Young Finns Study. Diabetes Care 2016;39(12):2311-7.

27. Werneck AO, Silva DR, Collings PJ, Fernandes RA, Ronque ERV, Barbosa DS, et al. Biological maturation, central adiposity, and metabolic risk in adolescents: a mediation analysis. Child Obes 2016;12(5):377-83.

28. Gupta N, Shah P, Nayyar S, Misra A. Childhood obesity and the metabolic syndrome in developing countries. Indian J Pediatr 2013;80(Suppl 1):S28-37.

29. Laurson KR, Welk GJ, Marton O, Kaj M, Csányi T. Agreement and diagnostic performance of FITNESSGRAM®, International Obesity Task Force, and Hungarian National BMI Standards. Res Q Exerc Sport 2015;86:S21-8.

30. Srinivasan SR, Myers L, Berenson GS. Predictability of childhood adiposity and insulin for developing insulin resistance syndrome (syndrome X) in young adulthood: the Bogalusa Heart Study. Diabetes 2002;51(1):204-9.

31. Santos MC, Coutinho APC, Dantas MS, Yabunaka LAM, Guedes DP, Oesterreich SA. Correlates of metabolic syndrome among young Brazilian adolescents population. Nutr J 2018;17(1):66.

32. Cureau FV, Ekelund U, Bloch KV, Schaan BD. Does body mass index modify the association between physical activity and screen time with cardiometabolic risk factors in adolescents? Findings from a country-wide survey. Int J Obes 2017;41(4):551-9.

33. Sirard JR, Pate RR. Physical activity assessment in children and adolescents. Sports Med 2001;31(6):439-54.

34. Edwardson CL, Gorely T, Davies MJ, Gray LJ, Khunti K, Wilmot EG, et al. Association of sedentary behaviour with metabolic syndrome: a meta-analysis. PLoS One 2012;7(4):e34916.

35. Calton EK, James AP, Pannu PK, Soares MJ. Certain dietary patterns are beneficial for the metabolic syndrome: reviewing the evidence. Nutr Res 2014;34(7):559-68.

Table I. Descriptive information of the sample selected for the study (n = 1,035)

	n (%)
Demographic indicators	
Sex	
Girls	565 (54.6)
Boys	470 (45.4)
Age	
12-15 years	586 (56.6)
16-20 years	449 (43.4)
Ethnicity	
Caucasian	845 (81.6)
Non-Caucasian	190 (18.4)
Economic class	
Class D-E (low)	346 (33.4)
Class C	391 (37.8)
Class A-B (high)	298 (28.8)
Parent/Guardian education	
≤ 4 years	292 (28.2)
5-8 years	274 (26.5)
9-11 years	248 (24.0)
≥ 12 years	221 (21.3)
Family structure	
Father and mother	727 (70.2)
Separated parents	205 (19.8)
Relatives	103 (10.0)
Work activity	
None	809 (78.2)
Eventually	119 (11.5)
≥ 20 hours/week	107 (10.3)
Anthropometric nutritional status	
Body mass index	
Low body weight	42 (4.1)
Eutrophic	769 (74.3)

Overweight	168 (16.2)
Obesity	56 (5.4)
Behavioral indicators	
Physical activity	
Low	374 (36.1)
Moderate	348 (33.6)
High	313 (30.3)
Recreational screen time	
≤ 2 hours/day	278 (26.9)
> 2 hours/day	757 (73.1)
Consumption of fruits/Vegetables	
No consumption	205 (19.8)
Consumption 1-4 days/week	572 (55.3)
Consumption ≥ 5 days/week	258 (24.9)
Consumption of sugary/Soft drinks	
No consumption	106 (10.2)
Consumption 1-4 days/week	424 (41.0)
Consumption ≥ 5 days/week	505 (48.8)
Components of metabolic	
syndrome	154 (14.9)
High waist circumference	43 (4.2)
Increased triglyceride	273 (26.4)
HDL-cholesterol decreased	46 (4.4)
Elevated fasting glycemia	93 (9.0)
Altered blood pressure	

Table II. Prevalence and prevalence ratio of metabolic syndrome with stratification for demographic indicators, nutritional status and determinants of the lifestyle of adolescents from Jacarezinho, Paraná, Brazil (2014)

	Prevalence (CI 95%)	Prevalence ratio (CI 95%)	p-value
Global	4.5 (3.8-5.4)		
Demographic Indicators			
Sex			0.173
Girls	3.9 (3.4-4.5)	Reference	
Boys	5.2 (4.3-6.2)	1.23 (1.02-1.58)	
Age			0.127
12-15 years	3.7 (3.2-4.3)	Reference	
16-20 years	5.3 (4.3-6.5)	1.33 (1.08-1.66)	
Ethnicity			0.335
Caucasian	4.7 (3.9-5.6)	1.04 (0.91-1.27)	
Non-Caucasian	4.4 (3.7-5.1)	Reference	
Economic class			0.119
Class D-E (low)	3.6 (3.2-4.0)	Reference	
Class C	4.7 (3.9-5.5)	1.16 (1.00-1.40)	
Class A-B (high)	5.3 (4.4-6.4)	1.35 (1.09-1.79)	
Parent/Guardian education			0.168
≤ 4 years	3.8 (3.4-4.3)	Reference	
5-8 years	4.5 (3.8-5.3)	1.11 (0.96-1.38)	
9-11 years	4.9 (4.0-5.9)	1.17 (0.99-1.46)	
≥ 12 years	5.1 (4.1-6.2)	1.22 (1.02-1.67)	
Family structure			0.312
Father and mother	4.7 (3.9-5.7)	1.07 (0.93-1.34)	
Separated parents	4.2 (3.6-5.0)	Reference	
Relatives	4.6 (3.9-5.4)	1.05 (0.92-1.38)	
Work activity			0.304
None	4.7 (3.9-5.7)	1.03 (0.89-1.32)	
Eventually	4.4 (3.7-5.2)	Reference	
≥ 20 hours/week	4.9 (3.9-6.2)	1.10 (0.97-1.37)	

Anthropometric nutritional			
status			0.001
Body mass index	3.6 (3.2-4.1)	Reference	
Low body weight	4.2 (3.6-4.9)	1.09 (0.96-1.33)	
Eutrophic	5.0 (4.0-6.2)	1.24 (1.02-1.69)	
Overweight	5.7 (4.5-7.1)	1.49 (1.19-2.02)	
Obesity			
Lifestyle determinants			
Physical activity			0.184
Low	5.1 (4.1-6.3)	1.20 (1.01-1.57)	
Moderate	4.6 (3.9-5.4)	1.13 (0.99-1.48)	
High	3.9 (3.4-4.5)	Reference	
Recreational screen time			0.139
≤ 2 hours/day	3.8 (3.3-4.4)	Reference	
> 2 hours/day	5.3 (4.2-6.6)	1.32 (1.07-1.74)	
Consumption of			0.003
fruits/vegetables	5.4 (4.3-6.7)	1.46 (1.18-1.99)	
No consumption	4.7 (3.9-5.7)	1.19 (1.01-1.61)	
Consumption 1-4 days/week	3.5 (3.0-4.1)	Reference	
Consumption ≥ 5 days/week			0.195
Consumption of sugary/Soft	4.0 (3.5-4.8)	Reference	
drinks	4.5 (3.7-5.3)	1.08 (0.95-1.43)	
No consumption	5.1 (4.0-6.2)	1.19 (1.00-1.73)	
Consumption 1-4 days/week			
Consumption ≥ 5 days/week			

Table III. Hierarchical multiple logistic regression for demographic indicators (level 1), nutritional status (level 2) and determinants of lifestyle (level 3) of metabolic syndrome in adolescents from Jacarezinho, Paraná, Brazil (2014)

Correlates	Crude OR (CI 95%)[1]	Adjusted OR (CI 95%)[b]
Level 1 - Demographic indicators		
Sex		
Girls	Reference	Reference
Boys	1.26 (1.02-2.02)	1.22 (0.99-1.87)
Age		
12-15 years	Reference	Reference
16-20 years	1.37 (1.10-1.95)	1.34 (1.09-1.80)
Economic class		
Class D-E (low)	Reference	Reference
Class C	1.19 (0.98-1.81)	1.16 (0.97-1.56)
Class A-B (high)	1.39 (1.11-2.02)	1.35 (1.08-1.86)
Parent/Guardian education		
≤ 4 years	Reference	Reference
5-8 years	1.16 (0.97-1.79)	1.11 (0.95-1.59)
9-11 years	1.19 (0.99-1.98)	1.13 (0.96-1.82)
≥ 12 years	1.24 (1.03-2.06)	1.20 (0.99-1.94)
Level 2 - Anthropometric nutritional status		
Body mass index	Reference	Reference
Low body weight	1.18 (0.99-1.77)	1.10 (0.95-1.59)
Eutrophic	1.30 (1.04-2.05)	1.21 (0.99-1.96)
Overweight	1.79 (1.41-2.68)	1.62 (1.28-2.47)
Obesity		
Level 3 - Lifestyle determinants		
Physical activity		
Low	1.24 (1.03-2.04)	1.17 (0.96-1.77)
Moderate	1.20 (1.00-1.83)	1.14 (0.95-1.69)
High	Reference	Reference
Recreational screen time		

≤ 2 hours/day	Reference	Reference
> 2 hours/day	1.37 (1.10-2.11)	1.32 (1.07-1.94)
Consumption of fruits/Vegetables		
No consumption	1.61 (1.26-2.65)	1.53 (1.25-2.31)
Consumption 1-4 days/week	1.27 (1.02-2.27)	1.23 (1.01-1.87)
Consumption ≥ 5 days/week	Reference	Reference
Consumption of sugary/Soft drinks		
No consumption	Reference	Reference
Consumption 1-4 days/week	1.19 (0.99-1.98)	1.13 (0.95-1.66)
Consumption ≥ 5 days/week	1.23 (1.03-2.17)	1.17 (0.98-1.84)

[1]Odds ratio not adjusted. [2]Odds ratio adjusted by the other variables included in the model.