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Food habits and risk of cardiovascular disease in schoolchildren from *Ouro Preto, Minas Gerais*

Hábitos alimentares e risco de doenças cardiovasculares em escolares de Ouro Preto, Minas Gerais

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A B S T R A C T

Objective

To investigate the relationship between food habits and risk factors for cardiovascular disease in schoolchildren of the city *Ouro Preto*, *Minas Gerais*.

Methods

A cross-sectional study was conducted in a population-based sample of 738 schoolchildren aged 6-14 years. A semi-structured questionnaire was used for collecting demographic, socioeconomic, biochemical, clinical, and anthropometric data. Food intake was determined by a food-frequency questionnaire. Food habits were evaluated according to the adapted Recommended Food Score. Multiple linear regression models were constructed to assess how food consumption was associated with cardiovascular risk factors.

Results

The schoolchildren presented a dietary pattern characterized by low consumption of healthy foods. Association of cardiovascular risk factors showed that the consumption of foods according to the adapted Recommended

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Food Score was negatively and significantly associated with tetrapolar percentage of body fat (*p*=0.030) and systolic blood pressure (*p*=0.049) in children aged 6-9 years.

Conclusion

Children's dietary patterns proved to be an important determinant of some of the cardiovascular risk factors studied. Thus, food intake assessment is a primary tool for the prevention and early intervention on cardiovascular risk factors during childhood.

Keywords: Adolescent. Cardiovascular diseases. Child. Food habits. Risk factors.

R E S U M O

Objetivo

Investigar a relação entre hábitos alimentares e fatores de risco para doenças cardiovasculares em escolares da cidade de Ouro Preto, Minas Gerais.

Métodos

Realizou-se estudo transversal com uma amostra representativa de 738 escolares, com idade entre 6 e 14 anos. Um questionário semiestruturado foi aplicado para coleta das variáveis demográficas, socioeconômicas, bioquímicas, clínicas e antropométricas. Os dados dietéticos foram obtidos com um questionário de frequência alimentar, a partir do qual o consumo alimentar foi avaliado segundo o Recommended Food Score *adaptado. Modelos de regressão linear múltipla foram construídos para avaliar o quanto o consumo alimentar foi associado aos fatores de risco cardiovascular.*

Resultados

Os escolares apresentaram um padrão alimentar caracterizado por um baixo consumo de alimentos saudáveis. Na associação dos fatores de risco cardiovascular, o consumo dos alimentos que compuseram aquele score *foi associado negativamente e significativamente com o percentual de gordura corporal - tetrapolar (p=0,030) e com a pressão arterial sistólica (p=0,049) nas crianças de 6 a 9 anos de idade.*

Conclusão

O padrão alimentar adotado pelas crianças mostrou-se um importante determinante para alguns dos fatores de risco cardiovascular estudados. Assim, a avaliação do consumo alimentar constitui uma ferramenta primordial para a prevenção e intervenção precoce sobre os fatores de risco cardiovascular durante a infância.

Palavras-chave: *Adolescente. Doenças cardiovasculares. Criança. Hábitos alimentares. Fatores de risco.*

I N T R O D U C T I O N

Cardiovascular Diseases (CVD) are the leading cause of morbidity and mortality in several countries, being responsible, in 2011, for about 17 million deaths[1]. This situation is also true for Brazil since specific mortality due to these diseases stands out as the leading cause of death, with a mortality from these diseases of 53.8 deaths/one thousand inhabitants[2].

In *Ouro Preto* (MG), CVD are also the leading cause of mortality and represent the second leading cause of hospitalization among adults over age 20 years[3]. This scenario is also alarming in the age groups under 20 years (children and adolescents). Cândido *et al.*[4]

observed that schoolchildren aged 6-14 years residing in that city present a high prevalence of overweight (14.9%) and dyslipidemia, particularly in relation to total cholesterol (36.9%); they also observed an increase in the clustering of risk factors, which may indicate a higher risk of CVD in this population in the future.

These findings are consistent with those of other studies, such as the classic Bogalusa Heart Study. In this study, Berenson *et al.*[5] showed that much of the etiology of CVD and their risk factors have their roots in childhood, noting that environmental factors such as diet and physical activity influence significantly the development of these diseases.

About food habits, there is convincing epidemiological evidence that a healthy diet can reduce the risk of chronic diseases, such as cardiovascular diseases and their risk factors[6], since these foods contain dietary elements that confer protection against cardiovascular risk, such as mono- and polyunsaturated fatty acids, dietary fiber, antioxidants, and minerals, such as iron, potassium, and calcium[7].

It is important to highlight that such dietary elements should not be assessed individually since food and nutrients are consumed together and their combined effects only occur when the whole diet is considered, thus providing a better understanding of the relationship between diet and risk of desease[8].

According to Aranceta et al.[9], food habits and preferences develop during childhood and adolescence, so it is very important to study these habits using methods that assess the overall diet and its influence on CVD risk in these age groups, allowing early intervention, prevention, and control of these diseases in order to maintain health throughout life. Therefore, this study aims to investigate the relationship between healthy food habits and cardiovascular risk factors in schoolchildren of the city of Ouro Preto (MG), Brazil.

METHODS

This is a cross-sectional study conducted with schoolchildren aged 6-14 years living in the city of Ouro Preto, located in the state of Minas Gerais, a metallurgic industry area in southeastern Brazil.

Children and adolescents were selected by stratified random sampling by proportion of students by age, gender, and class, in public (n=14) and private (n=2) schools of Ouro Preto. The total sample (n=850) was calculated according to the following assumptions: 8% prevalence of overweight and obesity, 3% accuracy, 20% loss, 95% power, and 5%

significance[10]. Children and adolescents with special needs were not included in the study.

Data collection and analysis

Data were collected by a trained team of researchers from March to December 2006 using a structured questionnaire that included questions about sociodemographic (gender, age, and family income in reais), clinical (blood pressure), anthropometric (weight, height, body fat, waist circumference), and biochemical (total cholesterol and fractions, triglycerides, and plasma glucose) aspects and dietetic variables.

Blood pressure was measured three times at an interval of 10 minutes using the oscillometric device Omron® 705CP (Omron Healthcare, Kyoto, Japan) following the protocol established by the V Diretrizes Brasileiras de Hipertensão Arterial[11]. When the mean arterial blood pressure exceeded the 90th percentile, the measurements were repeated with auscultation.

Weight was measured by scales Tanita® BF542 (Tanita Corporation of America, Arlington Heights, IL, USA), whereas height was determined by the WCS® stadiometer; these data were used for calculating Body Mass Index (BMI)-for-age, expressed as Z-score, using the World Health Organization (WHO) - Anthro Plus 2007 program. Waist circumference was measured with a simple inelastic tape measure at the midpoint between the iliac crest and last rib.

Percentage of body fat was determined by a Tetrapolar Bioelectric Impedance Device (Quantum II, RJL System), and the skinfold thicknesses (triceps, biceps, suprailiac, and subscapular) were measured three times by the adipometer Cescorf® with an accuracy of 0.1 mm, taking the average of the two closest values. For tetrapolar bioelectrical impedance, the equations proposed by the manufacturer of the device were used for determining the percentage of body fat through the resistance and reactance in relation

to age. In the case of the skinfold thicknesses, we used the formulas proposed by Deurenberg *et al.*[12], which estimate the percentage of body fat by measuring the triceps, biceps, suprailiac, and subscapular skinfold thicknesses according to the stages of sexual maturation.

Blood samples were collected by venipuncture in the antecubital region after a 12-hour fast. Fasting glucose and lipid profile were determined by commercial colorimetric enzyme assay kits (*In Vitro* Diagnostics®, *Itabira*, MG, Brazil) and Airone 200® analyzer (Crony Instruments, Rome, Italy).

The dietary data were collected by a Food Frequency Questionnaire (FFQ) developed and validated by Slater *et al.*[13], which was adapted, for this study, by adding the foods that are commonly consumed in this region, according to Faria[14] and adapted to the age of the study schoolchildren. The main feature of the FFQ is a list of 120 food items in which consumption frequency is categorized as never, less than once a month, 1-3 times a month, once a week, 2-4 times a week, once a day and 2 or more times a day.

Healthy eating score

Dietetic data obtained by the FFQ was evaluated by a healthy eating score. This score refers to the Recommended Food Score (RFS), whose purpose is to check the overall quality diet by using a FFQ, focusing on the consumption of vegetables, fruits, lean meats, grains and low-fat dairy products. The score was developed initially by Kant *et al.*[15] and McCullough *et al.*[16], whereas the present study used the RFS adapted by Coelho *et al.*[17].

For this adaptation, the authors selected fifty of the 120 food items of the FFQ to compose a list of recommended RFS foods, and the score was calculated by attributing one point to each recommended food consumed at least once a week, which resulted in a maximum score of 50 points[17].

Statistical analysis

Descriptive statistics expressed the continuous variables as median, minimum, and maximum, mean and standard deviation; and the categorical variables as absolute and relative frequencies.

Data normality was checked by Kolmogorov-Smirnov test. Data with normal distribution were compared by the Student's *t* test and one-factor Analysis of Variance (Anova); data without normal distribution were compared by the Mann-Whitney U-test or Kruskal-Wallis test. Multiple comparisons were made using the Tukey correction. The correlation between the healthy diet score and cardiovascular risk factors was assessed using the Spearman correlation coefficient.

In addition, to assess how food consumption was associated with cardiovascular risk factors, multiple linear regression models (enter method) were performed using variables significantly associated with the healthy diet score in univariate analysis. To adjust the models, only the variables with $p \leq 0.25$, biological plausibility, and epidemiological relevance were considered. Residual analysis verified the adequacy of the models.

The statistical analyses were performed by the software PASW Statistics GradPack 17.0[18]. The significance level for all tests was set at 5% ($p < 0.05$).

Ethical issues

This study was approved by the Research Ethics Committee of *Universidade Federal de Ouro Preto* (Report n° 2004/46). The participation of children and adolescents was entirely voluntary: the children, adolescents, parents, and/or legal guardians gave their Informed Consent before the participants joined the study.

R E S U L T S

This study consisted of a final sample of 738 schoolchildren, 52.6% (n=388) were female, with mean age of 10.44 ± 2.42.

Tables 1 and 2 present the sociodemographic, anthropometric, clinical, biochemical, and dietetic characteristics of the students stratified by age group. Children aged 6-9 years and adolescents aged 10-14 years differed significantly in waist circumference, Tetrapolar Percentage of Body Fat (BFP-T), Skinfold Thicknesses (BFP-S), Systolic Blood Pressure (SBP), Diastolic Blood Pressure (DBP), and fasting glucose. Regarding the healthy diet score, the median RFS among schoolchildren was 15.00 points, and no statistical difference was observed between children and adolescents.

Regarding the frequency of quality food intake, the most consumed vegetables were tomato (75.1%) and lettuce (73.7%). The most frequently consumed fruits were banana (74.7%), orange (61.7%), and apple (59.5%). As for meats, 43.8% of the students ate chicken most frequently. Rice (99.3%) and beans (97.2%) were the most consumed grains and legumes, respectively. For low-fat dairy foods, fruit yogurts (43.3%) and low-fat cheeses (37.7%) were consumed most frequently.

Healthy eating score and its association with cardiovascular risk

The possible relationships between the sociodemographic, anthropometric, clinical, and biochemical variables of schoolchildren and the healthy diet score were evaluated by Spearman's correlation. Family income correlated positively with the RFS (r_{Sp}=0.122 and p=0.001), and BFP-T and SBP correlated inversely with the score in question (r_{Sp}=-0.082 e p=0.029, r_{Sp}=-0.083 e p=0.026, respectively).

The healthy diet score was not significantly associated with cardiovascular risk factors when considering all students in the construction of multivariate linear models, but when stratified by age, the RFS was able to predict BFP-T and SBP only in children.

Tables 3 and 4 present the regression coefficients (β) and the 95% confidence intervals of the multiple linear regression analysis between BFP-T, SBP, and healthy diet score stratified by age group. There is an inverse correlation between the RFS and BFP-T in children, which remains after controlling for gender (β=-0.173) and family income (β=-0.128); statistical significance also remained when biochemical variables (Low Density Lipoprotrein-cholesterol [LDL-c] and

Table 1. Descriptive analysis of the sociodemographic, anthropometric, biochemical, and dietary characteristics of *Ouro Preto* (MG) schoolchildren, 2006.

Characteristics	Total (n=738)		Children (n=286)		Adolescents (n=452)		p*ª
	Median	(Min - Max)	Median	(Min - Max)	Median	(Min - Max)	
Age (years)	10	(6 - 14)	8	(6 - 9)	12	(10 - 14)	<0.001
Family income (*reais*)	700	(80 - 35,000)	700	(80 - 20,000)	700	(80 - 35,000)	0.740
BMI-for-age (Z-score)	0.01	(-3.7 - 4.3)	0.07	(-3.7 - 4.3)	-0.01	(-3.4 - 4.3)	0.082
Waist circumference (cm)	61.0	(46.5 - 109.0)	56.0	(46.5 - 93.5)	64.0	(49.0 - 109.0)	<0.001
Tetrapolar BF (%)	18.7	(3.3 - 47.2)	15.7	(3.4 - 40.9)	21.1	(3.3 - 47.2)	<0.001
BF-ST (%)	15.9	(2.9 - 39.6)	15.4	(6.8 - 34.2)	16.5	(2.9 - 39.6)	<0.014
HDL-c (mg/dL)	56.5	(22.0 - 99.1)	57.0	(22.0 - 99.0)	56.1	(30.0 - 99.1)	0.253
Triglycerides (mg/dL)	66.9	(16.9 - 673.1)	66.3	(16.9 - 513.7)	67.2	(20.0 - 673.1)	0.884
RFS (points)	15.0	(3.0 - 41.0)	16.00	(3.0 - 39.0)	15.0	(3.0 - 41.0)	0.562

Note: *p-values for the differences between children and adolescents. ªDifferences analyzed by the Mann-Whitney U-test.

BF: Body Fat; ST: Skinfold Thicknesses; RFS: Recommended Food Score; BMI: Body Mass Index; HDL-c: High Density Lipoprotein-cholesterol; Min: Minimum; Max: Maximum.

Table 2. Descriptive analysis of the clinical and biochemical characteristics of *Ouro Preto* (MG) schoolchildren, 2006.

Characteristics	Total (n=738)			Children (n=286)			Adolescents (n=452)			p*ᵃ
	M	±	SD	M	±	SD	M	±	SD	
Systolic blood pressure (mmHg)	101.18	±	13.51	96.28	±	13.63	104.22	±	12.52	<0.001
Diastolic blood pressure (mmHg)	62.71	±	9.27	59.96	±	9.34	64.42	±	8.81	<0.001
Total cholesterol (mg/dL)	158.76	±	29.78	159.55	±	27.11	158.26	±	31.37	0.569
LDL-c (mg/dL)	85.55	±	29.73	85.39	±	28.26	85.66	±	30.65	0.906
Plasma glucose (mg/dL)	82.44	±	7.97	80.40	±	7.52	83.73	±	7.98	<0.001

Note: *p-values for differences between children and adolescents. ᵃDifferences analyzed by the Student's t test.

M: Mean; SD: Standard Deviation; LDL-c: Low Density Lipoprotein-cholesterol.

Table 3. Linear regression analysis between food habits and tetrapolar percentage of body fat of *Ouro* Preto (MG) schoolchildren, 2006.

Model	Children			Adolescents		
	β	95%IC (β)	p	β	95%IC (β)	p
RFSᵃ	-0.173	[-0.314; -0,031]	0.017	-0.034	[-0.139; 0.070]	0.516
RFSᵇ	-0.128	[-0.297; -0,013]	0.033	-0.008	[-0.114; 0.096]	0.865
RFSᶜ*	-0.131	[-0.301; -0,015]	0.030	-0.013	[-0.121; 0.090]	0.774

Note: ᵃModel adjusted for gender. ᵇModel adjusted for gender and family income. ᶜFinal model: adjusted for variables listed in "b" and biochemical variables (Low Density Lipoprotein-cholesterol and fasting plasma glucose). *r^2 tetrapolar percentage of body fat - children = 0.060.
RFS: Recommended Food Score; 95%IC: 95% Confidence Interval.

Table 4. Linear regression analysis between the food habits and systolic blood pressure of *Ouro Preto* (MG) schoolchildren, 2006.

Model	Children			Adolescents		
	β	95%IC (β)	p	β	95%IC (β)	p
RFSᵃ	-0.337	[-0.578; -0.095]	0,006	-0.019	[-0.196; 0.157]	0.829
RFSᵇ	-0.158	[-0.572; -0.085]	0,008	-0.020	[-0.222; 0.144]	0.677
RFSᶜ	-0.149	[-0.553; -0.064]	0,014	-0.015	[-0.213; 0.155]	0.756
RFSᵈ*	-0.112	[-0.462; -0.001]	0,049	0.001	[-0.176; 0.181]	0.980

Note: ᵃModel adjusted for gender. ᵇModel adjusted for gender and family income. ᶜModel adjusted for gender, family income, and biochemical variables (Low Density Lipoprotein-cholesterol and fasting plasma glucose). ᵈFinal model: adjusted for variables listed in "c" and tetrapolar percentage of body fat. *r^2 systolic blood pressure - children = 0.213.
RFS: Recommended Food Score; 95%IC: 95% Confidence Interval.

fasting plasma glucose) (β=-0.131) were included in the model (Table 3).

The Recommended Food Score also correlated inversely with the SBP in children after controlling for gender (β=-0.337), family income (β=-0.337), biochemical variables (LDL-c and fasting plasma glucose) (β=-0.149) and BFP-T (β=-0.112) (Table 4). However, the same was not observed for the adolescents. Finally, the multiple linear regression models for the BFP-T and SBP presented in Tables 3 and 4 were appropriate according to residual analysis.

DISCUSSION

The present study revealed significant inverse correlations between BFP-T, SBP, and food intake of the study children. No association was

found between the other variables of interest (BMI-for-age, waist circumference, BFP-S, DBP, lipid profile, and fasting glucose) and the healthy diet score both for children for adolescents.

The healthy diet score adapted for this study reflects the quality of the diet, scoring foods that are considered healthy, so the higher the score, the healthier the diet. Among the study schoolchildren, children and adolescents obtained low RFS scores (16.00 and 15.00, respectively), which may reflect low diet quality.

It is also important to note that despite the low score, the consumption of Brazilian (pattern) staples, like rice and beans, is still very popular among the study children (99.3% and 97.2%, respectively). This aspect is very positive because the last two Family Budget Surveys conducted in Brazil showed that the amount of foods purchased for home consumption decreased significantly between 2002-2003 and 2008-2009 (the average amount of purchased rice decreased by 40.5% and beans by 26.4%)[19]. Moreover, according to recommendations made by the Brazilian Ministry of Health, eating rice and beans every day is a healthy food habit and should be maintained by Brazilians of all ages[20].

Currently, several studies aimed to analyze the diet quality of children and adolescents. Even though they used different dietary intake assessment methods, they all found dietary patterns characterized by low consumption of healthy foods[9, 21,22].

Among those studies, some should be highlighted, such as *Estudo do Coração de Belo Horizonte*, conducted with students aged 6 to 18 years living in the Brazilian city *Belo Horizonte*: 99.8% of the students presented inadequate intake of fruits, vegetables, and fiber[21]. Another relevant research is "The enKid Study", a population-based study that assessed the dietary patterns of Spanish children and adolescents and found low mean consumption of fruits and vegetables. In addition, the consumption of dairy

products, fruits, and vegetables among children aged 6-9 years (29.2%, 62.7%, and 46.9%, respectively) and adolescents aged 10-13 years (30.2%, 63.3% and 43.2%, respectively)[9] was highly inadequate.

Thus, given the low diet quality of children and adolescents who have participated in these studies, it is very important to study food quality as a risk factor for CVD since the maintenance of a healthy diet is essential for the conservation of a good state of health, reducing the risk of future events such diseases[23].

The healthy diet score was associated with the cardiovascular risk factors BFP-T and SBP in children, as indicated by multivariate linear models stratified by age group.

Such models, constructed by child's age and adjusted for the variables of interest, demonstrate that BFP-T and SBP are inversely correlated with the healthy diet score. The SBP model had an explanatory power of 21.3% (r^2=0.213) in the variability of blood pressure of schoolchildren, while the pattern of BFP-T explanatory power was 6.0% (r^2=0.060).

This association verified only in children may be due to the different dietary influences that children and adolescents are exposed to. Regarding children, parents and families have an important role in promoting a healthy diet because they determine what foods are offered, focusing on healthy foods with higher nutritional value such as rice and beans, vegetables, fruits, dairy products, and lean meats[20]. As for adolescents, the family has less control over their food, since they are more independent and belong to a group in which eating behavior is one of the items that identifies them socially[20].

Oliveira *et al*.[24] studied the influence of biological and environmental factors on the development of overweight and obesity among children aged 5-9 years and found results consistent with this work, such as an inverse association between high vegetable intake (three times a week) and overweight/obesity.

However, Ribeiro *et al.*[21] found conflicting results. They observed no association between inadequate consumption of fruits, vegetables, and fiber, and the levels of systolic and diastolic blood pressure in children and adolescents.

According to Monego & Jardim[25] and the Brazilian Ministry of Health[20], obesity and hypertension are considered the most common risk factors for CVD and constitute serious public health problems in Brazil since excess weight has been the most frequently reported determinant of cardiovascular risk in Brazilian children, and high blood pressure in this age group has already been observed in some studies[23].

The results of this study demonstrate the importance of including the diet when investigating the presence of cardiovascular risk factors because the high prevalence of CVD in the Brazilian population has been linked in recent years to changes in food habits, including lower intake of complex carbohydrates, vegetables, fruits, and fibres[26].

In addition, only a few studies evaluated the influence of child and adolescent food habits on cardiovascular risk and its determinants. According to Molina *et al.*[23], although studies report a consolidated relationship between diet and chronic diseases, the effect of diet on the development of cardiovascular risk factors during childhood is not so clear, and only a few dietary factors are known to increase blood pressure and obesity prevalence in children.

Regarding the study limitations, not to perform quantitative analysis of the diet of schoolchildren could be considered a limiting factor, however, authors such as Fung *et al.*[8] reported that the evaluation of food habits as a whole provide a better understanding of the relationship between diet and diseases, more than the consumption of individual food items since food and nutrients are not consumed in isolation.

Furthermore, according to Kant *et al.*[15], problems concerning the standardization of food portions and under/overestimation of food intake are often reported in dietary surveys, which means that the RFS was designed to score the foods recommended and consumed weekly, regardless of portion sizes, shielding it from inaccurate portioning claims.

One has to consider also the time between data collection and publication of the article as a possible limitation of the study. However, drastic changes in the population morbidity and mortality profile and behavior of Brazilian youth have not occurred since CVD are still the leading cause of death in Brazil[2] and recent studies continue to report the low quality diet of children and adolescents[27,28], thus ensuring the quality of the conclusions of this research.

Therefore, the selection of a population sample, the detailed collection of food consumption by a validated instrument, as well as a different approach for the evaluation of food habits are unique features of this study. Another important aspect is that this study allowed determining the diet quality of schoolchildren living in *Ouro Preto* (MG) and its influence on the development of cardiovascular risk, which will enable the subsidy, guidance, and improvement of nutritional guidelines for children and youth.

CONCLUSION

The study schoolchildren showed a dietary pattern characterized by low consumption of healthy foods. RFS was inversely related to BFP-T and SBP in children. Therefore, assessment of quality diet and determination of the dietary pattern of children are important tools to support the development of specific nutritional guidelines for children and adolescents, and to promote better health and quality of life, since early intervention is the best way to reduce the prevalence of chronic diseases, including cardiovascular disease in adulthood.

study, the *Fundação de Amparo a Pesquisa* of the state of *Minas Gerais* for providing the scholarship for master's degree, and *Universidade Federal de Ouro Preto* for the logistic support and transportation.

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