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Dietary patterns of Brazilian adolescents according to geographic region: an analysis of the *Study of Cardiovascular Risk in Adolescents* (ERICA)

Padrões alimentares de adolescentes brasileiros por regiões geográficas: análise do *Estudo de Riscos Cardiovasculares em Adolescentes* (ERICA)

Patrones alimentarios de adolescentes brasileños por regiones geográficas: análisis del *Estudio de Riesgos Cardiovasculares en Adolescentes* (ERICA)

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Abstract

The study aimed to identify the dietary patterns of Brazilian adolescents in each of Brazil's five major geographic regions and verify possible differences in adherence to dietary patterns according to age, sex, and type of school. Data were analyzed from 71,298 adolescents 12 to 17 years of age that participated in the Study of Cardiovascular Risk in Adolescents *(ERICA), a cross-sectional nationwide, multicenter, school-based survey. Food consumption data were obtained using a 24-hour food recall, and identification of dietary patterns used factor analysis. Associations between the adolescents' sociodemographic characteristics and dietary patterns were verified by linear regression analyses, stratified by age and adjusted for nutritional status, total energy intake, and physical activity. In the five geographic regions, three dietary patterns with similar characteristics were identified: traditional pattern, bread-and-coffee pattern, and unhealthy pattern. The North of Brazil showed a fourth dietary pattern characterized by typical regional foods, called the traditional-North pattern. In all five regions, male adolescents showed the highest adherence to the traditional pattern and the lowest adherence to the unhealthy pattern. Private school students showed higher adherence to the unhealthy pattern and lower adherence to the traditional pattern. The results suggest that in this sample of adolescents, males were associated with traditional Brazilian foods such as rice and beans, while higher socioeconomic status was associated with the consumption of unhealthy foods like sugary beverages and snacks.*

Feeding Behavior; Adolescent; Adolescent Nutrition; Estudios Transversales

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Introduction

Adolescence is a period of intense change. Habits and knowledge acquired by teens have an important influence on many aspects of adulthood, affecting diet, health, preferences, and psychosocial development, among others [1]. Adolescents' diet has been characterized by high consumption of ultra-processed foods (high in fats, sugars, and sodium) [2] and insufficient consumption of natural foods such as fruits and vegetables [3,4].

Inadequate diet in childhood and adolescence is an important risk factor for obesity and other chronic noncommunicable diseases (NCDs) such as cardiovascular diseases, diabetes, and cancer [5,6]. The identification of adolescents' dietary habits is thus highly relevant for public health, in order to promote healthy eating in this group and thus reduce the risk of obesity and other NCDs.

However, research has shown that obesity and NCDs do not result from the consumption of single food groups, but from inadequate dietary patterns. Thus, the association between diet and health in adolescents should not consider only the presence or absence of certain nutrients, but of the foods consumed as a whole [7]. In this context, robust analytical approaches have been used to identify dietary patterns [8,9], allowing a broader representation of how foods are consumed and assessing the relationship between these dietary patterns and sociodemographic and behavioral characteristics and risk factors for NCDs.

Another important question when analyzing a country of continental dimensions like Brazil is the differences in dietary habits according to geographic region. Studies that assessed the consumption of food markers have already identified such differences, for example in the consumption of beans, sodas, and vegetables [4,10].

In the last five years, it has been witnessed a trend in the use of methodologies for assessing food consumption in Brazilian children and adolescents based on the identification of dietary patterns [11,12,13,14,15,16,17,18,19,20,1,21,22]. However, such studies involve localized samples, denoting a gap in studies with nationally representative probabilistic samples of Brazilian adolescents according to geographic region.

Considering the importance of assessing dietary patterns that reflect the adolescents' overall diet, besides considering regional differences in Brazilians' eating habits, the current study aimed to identify the dietary patterns of Brazilian adolescents according to geographic region and to verify differences by age, sex, and type of school.

Methods

Study design, sample, and data collection

Data were obtained from the *Study of Cardiovascular Risk in Adolescents* (ERICA), conducted in 2013-2014. ERICA was a nationwide, multicenter, school-based survey aimed at estimating the prevalence of cardiovascular risk factors and metabolic syndrome in adolescents 12 to 17 years of age, enrolled in public and private schools. The study population was allocated across 32 geographic strata consisting of the 27 Brazilian state capitals and five sets of municipalities with more than 100 thousand inhabitants in each of the country's five major geographic regions. Schools were selected in each stratum with probabilities proportional to the number of students enrolled in the seventh, eighth, and ninth grades of primary school and the first, second, and third grades of middle school, and inversely proportional to the distance between the school's municipality and the state capital. In these schools, three combinations of grade and shift (morning and afternoon) were selected. In each combination, a class was selected, and all of its students were invited to participate in the study. In all, 1,251 schools were selected in 124 municipalities, out of a total of 273 municipalities with more than 100,000 inhabitants. The sample was probabilistic and representative of the country, the five regions, and the state capitals [23,24,25].

Participation in the data collection included all the eligible adolescents that signed the consent form. The study excluded pregnant adolescents and individuals with physical or mental disabilities. Details on the study protocol, design, and sampling have been published elsewhere [23,24,25].

Sociodemographic data were collected with the adolescent's questionnaire. This instrument was self-administered with an electronic data collector, a PDA (personal digital assistant) model LG GM750Q (LG Electronics, Seoul, Korea). The questionnaire was used to obtain information on age, sex, type of school administration (public or private), and others. Adolescents reported on frequency and duration of certain physical activities in the previous seven days. The variables sex, type of school (public or private), geographic region (North, Northeast, Central, Southeast, and South), and age (12-14 and 15-17 years) were analyzed categorically, and physical activity (minutes/week) was analyzed as a continuous variable.

Anthropometric measurements were recorded with the adolescents wearing light clothing, barefoot, and in orthostatic position. Weight was measured with a digital scale (model P150m Líder, São Paulo, Brazil) with a capacity of 200kg and accurate to 50g. Height was measured with a calibrated stadiometer (Alturexata, Minas Gerais, Brazil), with a maximum height of 213 cm and calibrated in millimeters. The anthropometric measurements were used to calculate body mass index (BMI = weight/height^2), and classified by the cutoff points for sex and age published by the World Health Organization (WHO) [26]. BMI was categorized as: underweight (including very low weight and low weight), normal weight, and excess weight (including overweight and obesity).

A 24-hour food recall (24hR) was applied to each adolescent using an individual face-to-face interview, performed by previously trained field interviewers. The multiple-pass method [27] was applied during the interviews, which organizes the 24hR in five steps to reduce underreporting of food consumption. The 24hR was completed directly on netbooks with a specific software for entering food consumption data, the ERICA-REC24h [28]. This software contained a list of foods developed from a database on food and beverage purchases from the *Brazilian Household Budgets Survey* (POF) 2008-2009, conducted by the Brazilian Institute of Geography and Statistics [28,29]. The interviewers used photographs in the software to help estimate the size of portions. Foods reported by adolescents that were not in the ERICA-REC24h database were keyed in by the interviewers.

Application of the 24hR produced a databank with 1,128 foods. Due to the large volume of food consumption data, we opted to group these foods according to the similarity of macronutrients, creating food groups with similar nutritional composition. This procedure is often used in the specific literature [30,31] and was based on a grouping performed in a previous publication [4] which also used the food consumption data from ERICA. The reported foods were categorized in 19 groups (Box 1), and final consumption was estimated in grams for each of the food groups. Energy intake was estimated by the *Table of Nutritional Composition of Foods Consumed in Brazil* [32].

From the total of 102,327 eligible adolescents, 71,740 (70.1%) presented complete information from the adolescent's questionnaire, anthropometry, and 24hR. The current study excluded adolescents with total daily energy intake less than 400Kcal or greater than 8,000Kcal [33] (388 individuals), leaving a final sample of 71,298 adolescents (69.7% of those eligible). The sociodemographic characteristics of participating and non-participating adolescents were described in a previous publication; briefly, the percentage of male adolescents and older adolescents was slightly higher in nonparticipants. Among nonparticipants with incomplete data, but with anthropometric measurements (8.5% of the nonparticipants), mean BMI was slightly higher than that of participants. The point estimates obtained with the analytical strategy used for a complex sample showed that the study participants are also representative of the nonparticipants [34].

Statistical analyses

Dietary patterns were identified by factor analysis, using estimation by principal components analysis [35], and the factors obtained were rotated by varimax orthogonal rotation. To test the applicability of factor analysis to food consumption data, the Bartlett and Kaiser-Meyer-Olkin (KMO) sphericity tests were applied [36]. The criteria used for retention of factors were eigenvalues > 1, and the best interpretability of factors was used for the final decision. Food groups with a factor load greater than or equal to +0.3 and less than or equal to -0.3 were considered important components of the dietary pattern. Analyses of dietary patterns were performed separately for each of Brazil's major geographic regions

Box 1

Food groups reported by adolescents 12 to 17 years of age, according to similarity of macronutrients. *Study of Cardiovascular Risk in Adolescents* (ERICA), Brazil, 2013-2014.

Food groups	Description
Rice	Rice, rice with vegetables, sushi, and other rice dishes
Beans	Beans, bean dishes, and other legumes
Sugary beverages	Sodas, juices, refreshments, and sweetened milk drinks
Corn	Corn, corn flour, polenta, and other corn dishes
Roots/tubercles	Potatoes (except potato chips), cassava, and root/tubercle flour
Fruits/vegetables	Fruits, leafy vegetables, vegetables, and oilseeds
Pasta	Pasta, lasagna, pancakes, and pasta dishes
Bread	White and whole wheat bread, toast, and sandwiches
Cakes/cookies	Cakes and pies, sweet and cream-filled cookies
Chicken	Chicken and chicken dishes
Meat	Beef, pork, and meat dishes
Fish/seafood	Fish, seafood, and fish and seafood dishes
Processed meat	Ham, salami, sausage, and other processed beef, pork, poultry, and fish
Eggs	Eggs and egg dishes
Milk and cheese	Whole and skim milk, yogurt, cheese, and cheese dishes
Coffee	Coffee, *café au lait*, cappuccino, and tea
Sweets/dessert	Fruit sweets and desserts, chocolates, sweet rolls, and other candies, sugar, honey, molasses, breakfast cereal, cereal bars, oatmeal, others
Oils and fats	Vegetable oils, olive oil, butter, lard, margarine, cream, sauces, and flavorings
Snacks	Pizzas, fast food, hamburgers, salted and toasted snacks, packaged snacks (chips), cheese rolls, French fries, crackers

(North, Northeast, Central, Southeast, and South). Finally, a factor score was calculated for each adolescent in each of the dietary patterns using the predict command.

Analysis of the association between the adolescents' characteristics (independent characteristics) and the factor scores of each region's dietary patterns (dependent variables) used linear regression analysis stratified by age group (12-14 and 15-17 years), representing primary school and middle school students, respectively. The models were adjusted a priori for nutritional status (underweight, normal weight, and excess weight), physical activity (minutes/week), and total energy intake (Kcal). Adjustment of the analyses of association by the nutritional status and physical activity variables was performed as a function of their direct influence on individual food consumption levels and by the fact that they were also associated with the target exposures, sex and socioeconomic status (type of school administration). Adjustment by total energy intake is also recommended in epidemiological studies to control for "confounding", as discussed in Willet et al. [37]. The descriptive, factor, and linear regression analyses used Stata version 13.1 (https://www.stata.com) and considered the complex sampling design.

Ethical aspects

The study complied with the ethical principles laid out in the *Declaration of Helsinki* and was approved by the Institutional Review Board of the Institute of Public Health Studies of the Federal University of Rio de Janeiro (IESC/UFRJ), case review n. 01/2009, protocol no. 45/2008. The study was also approved by research ethics committees in each state of Brazil.

Results

Table 1 shows the participants' characteristics. The majority of the adolescents were 15-17 years of age (54.1%), studied in public schools (78.5%), and had normal weight (72.5%). Excess weight was found in 24.5% of the sample. The median values for physical activity and energy consumption were 300 minutes/week and 2,134Kcal, respectively.

A total of 16 dietary patterns were identified, four of which in the North and three in each one of the other four regions of the country. The first pattern in the North consisted of the food groups meat, rice, and beans. The second consisted of bread, coffee, oils, and fats. The third consisted of sugary beverages, snacks, pasta, sweets and desserts, and cake and cookies. The fourth dietary pattern in the North of Brazil consisted of roots/tubercles, fruits and vegetables, chicken, fish, seafood, and eggs. The dietary patterns in the North explained 29.5% of the variability in food consumption data and were named as follows: "traditional", "bread-and-coffee", "unhealthy", and "traditional-North", respectively (Table 2).

The first pattern in the Northeast consisted of bread, coffee, oil and fat, processed meat, and corn. The second consisted of sugary beverages, snacks, pasta, cake and cookies, and sweets and desserts. The third dietary pattern consisted of rice, beans, meat, and roots/tubercles. The dietary patterns in the Northeast explained 23% of the variability in the food consumption data and were named as: "bread-and-coffee", "unhealthy", and "traditional", respectively (Table 2).

The first pattern in the Southeast consisted of rice, beans, and meat and showed a negative factor load for pasta. The second consisted of bread, oil and fat, coffee, and pasta. The third dietary pattern consisted of sugary beverages, snacks, sweets and desserts, milk and cheese, and cake and cookies. The dietary patterns in the Southeast explained 24.3% of the variability in the food consumption data and were named as: "traditional", "bread-and-coffee", and "unhealthy", respectively (Table 2).

Table 1

Characteristics of the sample. *Study of Cardiovascular Risk in Adolescents* (ERICA), Brazil, 2013-2014.

Variable	12-14 years		15-17 years	
	n	%	n	%
Sex				
Female	17,994	55.0	21,525	55.8
Male	14,733	45.0	17,046	44.2
Type of school				
Public	25,115	76.7	30,833	79.9
Private	7,612	23.3	7,738	20.1
Geographic region				
North	6,604	20.2	7,796	20.2
Northeast	10,088	30.8	12,064	31.3
Southeast	7,604	23.2	8,796	22.8
South	4,086	12.5	4,973	12.9
Central	4,345	13.3	4,942	12.8
Nutritional status				
Underweight	950	2.9	1,157	3.0
Normal weight	22,630	69.2	29,088	75.4
Excess weight	9,147	27.9	8,326	21.6
	n	**Median (IQR)**	**n**	**Median (IQR)**
Physical activity (minutes/week)	30,103	300 (75-720)	35,953	300 (60-710)
Energy intake	32,727	2,047.3 (1,506.3-2,744.3)	38,571	2,177.7 (1,591.6-2,926.3)

IQR: interquartile ratio.

Table 2

Composition and percent explanation of dietary pattern variability in each region of the country. *Study of Cardiovascular Risk in Adolescents* (ERICA), Brazil, 2013-2014.

Region	Dietary patterns				% variability
North	Traditional: Meat Rice Beans	Bread-and-Coffee: Bread Cofee Oil/Fat	Unhealthy: Sugary beverages Snacks Pasta Sweets/Deserts Cake/Cookies	Traditional North: Roots/Tubercles Fruits and vegetables Chicken Fish/Seafood Eggs	29.5
Northeast	Bread-and-Coffee: Bread Coffee Oil/fat Processed meat Corn	Unhealthy: Sugary beverages Snacks Pasta Cake/cookies Sweets/desserts	Traditional: Rice Beans Meat Roots/tubercles	-	23.0
Southeast	Traditional: Rice Beans Meat Pasta *	Bread-and-Coffee: Bread Oil/fat Coffee Pasta	Unhealthy: Sugary beverages Snacks Sweets/desserts Milk and cheese Cake/cookies	-	24.3
South	Traditional: Rice Beans Meat	Bread-and-coffee: Bread Oil/fat Processed meat Milk and cheese Coffee	Unhealthy: Sugary beverages Snacks Cake/cookies Sweets/desserts	-	24.6
Central	Traditional: Rice Beans Meat	Bread-and-Coffee: Bread Oil/fat Milk and cheese Processed meat Chicken Eggs Ovos	Unhealthy: Sugary beverages Snacks Sweets/desserts Cake/cookies	-	23.2

* The pasta food group had a negative factor load in the first dietary pattern in the Southeast.

The first pattern in the South consisted of rice, beans, and meat. The second consisted of bread, oil and fat, processed meat, milk, cheese, and coffee. The third dietary pattern consisted of sugary beverages, snacks, cake and cookies, and sweets and desserts. The dietary patterns in the South explained 24.6% of the variability in food consumption data and were named as: "traditional", "bread-and-coffee", and "unhealthy", respectively (Table 2).

The first pattern in the Central consisted of rice, beans, and meat. The second consisted of bread, oil and fat, milk and cheese, processed meat, chicken, and eggs. The third dietary pattern consisted of sugary beverages, snacks, sweets and desserts, and cake and cookies. The dietary patterns in the Central explained 23.2% of the variability in the food consumption data and were named as: "traditional, "bread-and-coffee", and "unhealthy", respectively (Table 2).

No major differences were observed in dietary patterns by geographic region, and in most of the regions the patterns were traditional, bread-and-coffee, and unhealthy, with the exception of the

Northeast, where the order was different, namely, the first pattern was bread-and-coffee and the last was traditional. A fourth pattern was identified in the North, consisting of traditional regional foods.

Tables 3 and 4 presents the results of the associations between the factor scores for dietary patterns and the variables sex and type of school, according to the age groups 12-14 and 15-17 years, respectively. In the North, independently of age group, male adolescents showed greater adherence to the traditional and bread-and-coffee pattern and less adherence to the unhealthy pattern. No significant associations were found between sex and type of school and the traditional-North pattern (Tables 3 and 4).

In the Northeast, the results were similar for the two age groups. Boys showed greater adherence to the bread-and-coffee and traditional patterns and lower adherence to the unhealthy pattern. Private school students showed less adherence to the bread-and-coffee and traditional patterns greater adherence to the unhealthy pattern (Tables 3 and 4).

In the Southeast, adolescents from both age groups and boys showed greater adherence to the traditional and bread-and-coffee patterns and less adherence to the unhealthy pattern. Meanwhile, private school students, also in both age groups, showed lower adherence to the traditional and bread-and-coffee patterns and greater adherence to the unhealthy pattern. In the South, boys showed greater adherence to the traditional and bread-and-coffee patterns, independently of age group. In relation to the unhealthy pattern, lower adherence was seen in the younger adolescent boys (12-14 years) and greater adherence in private school students, independently of age (Tables 3 and 4).

Table 3

Association between dietary patterns and sociodemographic characteristics of adolescents 12-14 years of age, by geographic region. *Study of Cardiovascular Risk in Adolescents* (ERICA), Brazil, 2013-2014.

Dietary pattern	Sex		Type of school	
	β	(95%CI)	β	(95%CI)
North				
Traditional	0.17	0.09; 0.26	-0.16	-0.42; 0.09
Bread-and-coffee	0.21	0.12; 0.31	-0.23	-0.40; -0.06
Unhealthy	-0.10	-0.17; -0.03	0.38	0.25; 0.52
Traditional-North	-0.05	-0.11; 0.01	0.02	-0.16; 0.19
Northeast				
Bread-and-coffee	0.18	0.09; 0.27	-0.48	-0.58; -0.37
Unhealthy	-0.05	-0.14; 0.04	0.37	0.29; 0.45
Traditional	0.13	0.04; 0.21	-0.26	-0.36; -0.15
Southeast				
Traditional	0.28	0.19; 0.36	-0.36	-0.57; -0.15
Bread-and-coffee	0.17	0.09; 0.26	-0.26	-0.39; -0.14
Unhealthy	-0.10	-0.16; -0.04	0.33	0.25; 0.41
South				
Traditional	0.28	0.20; 0.36	-0.13	-0.30; 0.05
Bread-and-coffee	0.17	0.10; 0.24	-0.01	-0.12; 0.10
Unhealthy	-0.24	-0.33; -0.15	0.18	0.03; 0.33
Central				
Traditional	0.27	0.17; 0.36	-0.41	-0.51; -0.31
Bread-and-coffee	0.08	-0.02; 0.17	0.10	-0.03; 0.23
Unhealthy	-0.14	-0.23; -0.04	0.16	0.05; 0.27

Note: all models were adjusted by nutritional status, physical activity, and total energy intake. Reference sex: female. Reference type of school: public.

Table 4

Association between dietary patterns and sociodemographic characteristics of adolescents 15-17 years of age, by geographic region. *Study of Cardiovascular Risk in Adolescents* (ERICA), Brazil, 2013-2014.

Dietary pattern	Sex		Type of school	
	β	(95%CI)	β	(95%CI)
North				
Traditional	0.26	0.18; 0.34	-0.26	-0.35; -0.16
Bread-and-coffee	0.41	0.32; 0.49	-0.41	-0.51; -0.31
Unhealthy	-0.21	-0.28; -0.14	0.27	0.17; 0.38
Traditional-North	0.02	-0.06; 0.09	0.09	-0.06; 0.23
Northeast				
Bread-and-coffee	0.34	0.23; 0.45	-0.45	-0.58; -0.31
Unhealthy	-0.14	-0.26; -0.03	0.24	0.16; 0.33
Traditional	0.29	0.18; 0.39	-0.26	-0.34; -0.17
Southeast				
Traditional	0.32	0.19; 0.45	-0.32	-0.46; -0.18
Bread-and-coffee	0.23	0.14; 0.32	-0.15	-0.28; -0.02
Unhealthy	-0.13	-0.21; -0.05	0.23	0.13; 0.34
South				
Traditional	0.40	0.28; 0.52	-0.42	-0.55; -0.30
Bread-and-coffee	0.10	0.02; 0.18	0.01	-0.19; 0.21
Unhealthy	-0.05	-0.16; 0.06	0.09	-0.04; 0.21
Central				
Traditional	0.40	0.25; 0.55	-0.45	-0.59; -0.32
Bread-and-coffee	0.09	-0.01; 0.18	0.23	0.05; 0.41
Unhealthy	-0.01	-0.07; 0.06	0.17	0.08; 0.25

95%CI: 95% confidence interval.

Note: all models were adjusted by nutritional status, physical activity, and total energy intake. Reference sex: female. Reference type of school: public.

In the Central, boys in both age groups showed greater adherence to the traditional pattern, and younger boys showed lower adherence to the unhealthy pattern. Private school students showed lower adherence to the traditional pattern and greater adherence to the unhealthy pattern. Private school students showed greater adherence to the bread-and-coffee pattern, but only among adolescents 15 to 17 years of age (Tables 3 and 4).

In general, the results showed that in all five regions of Brazil, when compared to their female peers, male adolescents were more likely to adhere to the dietary pattern characterized by the consumption mainly of rice, beans, and meat, while adhering less to the pattern characterized by the consumption of sugary beverages, snacks, cake and cookies, and sweets and desserts. Meanwhile, private school students adhered more to the pattern characterized by the consumption of unhealthy foods and less to the pattern characterized by rice, beans, and meat (Tables 3 and 4).

Discussion

The current study identified adolescents' dietary patterns in each of Brazil's five major geographic regions and found some differences in the number and order of patterns and in the foods comprising the patterns. In most of the regions, the patterns' order was: traditional, bread-and-coffee, and unhealthy, with the exception of Northeast Brazil, where the order changed, namely, the first pattern was bread-and-coffee and the last was traditional. A fourth pattern was identified in the North of Bra-

zil, characterized by traditional regional foods, and called the traditional-North pattern. The results also showed that male adolescents adhered more to the traditional pattern and less to the unhealthy pattern, when compared to female adolescents. Private school students showed the opposite, with greater adherence to the unhealthy pattern and lower adherence to the traditional pattern.

Generally speaking, in relation to the patterns identified in this study, the traditional pattern was characteristic of a healthier diet, the bread-and-coffee pattern as intermediate, and the unhealthy pattern characterized by inadequate food choices. Thus, considering the patterns' order, the Northeast showed the least healthy food consumption, since the traditional pattern was first in the other four regions but last in the Northeast. Importantly, however, with the exception of the North, no pattern was identified that was characterized by the consumption of fruits and vegetables.

A study with data from the *National School Health Survey* (PeNSE) of 2009, with 9th grade students from Brazil's state capitals and the Federal District (Brasilia), identified three dietary patterns: healthy, unhealthy, and mixed. Comparisons with the study's results are limited, since the patterns were identified with a different methodology (cluster analysis) and based on grouping of the foods in markers of healthy and unhealthy diet. However, the study found differences in the patterns' prevalence rates both within and between regions. Higher proportions of the healthy pattern were observed in adolescents in the state capitals of the Southeast, South, and Central of Brazil [8].

Identification of the traditional pattern as the most frequent in four of the five regions is consistent with the results of another study performed with data from ERICA, which assessed the foods most consumed by Brazilian adolescents. The study identified rice and beans among the most frequently consumed foods [4]. The dietary patterns identified in our study are also similar to those reported by Cunha et al. [21], who also used factor analysis to identify dietary patterns in Brazilian adolescents and found a pattern characterized by traditional Brazilian foods, another marked by the consumption of bread-and-coffee, and a third pattern characterized by unhealthy foods.

We identified a fourth dietary pattern in the North of Brazil, called the traditional-North pattern, characterized by typical regional foods such as root/tubercles, fruits and vegetables, and fish and seafood. Food consumption by Brazilian adolescents has been marked increasingly by greater consumption of ultra-processed foods and a drop in the consumption of fruits and vegetables [2,3,4]; however, adolescents in the North of Brazil are apparently those that still tend to maintain their typical regional diet. Souza et al. [38] also identified a high prevalence of consumption of cassava flour, fresh fish, and fish-based dishes in the North of Brazil.

One characteristic of the North of Brazil, also part of the Amazon Region, is the availability of various highly nutritious fruits. The Amazon has as many fruit species as all of the rest of the Americas [39]. In addition to fruits, the Amazon Region is bathed by dozens of rivers with diverse fish species containing high-quality protein and high in polyunsaturated fats [40]. Thus, in addition to the supply of fruits, Northern Brazil is characterized primarily by high consumption of fish, whole flours, and starches, exceeding by several times the average Brazilian consumption. This has even been described as the staple diet of the rural Amazonian population [41,42,43]. However, the current study was performed in urban areas of municipalities in the North.

The Northeast of Brazil was the only region with the "corn" food group (corn, cornmeal, polenta, and other corn-based dishes) in the bread-and-coffee dietary pattern. This food group's presence can be explained by the consumption of typical regional dishes containing corn as a staple ingredient. Coelho & Gubert [44] identified high consumption of corn couscous among adolescents in Northeast Brazil. The region also has a historically large corn crop, which may be reflected in the population's food consumption [45]. The high consumption of tapioca, pirão (thick cassava gravy), and cassava flour in this region [44] may also explain the presence of the roots/tubercles group in the traditional pattern in the Northeast. The South and Central regions showed the milk and cheese group in the bread-and-coffee pattern, and this food group was present in the unhealthy pattern in the Southeast. The consumption of this food group may be explained by the extensive production and processing of milk and dairy products, characteristic of these regions of Brazil [46].

The dietary patterns identified in Brazilian adolescents have certain characteristics that attest to specificities in regional dietary habits, aspects that were already identified in the mid-1940s by Josué de Castro in *The Geography of Hunger* [47], and that appear to have been preserved to this day, despite the profound changes in the profile of food availability and food consumption in the Brazilian popula-

tion in the last seventy years [48]. They also preserve characteristics of the indicators of household food availability observed in the POF 2008-2009 [49,50], which generated several publications pointing to specificities in regional Brazilian food habits.

According to the current study's results, male adolescents appear to have a healthier dietary pattern, since they show greater adherence to the traditional pattern and lower adherence to the unhealthy pattern, compared to female adolescents. Similar results were found in a study of adolescent students in public schools in Bahia, where the "healthy" pattern was inversely associated with female adolescents [17].

Since no other study was found that related dietary pattern to type of school, we compared our results to those of studies that assessed the association between the adolescents' dietary pattern and socioeconomic characteristics, since type of school (public versus private) can be considered a proxy for socioeconomic status in Brazil [51]. In the current study, adolescents enrolled in private schools showed greater adherence to the pattern characterized by consumption of unhealthy foods and lower adherence to the traditional pattern, while in México the Western dietary pattern was positively associated with the adolescents' level of schooling and housing quality index [52]. On the other hand, the same pattern was inversely associated with income in Australia [53], socioeconomic status in Germany [54], and income and maternal schooling in Salvador, Bahia, Brazil [55]. In relation to the healthy pattern, studies have found a positive association between this dietary pattern and socioeconomic status [54,56]. This finding can also be explained by the presence of canteens and snack bars that sell unhealthy foods inside schools, while public schools are supported by the National School Feeding Program (PNAE), the goal of which is guarantee healthy, natural diet [57].

The results of this study are subject to some limitations. The cross-sectional design precludes inference of causality in the associations. The percentage of losses in the study can be considered high, but Silva et al. [34] analyzed the differences between participating and non-participating adolescents and concluded that the analytical procedures used in ERICA ensured that the participants were representative of the non-participants (since the losses were random), and thus the non-response rate had little impact on the resulting estimates' precision. In addition, the food consumption data obtained by just one 24hR may not represent the target population's usual consumption. However, ERICA was the first nationwide school-based survey in Brazil to apply this food consumption instrument to a nationally and regionally representative sample of adolescents. Another limitation was the use of type of school (public versus private) as a proxy for socioeconomic status to describe dietary patterns. This choice was due to the fact that variables related more directly and individually to socioeconomic status (and thus to food consumption), such as maternal schooling (23.8% missing data) and head-of-family's schooling (36.5% missing data) to classify social class showed such high non-response rates, since adolescents are often unable to answer these questions. Meanwhile, the type of school administration (public versus private) is not only strongly related to maternal schooling and income/socioeconomic status (data not shown), but also differs substantially in relation to the food available during school hours, since private schools in Brazil rarely offer school lunch programs (data not shown).

Considering ERICA's sample size and representativeness, the current study makes important contributions to adolescents' food consumption in each of Brazil's five geographic regions and highlights the need for educational measures aimed at reducing the consumption of processed and ultra-processed foods, targeted specifically to Brazilian adolescents.

Contributors

M. A. Alves, A. M. Souza and F. A. G. Vasconcelos contributed to the study's conception, analysis and interpretation of the results, writing of the article, and approval of the final version for publication and is responsible for all aspects of the study, guaranteeing the accuracy and integrity of all parts of the work. L. A. Barufaldi, B. M. Tavares and K. V. Bloch contributed to the analysis and interpretation of the results, writing of the article, and approval of the final version for publication and is responsible for all aspects of the study, guaranteeing the accuracy and integrity of all parts of the work.

Additional informations

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Resumo

O estudo teve como objetivo identificar os padrões alimentares de adolescentes brasileiros para cada uma das cinco regiões do país, e verificar se há diferença na adesão dos padrões alimentares de acordo com idade, sexo e tipo de escola. Foram analisados dados de 71.298 adolescentes de 12-17 anos que participaram do Estudo de Riscos Cardiovasculares em Adolescentes *(ERICA), pesquisa transversal, nacional, multicêntrica e de base escolar. Os dados de consumo alimentar foram obtidos por meio de recordatório alimentar de 24hs, e para a identificação dos padrões alimentares foi aplicada análise fatorial. A associação entre as características dos adolescentes e os padrões alimentares foi verificada por meio de análises de regressão linear, estratificadas por idade e ajustadas por estado nutricional, ingestão energética total e atividade física. Nas cinco regiões foram identificados três padrões alimentares com características similares: padrão tradicional, padrão pão e café e padrão não saudável. A Região Norte apresentou um quarto padrão alimentar caracterizado por alimentos típicos da região: padrão tradicional Norte. Em todas as regiões, os adolescentes do sexo masculino registraram maior adesão ao padrão tradicional e menor adesão ao padrão não saudável. entre os estudantes de escolas privadas foi observada maior adesão ao padrão não saudável e menor adesão ao padrão tradicional. Os resultados sugerem que, entre os adolescentes avaliados, ser do sexo masculino foi associado ao maior consumo de alimentos tradicionalmente brasileiros como o arroz e feijão, já o maior nível socioeconômico esteve associado ao consumo de alimentos não saudáveis como bebidas açucaradas e lanches.*

Comportamento Alimentar; Adolescente; Nutrição do Adolescente; Estudos Transversais

Resumen

El objetivo del estudio fue identificar los patrones alimentarios de adolescentes brasileños para cada una de las cinco regiones del país, y verificar si existen diferencias en la adhesión a los patrones alimentarios, de acuerdo a la edad, sexo y tipo de escuela. Se analizaron datos de 71.298 adolescentes de 12-17 años que participaron en el Estudio de Riesgos Cardiovasculares en Adolescentes *(ERICA), investigación transversal, nacional, multicéntrica y de base escolar. Los datos de consumo alimentario se obtuvieron mediante un recordatorio alimentario de 24h, y para la identificación de los patrones alimentarios se aplicó el análisis factorial. La asociación entre las características de los adolescentes y los patrones alimentarios se verificó mediante un análisis de regresión lineal, estratificado por edad y ajustado por estado nutricional, ingestión energética total y actividad física. En las cinco regiones se identificaron tres patrones alimentarios con características similares: patrón tradicional, patrón pan y café y patrón no saludable. La Región Norte presentó un cuarto patrón alimentario caracterizado por alimentos típicos de la región: patrón tradicional Norte. En todas las regiones, los adolescentes del sexo masculino registraron una mayor adhesión al patrón tradicional y menor adhesión al patrón no saludable. Entre los estudiantes de escuelas privadas se observó una mayor adhesión al patrón no saludable y menor adhesión al patrón tradicional. Los resultados sugieren que, entre los adolescentes evaluados, ser de sexo masculino se asoció a un mayor consumo de alimentos tradicionalmente brasileños como el arroz y frijoles, por otra parte, un mayor nivel socioeconómico estuvo asociado al consumo de alimentos no saludables como bebidas azucaradas y aperitivos.*

Conducta Alimentaria; Adolescente; Nutrición del Adolescente; Estudios Transversales

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