Dietary patterns of Brazilian adolescents: results of the *Brazilian National School-Based Health Survey* (PeNSE)

Padrões alimentares de adolescentes brasileiros: resultados da *Pesquisa Nacional de Saúde do Escolar* (PeNSE)

Patrones alimenticios de los adolescentes brasileños: resultados de la *Encuesta Nacional de Salud del Escolar* (PeNSE)

Letícia Ferreira Tavares [1]
Inês Rugani Ribeiro de Castro [2]
Renata Bertazzi Levy [3]
Letícia de Oliveira Cardoso [4]
Rafael Moreira Claro [5]

[1] *Instituto de Nutrição Josué de Castro, Universidade Federal do Rio de Janeiro, Rio de Janeiro, Brasil.*
[2] *Instituto de Nutrição, Universidade do Estado do Rio de Janeiro, Rio de Janeiro, Brasil.*
[3] *Faculdade de Medicina, Universidade de São Paulo, São Paulo, Brasil.*
[4] *Escola Nacional de Saúde Pública Sergio Arouca, Fundação Oswaldo Cruz, Rio de Janeiro, Brasil.*
[5] *Escola de Enfermagem, Universidade Federal de Minas Gerais, Belo Horizonte, Brasil.*

Correspondence
L. F. Tavares
Instituto de Nutrição Josué de Castro, Universidade Federal do Rio de Janeiro.
Av. Carlos Chagas Filho 373, Bloco J, 2º andar, Rio de Janeiro, RJ 21941-902, Brasil.
tavares.nutricao@gmail.com

Abstract

The objectives of this study were to identify dietary patterns in Brazilian adolescents, describe their distributions in Brazil's State capitals and Federal District, and analyze the correlations with the Municipal Human Development Index (HDI-M). The study analyzed a sample of 60,954 ninth-graders from public and private schools who participated in the National School-Based Health Survey *(PeNSE) in 2009. Cluster analysis was used to characterize dietary patterns. Three patterns were identified: healthy (27.7%), unhealthy (34.6%), and mixed (37.7%). Adolescents in the country's Southeast, South, and Central West regions showed a higher proportion of the healthy eating pattern. HDI-M showed a positive correlation with the healthy pattern and a negative correlation with the mixed pattern. The identification of different dietary patterns within and between regions and according to HDI-M highlights the need for better knowledge of each local context in terms of both the magnitude of events and the examination of determinants within these different realities.*

Feeding Behavior; Adolescent; Students

Resumo

Os objetivos deste trabalho foram identificar os padrões alimentares de adolescentes brasileiros, descrever suas distribuições nas capitais brasileiras e no Distrito Federal e analisar sua associação com o Índice de Desenvolvimento Humano Municipal (IDH-M). Foram estudados 60.954 alunos, de escolas públicas e privadas, que cursavam o último ano do Ensino Fundamental e participaram da Pesquisa Nacional de Saúde do Escolar *(PeNSE) conduzida em 2009. Para caracterização do padrão alimentar foi utilizada análise de* cluster. *Foram identificados três padrões: saudável (27,7%), não saudável (34,6%) e misto (37,7%). Observou-se maior proporção do padrão saudável entre adolescentes nas capitais das regiões Sudeste, Sul e Centro-oeste. O IDH-M apresentou correlação positiva com o padrão saudável e negativa com o padrão misto. A identificação de padrões alimentares diferenciados intra e entre regiões e segundo IDH-M aponta a necessidade de se conhecer melhor cada contexto local, seja no tocante à magnitude dos eventos, seja no exame dos determinantes dessas diferentes realidades.*

Comportamento Alimentar; Adolescente; Estudantes

Introduction

Inadequate diet is a risk factor for the development of chronic non-communicable diseases (NCD) [1,2,3,4,5] and appears in young people in various countries, including Brazil. Eating habits among Brazilian adolescents have shown high intake of ultra-processed products [6] that are rich in fats, sugars, and sodium, and low consumption of fruits and vegetables [7,8,9,10,11,12,13].

Studies in nutritional epidemiology have traditionally evaluated the relationship between health and the intake of specific nutrients or foods. From the public health perspective, it is essential to study dietary patterns, since people do not consume nutrients or a single type of food separately, but rather a combination of foods and nutrients. The identification of dietary patterns has thus emerged as an alternative to food consumption assessment based only on foods and nutrients, and its implementation in public policies can be useful for better understanding the population's diet [14,15,16,17].

Activities that illustrate the international effort at prevention and control of NCD include the successful implementation of surveillance systems for health risk and protective factors in various countries [18,19,20]. In order to support health policies for young people, the World Health Organization (WHO) proposed the creation of surveillance systems for behavioral risk and protective factors for NCD that are specific to adolescents, to be developed within the school community [21].

According to this WHO guideline and based on prior experience in international [18,19,20] and national systems [10,22,23], Brazil organized a surveillance system for health risk and protective factors for adolescents based on regular school surveys known as the *National School-Based Health Survey* (PeNSE) [24]. Two editions of this survey have been held thus far, one in 2009 and another in 2012 [24,25].

As occurs with surveillance systems targeting adolescents in other countries [26,27,28,29,30,31,32,33], food consumption analyses conducted with data generated by the Brazilian system have been limited to the separate examination of foods and dietary practices as markers of healthy and unhealthy diet [24,25,34]. Based on the PeNSE 2009 survey, the current study aimed to identify and describe the prevalence of dietary patterns in Brazil's 26 State capitals and the Federal District (Brasilia) and analyze their association with the Municipal Human Development Index (HDI-M).

Methods

Study design, population, and sampling

This study used open-access data (Instituto Brasileiro de Geografia and Estatística. Banco de dados agregados. Pesquisa Nacional de Saúde Escolar – PeNSE 2009. http://loja.ibge.gov.br/pesquisa-nacional-de-saude-do-escolar-2009.html, accessed 02/Feb/2013) that were extracted from PeNSE 2009, a cross-sectional study with a population of 9th-graders from public and private schools in Brazil's 26 State capitals and the Federal District. The 2007 School-Based Census conducted by the "Anísio Teixeira" National Institute of Educational Studies and Surveys of the Ministry of Education provided the basis for calculating the sample [24].

Complex two-stage stratification and cluster sampling were performed to represent the set of 9th-grade public and private school students from the 26 State capitals and Federal District. The 27 sampling strata are represented by the State capitals and the Federal District. The first stage involved the selection of schools (primary sampling unit) by systematic sampling with probability proportional to the number of schools in the strata. The second stage was the selection of classes (secondary sampling unit) within each selected school. All students in the selected classes were invited to participate in the survey. Of the 63,411 students present in the selected classes on the date of the survey, 501 declined to participate in the study. The study sample thus consisted of 62,910 students that completed the questionnaires. The PeNSE 2009 report published by the Brazilian Institute of Geography and Statistics (IBGE) [24] contains a more detailed description of the sampling design.

Approximately half of the students in the sample were 14 years old, and 72.9% studied in public schools. About one-third of the schoolchildren's mothers had incomplete primary schooling and another third had complete university education [24].

The analyses in the current article used information from the schoolchildren that agreed to participate and answered the question on gender and at least one question on food consumption, totaling 60,954 students from 1,453 schools and 2,175 classes.

Data collection

Data were collected with a handheld computer (personal digital assistant – PDA), containing a structured and self-completed questionnaire divided into modules by subject: socio-demographic characteristics, diet, body image, physical activity, smoking, consumption of alcohol and other drugs, oral health, sexual behavior, violence, accidents, and security. The fieldwork lasted from March to June 2009.

Data analysis

Food consumption was assessed with a questionnaire referring to the week prior to the study. The student recorded the number of days on which he or she had consumed the following foods (or food groups): beans; raw vegetables; cooked vegetables; fresh fruits; milk; candy; cookies; crackers; French fries (including potato chips); fried snacks; cold cuts (hamburger, frankfurter, baloney, salami, ham, nugget-type breaded chicken, or sausage); soda (soft drinks). The first five foods were considered markers of healthy eating and the latter seven markers of unhealthy eating. This division was based on evidence that suggests an association between these variables and risk factors for chronic non-communicable diseases [1,2,3,4,5]. Milk was also included as a healthy food, since the *Food Guide for the Brazilian Population: Promoting Healthy Diet* [35] lists milk and dairy products as recommended foods. A similar classification was adopted in the two editions of the PeNSE survey [24,25] and in a previous publication based on the data from the first survey [34].

Although the percentage of missing data for each of the variables on food consumption varied from 1.4 to 1.8%, when they were combined to analyze dietary pattern, this proportion increased to 12.9%. The choice was made to impute the missing data on food intake, since the lack of information on at least one of the 12 target variables would exclude the individual from the cluster analysis used to identify the dietary pattern. The procedures used to impute missing data were those used in previous analyses of the PeNSE survey for the maternal schooling variable and for the creation of the household assets score [34]. A logistic regression model was used to identify ancillary variables that did not present any missing information and that were capable of predicting the target food consumption variable (e.g., gender, school administration category, State, household assets score, and maternal schooling). Next, classification trees were constructed, consisting of a nonparametric multivariate regression technique that allowed predicting the values to be imputed in the missing data [36,37,38,39]. Data imputation was done in an R environment and language, version 2.15 (The R Foundation for Statistical Computing, Vienna, Austria; http://www.r-project.org), using the *rpart* library.

Identification of dietary patterns considered the frequency of consumption (from zero to every day in the previous seven days) for the 12 target foods. Classification of dietary patterns used cluster analysis with the k-means non-hierarchical method. This method requires prior definition of the number of clusters to be adopted. Thus, cluster analysis was conducted setting different numbers of clusters [40].

The identification of three dietary patterns showed the best fit, considering the interpretation and size of the clusters and the internal consistency of the patterns by calculating Cronbach's alpha (values greater than 0.6 were considered satisfactory [40,41,42]). Determination of the items comprising each pattern used the centroid value for each food or food group. The foods included in the healthy and unhealthy patterns (described in detail in the Results section) were the ones that presented the highest centroid value. The mixed pattern was represented by foods that showed intermediate centroid values, i.e., no food presented the maximum consumption frequency value when compared to the other two patterns. F-statistic values were assessed to identify the foods that most discriminated between clusters [40,43]. To facilitate interpretation and discussion, each dietary pattern was named on the basis of the foods it contained. The assumptions proposed for cluster analysis by Hair et al. [40] were met.

To evaluate the reliability of the cluster analysis, two subsamples of the original sample were randomly selected and the analyses were replicated. Cluster analysis is considered satisfactory when the results obtained in the subsamples are similar to the findings for the total study sample [40].

Analysis of variance (ANOVA) was performed with the Scheffé *post hoc* test to compare the mean weekly intake of each food according to the dietary pattern. We also estimated the proportions (with 95% confidence intervals) of adolescents classified in each dietary pattern in each of the 26 State capitals and Federal District. These estimates were also performed for the set of State capitals in each of the country's five major geographic regions in order to facilitate comparison between regions, despite knowing that these data do not express each region as a whole (since the PeNSE 2009 sample only included the capital cities and not the other municipalities in each State).

Pearson's correlation coefficient was used to evaluate the correlation between dietary patterns and HDI-M in each of the municipalities. HDI-M includes life expectancy, education, and income and varies from 0 to 1 (Programa das Nações Unidas para o Desenvolvimento Brasil.

Atlas do desenvolvimento humano no Brasil 2013: HDI-M. http://atlasbrasil.org.br/2013/o_atlas/idhm, accessed on 02/Dec/2013). The current study used HDI-M estimates for 2010 (Programa das Nações Unidas para o Desenvolvimento Brazil. Ranking IDHM. Unidades da Federação 2010. http://www.pnud.org.br/atlas/ranking/Ranking-IDHM-UF-2010.aspx, accessed on 02/Dec/2013).

ANOVA was also used to compare mean prevalence of dietary patterns according to HDI-M tertiles. Statistical significance was set at 5%.

A *scatterplot* graph was also constructed adopting HDI-M as the independent variable and each of the three dietary patterns as the dependent variable. A smoothed line obtained by the *loess* function was then included in the graph for each of the patterns to facilitate visualization of the direction in the relationship between the variables. Two more lines marking the tertiles in the HDI-M distribution were also included, allowing readers to identify differences between proportions of the three patterns in these three tertiles.

The analyses were performed considering the sample design and using R programs, version 3.0 (The R Foundation for Statistical Computing, Vienna, Austria; http://www.r-project.org), Stata SE, version 12.1 (Stata Corp., College Station, USA), SPSS version 17 (SPSS Inc., Chicago, USA), and Microsoft Office Excel 2007 (Microsoft Corp., USA).

Results

Cluster analysis identified the three dietary patterns described next. The first pattern, called healthy (with 16,117 cases), was characterized by more frequent intake of all the healthy foods (cooked vegetables, fruits, milk, raw vegetables, and beans) and less frequent intake of all the unhealthy foods (cookies, crackers, candy, soda, fried snacks, cold cuts, and French fries). The second pattern, unhealthy (n = 20,202), was characterized by more frequent intake of all the unhealthy foods and less frequent consumption of all the healthy foods. The third pattern, mixed (n = 24,635), was characterized less discrepancy between weekly consumption of the target foods, i.e., consumption of healthy foods that was closer to that of unhealthy foods. In this pattern, consumption of healthy foods was less frequent than that observed in adolescents classified in the healthy pattern, and consumption of unhealthy foods was less frequent than in adolescents classified in the unhealthy pattern.

Figure 1 shows the weekly intake of selected foods according to dietary pattern. A statistically significant difference was observed between mean weekly intake of all target foods between the three dietary patterns (p-value < 0.001). Cookies, crackers, and cooked vegetables showed the highest F-statistic values and contributed the most to discriminating between the three dietary patterns (data not shown). The internal consistency in the healthy, mixed, and unhealthy patterns was generally considered satisfactory, with Cronbach's alpha values of 0.56, 0.65, and 0.75, respectively.

For the total sample of students, distribution of the healthy, mixed, and unhealthy patterns was 27.7%, 37.7%, and 34.6%, respectively. The distribution was not homogeneous, either between regions of the country or within each region (Table 1).

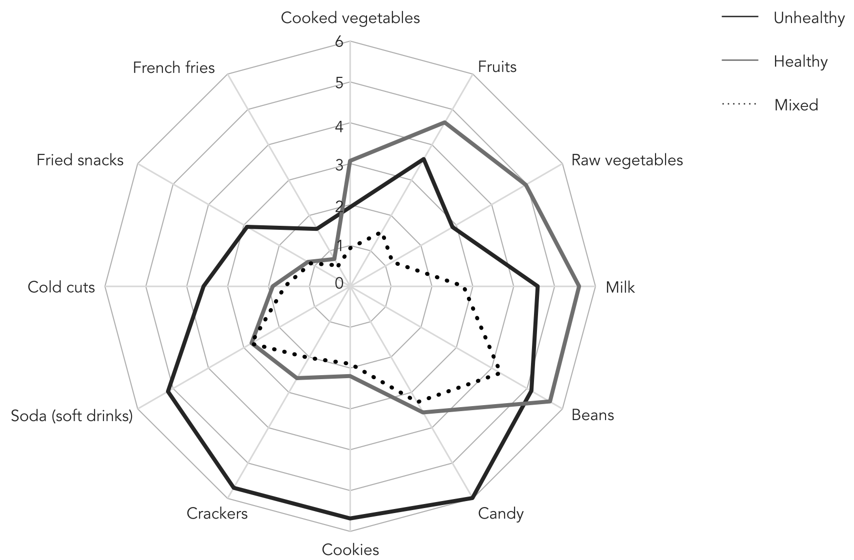
Analyzing the mean for the State capitals in each region of the country, the proportion of adolescents classified in the healthy pattern in the Southeast (31.5%), South (33.9%), and Central West (34.5%) was higher than for the total sample of students (27.7%). The North and Northeast showed a lower proportion of the healthy dietary pattern (20.6 and 18.6%, respectively). The mixed pattern was more frequent in the North (50.5%) and Northeast (46.2%) and less frequent in the Central West (33%) and Southeast (31.8%). Adolescents in the North and South of Brazil showed a lower proportion in the unhealthy pattern (28.4 and 30.5%, respectively) compared to the total sample (34.6%).

There was an important difference in the prevalence rates for the healthy pattern between municipalities in the North [from 16.2% in Macapá (Amapá) to 31.9% in Palmas (Tocantins)] and in the Northeast [from 14.8% in Recife (Pernambuco) to 25.7% in Teresina (Piauí)]. As for the unhealthy pattern, the most striking differences were also found in these two regions of Brazil, with prevalence rates ranging from 37.3% [in Rio Branco (Acre)] to 27.3% [in Manaus (Amazonas)] and from 47% (in Recife) to 25.3% [in São Luiz (Maranhão)] respectively. The seven municipalities classified as having high human development [HDI-M from 0.8 to 1, namely Florianópolis (Santa Catarina), Vitória (Espírito Santo), Brasília (Federal District), Curitiba (Paraná), Belo Horizonte (Minas Gerais), Porto Alegre (Rio Grande do Sul), and São Paulo] were among the eight with the highest prevalence rates for the healthy pattern, and five of them also coincided with the five having the lowest prevalence rates for the mixed pattern.

HDI-M was positively correlated (Pearson's correlation coefficient = 0.773) with the healthy

Figure 1

Mean weekly frequency of selected food intake according to dietary pattern in 9th-graders from Brazil's State capitals and Federal District. *National School-Based Health Survey*, 2009 (PeNSE 2009).



pattern and negatively correlated (Pearson's correlation coefficient = 0.676) with the mixed pattern ($p < 0.001$). There was no correlation between HDI-M and the unhealthy pattern (Figure 2). Similar results were also observed for the components of HDI-M: income, education, and life expectancy (results not shown). Although the range in HDI-M was not very wide in the municipalities studied here (from 0.721 to 0.847), three distinct situations were observed in the relationship between dietary patterns and HDI-M. The first tertile of HDI-M (up to 0.756) showed stability in the three patterns, and the mixed and healthy patterns showed the highest and lowest prevalence rates, respectively. The second tertile, including municipalities with HDI-M from 0.757 and 0.795, showed an increase in prevalence of the healthy pattern and decrease in prevalence of the mixed pattern with increasing HDI-M. Meanwhile, in the third tertile, (HDI-M > 0.795) the municipalities showed similar proportions of the healthy and mixed patterns. In this latter tertile only, which included the municipalities with HDI-M classified as very high (≥ 0.800), the prevalence rates for the healthy pattern exceeded those of the unhealthy pattern.

ANOVA corroborated the results shown in Figure 2, i.e., municipalities in the third tertile of HDI-M showed the highest proportion of adolescents in the healthy pattern and the lowest proportion in the mixed pattern when compared to the first and second tertiles of HDI-M. ANOVA also failed to show a correlation between the unhealthy pattern and HDI-M (Table 2).

Discussion

The dietary patterns observed in this study characterize food consumption by 9th-graders in public and private schools in Brazil's State capitals and Federal District. Three dietary patterns emerged: healthy, unhealthy, and mixed. The adolescents' overall dietary pattern was unsatisfactory. The study showed low proportions of the healthy pattern among the municipalities in the sample. Differences were observed between prevalence rates for the patterns, both between and within regions, with greater heterogeneity in the North and Northeast regions. Higher proportions of the healthy pattern were seen in adolescents from the capital cities in the Southeast, South, and Central West regions. HDI-M was directly correlated with prevalence of the healthy pattern and inversely correlated with the mixed pattern, while no association was seen between

Table 1

Municipal Human Development Index (HDI-M) and proportion of adolescents classified in each of the three dietary patterns in the State capitals, Federal District, and Major Geographic Regions of Brazil *. *National School-Based Health Survey*, 2009 (PeNSE 2009).

Regions of Brazil/ State capitals (State) and Federal District	HDI-M	Dietary Pattern					
		Healthy		Mixed		Unhealthy	
		%	95%CI	%	95%CI	%	95%CI
North		20.6	19.5-21.7	50.5	49.0-52.0	28.9	27.9-30.0
Palmas (Tocantins)	0.788	31.9	29.1-34.8	37.0	32.8-41.3	31.2	28.3-34.1
Boa Vista (Roraima)	0.752	29.1	26.8-31.4	42.9	40.0-45.9	28.0	25.6-30.6
Belém (Pará)	0.746	17.4	15.7-19.2	54.5	51.0-58.0	28.2	25.6-30.8
Manaus (Amazonas)	0.737	19.5	17.3-22.0	53.2	50.4-56.0	27.3	25.5-29.1
Porto Velho (Rondônia)	0.736	28.7	26.6-31.0	39.5	37.3-41.6	31.8	29.5-34.2
Macapá (Amapá)	0.733	16.2	14.6-17.9	55.4	52.5-58.3	28.4	26.2-30.8
Rio Branco (Acre)	0.727	22.7	19.8-23.9	41.0	37.9-44.2	37.3	34.4-40.3
Northeast		18.6	17.8-19.5	46.2	45.0-47.4	35.2	34.1-36.3
Recife (Pernambuco)	0.772	14.8	13.5-16.2	38.2	35.4-41.1	47.0	44.2-49.8
Aracaju (Sergipe)	0.770	23.3	21.0-25.8	42.8	40.3-45.4	33.9	31.5-36.4
São Luís (Maranhão)	0.768	19.1	17.4-20.8	55.6	53.5-57.9	25.3	23.1-27.6
Natal (Rio Grande do Norte)	0.763	21.2	19.4-23.2	43.5	41.1-45.8	35.3	33.2-37.5
João Pessoa (Paraíba)	0.763	19.1	17.4-20.9	42.2	39.5-44.8	38.7	36.0-41.6
Salvador (Bahia)	0.759	19.4	16.9-22.2	50.5	47.3-53.7	30.1	28.2-32.2
Fortaleza (Ceará)	0.754	17.3	15.4-19.4	48.3	45.2-51.5	34.4	31.5-37.4
Teresina (Piauí)	0.751	25.7	23.7-27.9	45.3	42.8-47.8	29.0	26.7-31.4
Maceió (Alagoas)	0.721	17.4	15.7-19.2	42.7	40.2-45.4	39.9	37.1-42.7
Southeast		31.5	30.0-33.1	31.8	30.5-33.2	36.7	35.1-38.3
Vitória (Espírito Santo)	0.845	33.6	31.3-35.9	32.8	30.6-35.2	33.6	31.1-36.3
Belo Horizonte (Minas Gerais)	0.810	34.5	32.3-36.7	28.5	26.8-30.4	37.0	34.6-39.4
São Paulo (São Paulo)	0.805	32.9	30.7-35.2	31.4	29.5-33.4	35.7	33.3-38.2
Rio de Janeiro (Rio de Janeiro)	0.799	27.1	24.3-30.0	34.1	31.8-36.5	38.9	36.7-41.2
South		33.9	32.3-35.5	35.7	34.0-37.4	30.5	28.8-32.1
Florianópolis (Santa Catarina)	0.847	34.5	32.5-42.3	40.0	37.7-42.3	25.5	23.2-28.0
Curitiba (Paraná)	0.823	34.7	32.6-36.9	32.9	30.7-35.1	32.4	30.2-34.8
Porto Alegre (Rio Grande do Sul)	0.805	32.0	29.0-35.0	40.0	36.6-43.4	28.1	25.3-31.0
Central-West		34.5	33.3-35.7	33.0	31.6-34.4	32.5	31.2-33.9
Brasília (Federal District)	0.824	36.1	34.1-38.2	32.0	29.4-34.7	37.9	29.5-34.4
Goiânia (Goiás)	0.799	36.6	34.5-38.7	31.5	29.4-33.7	31.9	20.1-33.7
Cuiabá (Mato Grosso)	0.785	27.8	25.7-30.0	36.0	32.6-39.5	36.2	32.7-39.9
Campo Grande (Mato Grosso do Sul)	0.784	30.2	28.0-32.4	36.7	34.0-39.5	33.1	30.6-35.7
Total		27.7	26.9-28.5	37.7	37.0-38.5	34.6	33.7-35.4

* Regions of Brazil: data refer to the sum of the State capitals for each region in the country.

HDI-M and the unhealthy pattern. Differences were seen in the relationship between prevalence rates for the dietary patterns in each tertile of the HDI-M.

The intra and inter-regional differences in dietary patterns and those associated with HDI-M highlight the need for better knowledge of the local context, both in the magnitude of the events and in the examination of determinants of these different realities. Further studies are needed to better understand these differences. Even so, considering the positive association between healthy diet and HDI-M, it is reasonable to assume that the synergistic effect between schooling, income, and health conditions (as expressed by life expectancy) contribute to the determination of healthier eating practices. Meanwhile, the lack of association between prevalence rates

Figure 2

Proportion of 9th-graders in each dietary pattern according to the Municipal Human Development Index (HDI-M) in Brazil's State capitals and Federal District. *National School-Based Health Survey*, 2009 (PeNSE 2009).

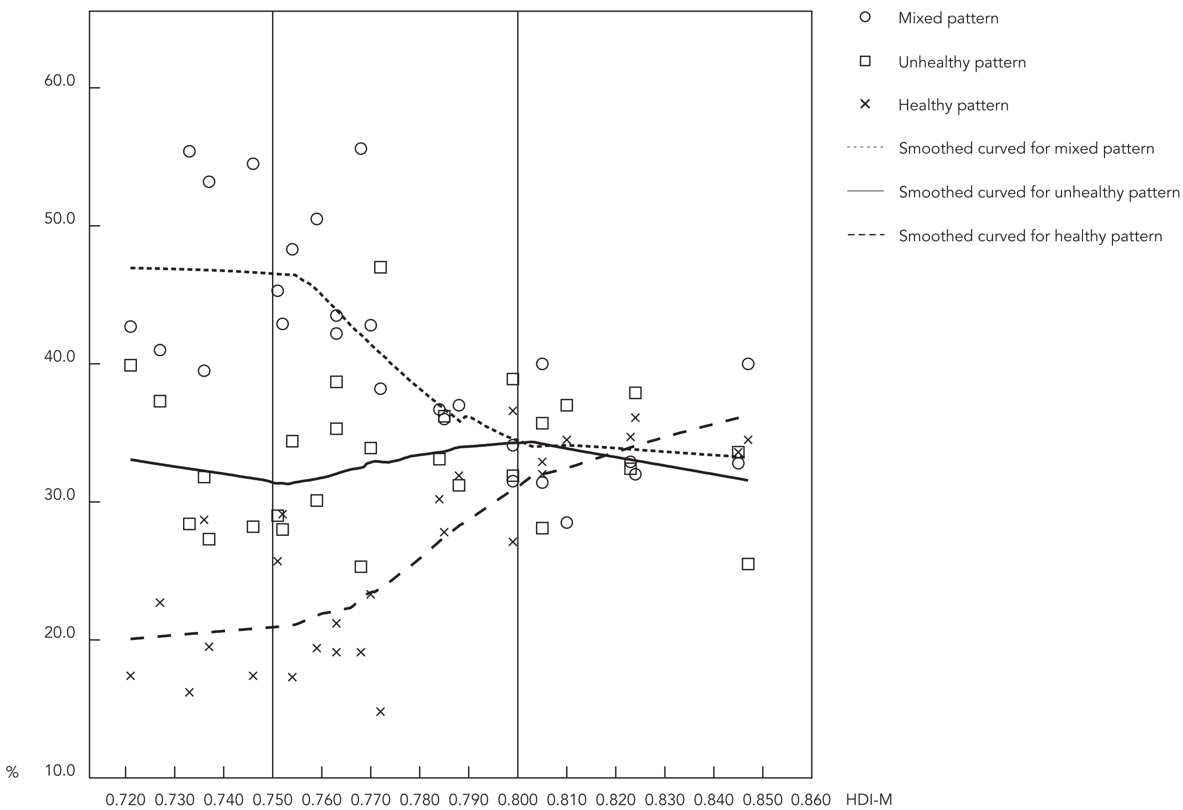


Table 2

Proportion* of adolescents classified in each of the three dietary patterns according to tertile in the Municipal Human Development Index (HDI-M). *National School-Based Health Survey*, 2009 (PeNSE 2009).

Dietary pattern	**HDI-M**			**p-value ****
	1st tertile	**2nd tertile**	**3rd tertile**	
Healthy	21.6[a]	23.0[b]	33.6[a,b]	< 0.001
Mixed	47.0[c]	42.5[d]	33.7[c,d]	< 0.001
Unhealthy	31.6	34.5	33.4	0.477

* Mean prevalence rates for each dietary pattern in State capitals in each HDI-M tertile.

** Analysis of variance (ANOVA) with Scheffé *post hoc* test.

[a,b,c] p-value < 0.001;

[d] p-value = 0.012;

[a,b,c,d] p-value corresponding to Scheffé *post hoc* test used to identify which tertiles of HDI-M showed differences in the proportion of adolescents classified in each of the dietary patterns. A p-value signaled with letters "a", "b", "c", and "d" represents the two-by-two comparison of prevalence in the patterns.

for the unhealthy pattern and increasing HDI-M suggests the uniformization of access to such foods as candy, cookies, and soda.

Comparison of our findings with those of other studies should be done with caution due to differences in the study population's characteristics and in the instruments used to assess food consumption. There are also numerous ways used to extract patterns, thus further limiting the studies' comparability.

Therefore, no comparison was made with specific data from specific studies, but rather a comparison with overall results – such as the methodology used to identify patterns, the number of patterns identified, and their main characteristics – from surveys performed in different parts of the world that have attempted to identify teenage eating patterns. Thus far, the two main methods used to identify dietary patterns in this age bracket have been factor analysis [42,44,45,46,47,48] and cluster analysis [42,49,50].

The studies generally identify two or three dietary patterns, one represented by the consumption of healthy foods (protective) [44,45,46,48], another by unhealthy foods (fast food or Western diet) [42,44,45,46,47,50], and the third by a traditional diet for that specific area [46,47,48,49].

In keeping with studies in adolescents that used cluster analysis, the current study showed a high prevalence of the dietary pattern characterized by frequent consumption of unhealthy foods and low consumption of healthy foods [42,49,50]. A study of Korean adolescents showed the existence of a modified or transitional pattern, equivalent to the mixed pattern described here, characterized by lower intake of healthy foods (vegetables, fruits, and milk) and intermediate intake of unhealthy foods (soda, French fries, cookies, and candy), when compared to the other two patterns identified (traditional and Western) [48]. The first Brazilian initiative to assess dietary pattern in adolescents based on surveys used in surveillance systems was in Rio de Janeiro [51] using a questionnaire very similar to that of the PeNSE study [24]. Four patterns were identified among adolescents in the city of Rio de Janeiro. The extreme patterns ("A" and "D") were similar to the healthy and unhealthy patterns identified in the current study. In both studies, the foods with the greatest capacity to distinguish between patterns were cookies, crackers, cooked vegetables, and fruits [51].

We also compared our findings to those of a study that investigated time trends in the dietary pattern of adults interviewed in the Telephone Surveillance System for Risk and Protective Factors for Chronic Diseases (VIGITEL) [43]. Although the studies target different age groups, both present data from Brazil's Federal District and 26 State capitals. They also show methodological similarities in both the target foods and the use of cluster analysis to identify dietary patterns. Evaluation of dietary patterns with VIGITEL data identified two patterns: the first consisted of healthy eating or the consumption of foods classified as healthy and the second characterized by the consumption of unhealthy foods. Although a pattern was identified that consisted of foods considered healthy and another consisting of foods classified as unhealthy, approximately 90% were classified in the healthy pattern. The authors emphasized that the identification of dietary patterns did not prove satisfactory, since the high prevalence of the healthy pattern is not characteristic of the Brazilian population's eating habits. In addition, unlike the current study's findings, no differences were observed between the two clusters in the mean consumption of target foods [43].

Since no other study was found that related dietary pattern to HDI-M and its three components (education, life expectancy, and income), the current study's results were compared with others that evaluated the association between adolescents' dietary pattern and socioeconomic characteristics. While our study showed no correlation between the unhealthy pattern and HDI-M, in Mexico the Western diet was positively associated with adolescents' level of schooling and housing quality index [42]. Meanwhile, this pattern showed an inverse association with income in Australia [44], with socioeconomic status in Germany [46], and with income and maternal schooling in Salvador, Bahia State, Brazil [47]. As for the healthy pattern, our findings corroborate those of other studies that found a positive association between this dietary pattern and socioeconomic status [45,46], consumer goods score (tertile) [51], and maternal schooling [44].

As for methodological aspects, the study's main limitation was that the questionnaire used in the 2009 PeNSE survey did not allow a detailed quantitative or qualitative analysis of the adolescents' diet, since it included a limited number of foods and food groups. Even so, the number of dietary markers was considered satisfactory for the surveillance system's purposes and was similar to that used in other systems around the world [26,27,28,29,30,31,32,33].

Another potential limitation was that the use of a questionnaire covering seven days compromises estimation of the adolescents' usual food intake [52]. However, the section of questions on diet showed satisfactory performance in a validation study of the instrument in 9th-graders in the city of Rio de Janeiro [53]. Similar results have been found in monitoring systems that target adolescents in other countries and that are also based on a self-completed questionnaire [54,55].

As for the statistical method chosen to identify the dietary patterns, although k-means hierarchical cluster analysis does not require prior definition of the number of patterns to be identified, prior complementary procedures were performed to define the number of clusters [17,40,56].

The fact that the cluster method identifies mutually exclusive patterns could be considered a limitation, since it is possible for the same individual to belong to more than one pattern [51]. However, the fact that the cluster method identifies mutually exclusive patterns was one of the reasons for its application, since the study aimed to estimate prevalence rates and compare them between municipalities. This required generating a compound variable consisting of mutually exclusive categories. This way of analyzing the data is consistent with the objectives of surveillance systems for health risk and protective factors, which propose to describe magnitudes, distributions, and trends for target events.

In addition, even with the use of a limited amount of foods to conduct cluster analysis, the dietary patterns identified here display internal consistency and satisfactory reliability. Cluster analysis in subsamples showed a similar result to that described for the total sample of adolescents [40,41,42].

In relation to imputation of missing data, the classification tree consists of a stratification method that uses a set of characteristics in the adolescents that have complete information for the variables to be imputed and classifies them in homogeneous groups based on these characteristics [36]. Although prediction of food consumption involves characteristics that extrapolate the variables used in the imputation process, the variables' distribution before and after imputation was similar. In addition, the cluster analysis was only performed with the individuals that had complete information, and the results were maintained.

One of the current study's positive points was that the sample was designed to represent 9th-graders from public and private schools in Brazil's State capitals and Federal District. Cluster analysis is considered good when the sample is representative of the population for which the data will be extrapolated [40].

Besides the fact that the results were representative, another highlight was the unprecedented nature of the analyses, involving the first evaluation of dietary pattern based on information from a surveillance system that targeted adolescents. Previously, analyses of food consumption done by the Brazilian system [24,34] and by surveillance systems in other countries [28,29,30] were limited to the separate examination of foods as markers of healthy versus unhealthy diet. This was also the first analysis in Brazil that linked HDI-M with information on dietary pattern in adolescents from all the Brazilian State capitals and Federal District.

Cluster analysis allowed identifying dietary patterns capable of classifying adolescents as to the presence of health risk and protective factors related to diet. The lack of overlapping confidence intervals for prevalence rates of patterns in each region and the total sample suggests a real difference between dietary patterns in Brazil's major geographic regions. The estimated distribution of adolescents' dietary patterns in each State capital allows more detailed knowledge of the eating dynamics in this population group, thereby favoring the elaboration of more appropriate health promotion measures for each local reality.

Further such analyses with editions of the PeNSE survey subsequent to that used in the current study will allow monitoring time trends in adolescents' dietary pattern in the State capitals. It will also be possible to expand the analyses to include municipalities outside the State capitals, since the second edition of the PeNSE survey (held in 2012) was sized to estimate population parameters for the country as a whole.

In a surveillance system, the objective of evaluating diet is not to generate precise estimates of the intake of given nutrients, but to estimate the occurrence of relevant food consumption markers for monitoring risk factors for chronic non-communicable diseases. Given this objective, the current study provides timely analysis of dietary patterns in the context of the surveillance system targeting Brazilian adolescents, since it allowed evaluating overall diet, contributing to knowledge on the adolescents' reality in relation to food consumption and providing support for the consolidation of the Brazilian surveillance system for health risk and protective factors in adolescents.

Resumen

Los objetivos de este trabajo fueron identificar los patrones alimenticios de los adolescentes, describir sus distribuciones en las 26 capitales brasileñas y en el Distrito Federal y analizar su asociación con el Índice de Desarrollo Humano Municipal (IDH-M). Se estudiaron 60.954 alumnos de escuelas públicas y privadas, que estaban en su último año de la escuela primaria y participaron en la Encuesta Nacional de Salud del Escolar *(PeNSE) en 2009. Para caracterizar el patrón alimenticio se utilizó el análisis de clúster. Se identificaron tres patrones alimenticios: saludable (27,7%), no saludable (34,6%) y mixto (37,7%). Se observó una mayor proporción del patrón saludable en las capitales de las regiones Sudeste, Sur y Centro-oeste. El Índice de Desarrollo Humano Municipal (IDH-M) se correlacionó positivamente con el patrón saludable y negativamente con el patrón mixto. La identificación de los patrones alimenticios diferenciados intra y entre las regiones, y de acuerdo con el IDH-M, se indica la necesidad de comprender mejor cada contexto local, o con respecto a la magnitud del evento, considerando el análisis de las diferentes realidades.*

Conducta Alimentaria; Adolescente; Estudiantes

Contributors

L. F. Tavares and I. R. R. Castro contributed to the study design, data analysis, and writing of the manuscript. R. B. Levy and L. O. Cardoso collaborated in the study design, data analysis, and revision of the manuscript. R. M. Claro participated in the data analysis and revision of the manuscript.

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