

## Eating patterns in the *Brazilian Longitudinal Study of Adult Health (ELSA-Brasil)*: an exploratory analysis

Padrões alimentares no *Estudo Longitudinal de Saúde do Adulto (ELSA-Brasil)*: uma análise exploratória

Patrones alimenticios en el *Estudio Longitudinal de Salud del Adulto (ELSA-Brasil)*: un análisis exploratorio

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### Abstract

The food consumption of 15,071 public employees was analyzed in six Brazilian cities participating in the baseline for Brazilian Longitudinal Study of Adult Health (ELSA-Brasil, 2008-2010) with the aim of identifying eating patterns and their relationship to socio-demographic variables. Multiple correspondence and cluster analysis were applied. Four patterns were identified, with their respective frequencies: "traditional" (48%); "fruits and vegetables" (25%); "pastry shop" (24%); and "diet/light" (5%). The "traditional" and "pastry shop" patterns were more frequent among men, younger individuals, and those with less schooling. "Fruits and vegetables" and "diet/light" were more frequent in women, older individuals, and those with more schooling. Our findings show the inclusion of new items in the "traditional" pattern and the appearance of the "low sugar/low fat" pattern among the eating habits of Brazilian workers, and signal socio-demographic and regional differences.

Feeding Behavior; Urban Population; Multivariate Analysis; Adult

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## Introduction

Obesity, a leading health problem in many countries around the world, is very difficult to reverse. Dietary interventions based exclusively on energy intake and nutrients may yield immediate success, but fail in the medium and long term<sup>1</sup>. The current proposed dietary guidelines for the Brazilian population<sup>2</sup>, designed to promote a healthy diet in the Brazilian context and encouraging the consumption of “real food” (i.e. foods in their natural state or with minimal processing), constitute a new strategy for future interventions. However, it is fundamentally important to verify what Brazilian adults are eating today – not with a view to adjusting recommendations on nutrient intake in the strict sense, but to identify what foods are in fact being consumed, so as to suit the proposals of the guide to the realities of people’s actual diets.

International organizations have encouraged the study of dietary patterns<sup>3</sup> to evaluate a population’s overall diet. Dietary patterns are preferred over isolated nutrients, because studying specific compounds can attenuate the strength or prevent the identification of possible associations between overall diet and the risk of chronic disease<sup>4</sup>. Furthermore, identifying dietary patterns can help to establish new interventions, because they show how foods are combined into a dietary routine<sup>5</sup>.

Eating habits are changing in Brazil, as in other countries: consumption of ultra-processed and ready-to-serve foods is increasing, while consumption of minimally-processed and raw foods is decreasing, with adverse effects on health, as already indicated<sup>6,7</sup>. There is evidence that patterns of food consumption vary with demographic characteristics and socioeconomic levels. In Brazil, there are few studies relating to these dietary patterns. They are expected to be varied, given the country’s cultural and economic diversity<sup>5,8,9,10,11,12</sup>.

A recent study, representative of Brazil’s population, revealed that household acquisition of food is characterized, at the same time, by foods acknowledged to be beneficial to health (e.g. fruit and vegetables) and less healthy foods (e.g. confectionery, processed meats, ready meals), and also by a “traditional” pattern that includes rice, beans, eggs, roots and tubers<sup>13</sup>.

The *Brazilian Longitudinal Study of Adult Health* (ELSA-Brasil) evaluated food consumption in six cities in three of Brazil’s macro-regions (Northeast, Southeast and South). It thus offers an excellent opportunity to pursue in-depth knowledge of dietary patterns among Brazilian working populations residing in large cities –

particularly to explore the different patterns by socio-demographic characteristics.

## Materials and methods

### Study population

ELSA-Brasil is a multicenter cohort study that, at baseline (2008-2010), examined 15,105 civil servants at teaching and research institutions in six cities in Brazil<sup>14,15</sup>. Its main purpose was to estimate the incidence of cardiovascular diseases and diabetes and their social, environmental, occupational and biological determinants. All of the six institutions’ active and retired civil servants aged 35 to 74 were eligible for the study. Baseline evaluation lasted about 7 hours and was divided into two stages that included interviews and examinations conducted by a trained team. The interviews addressed sets of risk factors for the diseases of interest, as well as diet<sup>16</sup>. Quality control measures included direct team supervision, test-retest studies and centralized interpretation of laboratory and other test results<sup>17</sup>. The study was approved by the ethics committees of all six institutions and by the Brazilian National Research Ethics Committee and all participants signed a declaration of free and informed consent.

This study included 15,071 (99.8%) ELSA-Brasil participants for whom complete information was available from the food frequency questionnaire (missing data n = 29) and on other study variables (missing data n = 34).

### Measuring food consumption

A *Food Frequency Questionnaire* (FFQ) of 114 food items, based on a previously validated questionnaire<sup>18</sup>, was applied by trained interviewers, in order to evaluate participants’ usual consumption in the previous 12 months. The list of foods was modified on the basis of a study performed at the six research centers in which 100 24-hour dietary recalls (R24h) were applied<sup>19</sup>. Some foods (e.g. zucchini, chayote and eggplant) were grouped into single items. When different types of the same food displayed different nutritional features (e.g. white or whole rice; full-cream, semi-skimmed or skimmed milk), participants were asked to indicate which type they consumed most often, and only that one was recorded. The results of the quality evaluation studies of the ELSA-Brasil food frequency questionnaire demonstrated satisfactory reliability for all nutrients and acceptable relative validity for energy, macronutrients, calcium, potassium and vitamin E and C<sup>20</sup>.

The semi-quantitative food frequency questionnaire of the ELSA-Brasil study was structured as follows: (1) foods/preparations; (2) number of portions, expressed in household measures or reference units; and (3) consumption frequencies (“more than 3 times a day”, “2-3 times a day”, “once a day”, “5-6 times a week”, “2-4 times a week”, “once a week”, “1-3 times a month” and “never/almost never”). Participants were asked about their consumption of each food item in the 12 months preceding the interview. In order to facilitate their choices, participants were offered a response card with consumption frequency options, eliminating the need to memorize them<sup>19</sup>.

### Statistical analysis

- **Definition of food groups and frequency categories**

The 114 food items were assembled into ten groups by nutritional composition and by divisions used in previous studies in Brazil<sup>18,21</sup>.

Initial analyses using the original eight FFQ categories returned no interpretable results. Therefore, the number of food frequency categories was redefined using multiple correspondence analysis (MCA) in each food group. In this procedure, the correspondence matrix derived from the contingency table can be decomposed into eigenvalues and eigenvectors, from which the main coordinates of the table lines and columns can be defined. The first two axes of the lines and columns were used in this study as they are the most representative in terms of the association among the variables<sup>22</sup>. Two or three categories were set up, depending on the food group: (1) consumed once or more a week plus consumed sporadically and (2) not consumed; or (1) consumed daily, (2) consumed weekly and (3) consumed sporadically or not consumed. That decision was based on the type of clustering of frequency category coordinates observed on the graphs extracted from the first two axes. After that stage, the percentages in each frequency category were examined and, in cases where a category accounted for less than 1%, it was regrouped with the next most frequent consumption category.

Table 1 shows the composition of the food groups and the frequency categories adopted for each group. Food items that characterized typical preparations and beverages such as *chimarrão* (mate), *caruru* (okra, shrimp and nuts), *vatapá* (spicy shrimp and peanut paste), *acarajé* (fried shrimp croquette), *feijoada* (bean stew), Japanese food etc. were eliminated, because they were consumed much less frequently (less than

2%) or not at all in some of the study centers, making it harder to establish patterns. Alcoholic beverages were also eliminated as this study aimed to identify dietary patterns.

- **Definition of food subgroups**

#### a) Step 1

In this stage, the MCA was used once again, by inspecting the graphs, to indicate how many subgroups were formed.

#### b) Step 2

After identifying the number of possible subgroups from the MCA graphs, the vectors of the first two axes, corresponding to the coordinates of the food frequency categories, were extracted. That procedure made it possible to define the number of subgroups by cluster partition analysis (partitioning around medoids, PAM). At this stage, the cluster graphs were examined to ascertain intragroup homogeneity and intergroup heterogeneity, and the silhouette graphs were used to assist in analyzing the cluster quality of the previously established k groups (the closer to 1 the silhouette value, the better placed those items are in the group). In addition, the silhouette statistic was used as a parameter for defining the number of subgroups, the value desired being in excess of 0.523. Higher silhouette values indicated better clustering of items in the group. Negative silhouette values indicated that the food item was not appropriately classified in that subgroup and, in these cases, the analyses were repeated to test a different number of subgroups. The MCA, cluster and silhouette graphs for each subgroup are available at <http://www.elsa.org.br/artigos.html>.

#### c) Step 3

In this stage, a function was constructed to classify individuals by identifying the least distance between their coordinate values (extracted on the basis of the first two axes) and the centroid of the subgroup. In cases of subgroups with percentages of less than 1% (the criterion specified), the stages to define the number of subgroups were reviewed to assure proper definition of the content of each subgroup. From this stage onwards, the individuals were classified as belonging to the subgroups “x” of the fruits group, “y” of the vegetables group, “w” of the cereals group and so on, for all the food groups shown in Table 1. The subgroups generated in steps 1 to 3 are shown in Table 2.

Table 1

Food groups and frequency categories. *Brazilian Longitudinal Study of Adult Health (ELSA-Brasil), 2008-2010.*

Groups	Foods	Frequency categories
Refined cereals, whole cereals and tubers and roots	White rice; whole-grain rice; oats, granola and other whole flours; farofa (cassava flour with complements), cornmeal cuscus; cassava flour and corn flour; light bread; French rolls, sliced loaf and pita bread; wholemeal bread; simple cake; salt biscuit (cracker type); sweet biscuit w/o filling; potato (stewed, boiled or mashed); boiled cassava, yam, sweet potato; fried potato, cassava, polenta and sweet potato; macaroni; instant macaroni; and sweetcorn	1) consumed daily; 2) consumed weekly; 3) consumed sporadically or not consumed *
Confectionery	Sweets, caramels; cereal bar; sweet biscuit with filling; cake with filling, tart, trifle; chocolate bar, bonbons, chocolates; chocolate powder, chocolate drink, cappuccino; milk pudding, milk sweet, mousse; jelly; jam, fruit sweets; honey, syrup; sweet bread; fruit ice lolly; fruit salad with complements; and ice cream	1) consumed weekly or more often; 2) consumed sporadically or not consumed
Milk and dairy products	Full-cream yoghurt; light yoghurt; full-cream dairy milk; semi-skimmed dairy milk; skimmed dairy milk; butter; margarine; yellow cheeses; white cheeses; full-cream cheese spread; and light cheese spread	1) consumed daily; 2) consumed weekly; 3) consumed sporadically or not consumed
Red meats, processed meats and eggs	Boned beef (steak, minced meat and stewed meat); beef on the bone (rib, oxtail); pork; sausage; light cold meats (turkey sausage, turkey breast, chicken breast); ham, mortadella, salami; bacon; tripe; liver, offal; stroganoff; fried egg, omelette, scrambled egg; and boiled and poached egg	1) consumed weekly or more often; 2) consumed sporadically or not consumed.
White meats and fish	Boiled chicken; fried chicken; chicken breast; boiled, baked or grilled fish; fried fish; shrimp, shellfish; crab, swimming crab; and sardine, tuna	
Non-alcoholic beverages	Coffee with sugar; coffee with sweetener; coffee with no sugar; mate with sugar; mate with sweetener; sugar-free mate; soy extract; soft drinks; light soft drinks; artificial juice with sugar; artificial juice with sweetener; sugar-free artificial juice; industrialized juice with sugar; industrialized juice with sweetener; sugar-free industrialized juice; natural juice with sugar; natural juice with sweetener; sugar-free natural juice; and coconut water	1) consumed weekly or more often; 2) consumed sporadically or not consumed
Vegetables	Zucchini, chayote, eggplant; pumpkin; lettuce; garlic; beetroot; broccoli; onion; carrot; chicory, watercress, arugula, raw collards, raw spinach, escarole; braised collards, braised spinach; cauliflower; okra; tomato; runner beans; vegetable soup	1) consumed daily; 2) consumed weekly; 3) consumed sporadically or not consumed
Fruit	Avocado; pineapple; banana; persimmon, jack, pine nut; guava; orange, tangerine; apple, pear; papaya; mango; watermelon; melon; strawberry; peach, plum, cashew, kiwi; grape; and fruit salad with no complements	1) consumed daily; 2) consumed weekly; 3) consumed sporadically or not consumed
Fast food	Hamburger, cheese puffs, hotdog, popcorn, fried and baked savories, pizza, mayonnaise, instant soup	1) consumed daily; 2) consumed weekly; 3) consumed sporadically or not consumed
Legumes (items examined in isolation)	Beans (black, red, white, cowpeas etc.) Lentils, chickpeas and peas Walnuts, cashew nuts, Brazil nuts, peanuts, almonds and pistachio nuts	1) consumed daily; 2) consumed weekly; 3) consumed sporadically or not consumed

\* Except whole-grain rice, wholemeal bread, light bread, instant pasta, fried potato and polenta, which were categorized as consumed weekly or more often and consumed sporadically or not consumed.

Steps 1 to 3 were not applied for “beans”, “other legumes” and “nuts and other grains”, because of the small number of items. For these items, the separation of frequency categories

identified in the previous stage of the analysis was maintained.

Table 2

Description and proportion of food subgroups. *Brazilian Longitudinal Study of Adult Health (ELSA-Brasil)*, 2008-2010.

Group (mean silhouette)/Subgroup (SG)	Silhouette in subgroup	Proportion (% of individuals)
Refined cereals, whole cereals and tubers and roots (0.52)		
SG1. Whole-grain rice consumed daily or weekly and white rice not consumed	0.93	1.0
SG2. Cereals and tubers, except whole-grain rice, consumed weekly	0.55	41.3
SG3. Refined cereals consumed daily	0.52	27.9
SG4. Oats consumed daily and other flours or preparations based on refined flours not consumed	0.52	25.3
SG5. Potatoes, bread and pastas not consumed	0.46	2.8
SG6. Cereals, tubers and roots not consumed	0.46	1.0
SG7. Refined flour preparations consumed daily (cassava flour, pasta, cake)	0.43	2.2
Confectionery (0.59)		
SG1. Confectionery of all kinds not consumed	0.63	55.8
SG2. Low-calorie confectionery (honey, jam and cereal bar) consumed daily or weekly	0.61	11.4
SG3. High-calorie confectionery (ice cream, flan, iced cake and other preparations of the group) consumed daily or weekly	0.53	32.8
Milk and dairy products (0.47)		
SG1. Skimmed milk and light dairy products consumed weekly	0.72	4.8
SG2. Full-cream milk and dairy products consumed weekly	0.67	14.7
SG3. Skimmed milk and light dairy products consumed daily	0.61	4.6
SG4. White cheese and semi-skimmed milk consumed daily	0.52	38.4
SG5. Semi-skimmed milk, mix of full-cream dairy products and white cheese consumed weekly	0.38	9.9
SG6. Full-cream milk and dairy products and yellow cheeses consumed daily	0.31	27.6
Red and processed meats (0.44)		
SG1. Not consumed red meats	0.44	44.1
SG2. Red meats consumed daily or weekly	0.44	55.9
White meats and fish (0.50)		
SG1. Boiled chicken and fried consumed daily	0.87	18.9
SG2. Fish and shellfish consumed daily or weekly and chicken weekly	0.57	55.5
SG3. Chicken breast consumed daily or weekly and other white meats not consumed	0.35	22.6
Non-alcoholic beverages (0.56)		
SG1. Sugary beverages and soft drinks consumed daily or weekly	0.73	20.0
SG2. Beverages with sweetener and light soft drinks consumed daily or weekly	0.67	8.0
SG3. Soy-based and sugar-free beverages consumed daily or weekly	0.53	8.4
SG4. Coconut water consumed daily or weekly and other beverages not consumed	0.50	63.6
Vegetables (0.60)		
SG1. All vegetables consumed weekly	0.68	68.8
SG2. Light green vegetables consumed daily	0.66	0.02
SG3. Vegetables not consumed	0.64	22.0
SG4. Dark green and orange vegetables consumed daily	0.50	1.0
SG5. Lettuce, tomato, carrot, other, dark green vegetables consumed daily	0.33	8.0
Fruit (0.66)		
SG1. More popular fruit (papaya, apple, orange and banana) consumed daily	0.75	12.3
SG2. All types of fruit consumed weekly	0.70	51.0
SG3. Fruit not consumed	0.63	35.4
SG4. Less popular fruit and fruit salad without complement consumed daily	0.61	1.3
Fast food (0.47)		
SG1. Fast food consumed daily or weekly	0.67	57.7
SG2. Fast food not consumed	0.28	42.3
Other legumes [chickpeaks, lentils, peas] (item examined in isolation)		
SG1. Other legumes consumed daily or weekly	-	48.0
SG2. Other legumes not consumed	-	52.0
Nuts and other grains (item examined in isolation)		
SG1. Nuts and other grains consumed daily or weekly	-	51.5
SG2. Nuts and other grains not consumed	-	48.5
Beans (item examined in isolation)		
SG1. All types of bean consumed daily or weekly	-	95.7
SG2. No consumption	-	4.3

- **Identification of dietary patterns**

**a) Step 4**

After identification of the subgroups (treated as new variables that will form part of the pattern), steps 1 to 3 were applied to identify dietary patterns using the same criteria as described above.

The number of patterns was selected by the best graphic separation of the clusters, the best overall silhouette graph and the highest mean silhouette statistic<sup>23</sup>.

This study considered the following sociodemographic characteristics: sex, age group in whole years (35 to 44; 45 to 54; 55 to 64; and 65 and over), level of education (incomplete elementary school, elementary school, middle school, higher education and postgraduate education) and states where the ELSA-Brasil Study Centers were located: Bahia, Rio de Janeiro, São Paulo, Minas Gerais, Espírito Santo, and Rio Grande do Sul. The chi-square test was used to ascertain independence among the proportions. The analyses were conducted with the assistance of R software (v2.15.1), in the RStudio environment (v5.4) and using the FactoMineR and cluster libraries (The R Foundation for Statistical Computing, Vienna, Austria; <http://www.r-project.org>)<sup>24</sup>.

## Results

The number of subgroups identified among the food groups ranged from two to seven (Table 2). The highest silhouette values were observed for fruits, vegetables, sweets and non-alcoholic beverages.

In the cereals group, the two most frequent subgroups were those comprising refined foods and tubers (SG2 and SG3). The least frequent subgroups were characterized by consumption of whole cereals (SG1) or by non-consumption of potatoes, bread and pastas, cereals tubers and roots (SG5 and SG6). In the milk and dairy products group, the most frequent subgroup (SG4; 38.4%) comprised daily consumption of curd cheese and semi-skimmed milk, which may be considered healthier. Meanwhile, the second most frequent was SG6 (27.6%), characterized by daily consumption of full-cream milk and yellow cheeses. Striking in the non-alcoholic beverages group was the formation of a subgroup (SG4) differentiated by consumption of coconut water, while the others were characterized mainly by the presence or absence of sugar in beverages. Five subgroups were identified in the vegetables group, the most frequent characterized by consumption once a week of some type of vegetable

(SG1), followed by the “no consumption” subgroup (SG3). Similarly, the most frequent subgroups in the fruit group were consumption once a week of all fruit types (SG2) and “no consumption” (SG3) (Table 2).

The cluster that comprised the best separation of groups in the cluster graph was the one with four dietary patterns (Figure 1).

The cluster of the most frequent pattern (45.7%) can be termed “traditional” in that it includes beans and refined cereals (white rice, for instance) (Table 3). Most individuals in this pattern consumed beans, other legumes, red meats and processed red meat products, white meats and confectionery in general daily or weekly. They consumed milk, fruit and vegetables and refined cereals weekly, and did not consume fast-food.

The second most frequent profile (25.7%), “fruit and vegetables”, grouped individuals whose daily consumption included raw and light green vegetables, fruits, grilled chicken, white cheese and semi-skimmed milk, who consumed coconut water and fast-food daily or weekly and did not consume red meat, beans, refined cereals and confectionery in general.

The third most frequent consumption pattern (24.4%), “bakery products”, comprised daily consumption of refined cereals, bread, biscuits, fried chicken, full-cream milk and dairy products, with no consumption of vegetables, fruit and legumes. The least frequent pattern (4.3%) in the ELSA-Brasil study population, characterized mainly by consumption daily or weekly of whole-grain cereals, skimmed milk and sugarless or soy-based beverages, was termed the “low sugar/low fat” pattern (Table 3).

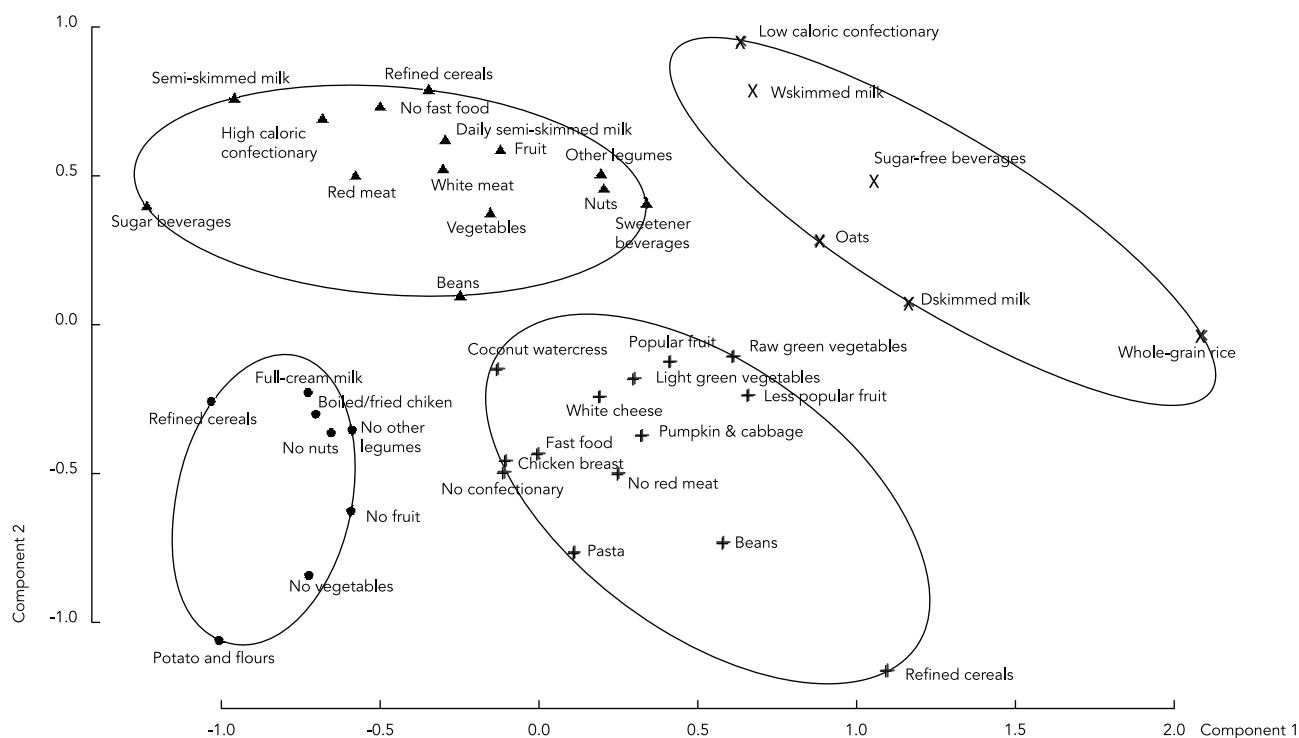
The “traditional” and particularly the “bakery products” patterns were the most frequent among the men, while the “fruit and vegetables” and “low sugar/low fat” patterns were the most frequent among the women (Table 4). The older the age group the smaller the proportion of the “traditional” pattern and the greater the proportion of the “fruit and vegetables” and “low sugar/low fat” patterns. In these two latter patterns (“fruit and vegetables” and “low sugar/low fat”), the relative difference between the 35 to 44 and 65 to 74 year age groups was three times or more.

Level of education was found to be inversely related to the “bakery products” pattern. That pattern was five times more frequent among individuals with incomplete elementary education than among those with postgraduate education. The “traditional”, “fruit and vegetables” and “low sugar/low fat” patterns were present in strikingly higher proportions among individuals with higher and postgraduate education. In addition,



Figure 1

Cluster graph of dietary patterns. *Brazilian Longitudinal Study of Adult Health (ELSA-Brasil), 2008-2010.*



the “low sugar/low fat” pattern was present in nearly twice the proportion of individuals with postgraduate education when compared with those with higher education (Table 4).

Distribution of the patterns differed with the participants’ city of residence. When the ELSA Study Centers were compared, it was observed that participants at the São Paulo and Bahia ELSA Study Centers were distributed more homogeneously among the four patterns. Participants at the Minas Gerais, Rio de Janeiro and Rio Grande do Sul ELSA Study Centers displayed the traditional pattern in the highest proportions (approximately 50% of participants). Minas Gerais, meanwhile, displayed the “fruit and vegetables” pattern in the smallest proportion. Participants at the Espírito Santo ELSA Study Center displayed the “bakery products” pattern in the highest proportion. The “low sugar/low fat” pattern was conspicuous among participants residing in Rio Grande do Sul (8.52%), where it was twice as frequent as in Bahia (4.36%) and Rio de Janeiro (4.1%) (Table 4).

## Discussion

The “traditional” pattern was the most frequent of the four dietary patterns identified. Among women, it was followed by the “fruit and vegetables” pattern and, among men, by the “bakery products” pattern. Regional differences were also observed.

As is usual in nutritional epidemiology, comparisons of our findings with those of previous studies are limited by differences in methods (as regards the questionnaire and the analysis used) to derive and name dietary patterns. In this respect, we have endeavored to identify similarities and differences in relation to the related literature.

Studies from the late 1990s, in São Paulo<sup>21</sup> and in Brazil’s Southeast and Northeast regions<sup>18</sup>, identified the presence of beans or legumes and rice or cereals in the traditional pattern, as do our results. The results of those previous studies showed that meats, milks and dairy products and confectionery were situated in other patterns,

Table 3

Description and proportion of dietary patterns. *Brazilian Longitudinal Study of Adult Health (ELSA-Brasil)*, 2008-2010.

Pattern (mean silhouette)/Composition	Silhouette of item	Proportion (%) of individuals
"Traditional" (0.43)		45.7
Milk and dairy products semi-skimmed consumed weekly	0.65	
Refined cereals consumed weekly	0.64	
White meats consumed weekly	0.63	
Fast food not consumed	0.61	
Fruit consumed weekly	0.59	
More energy-dense confectionery consumed daily or weekly	0.54	
Processed red meats and eggs consumed daily or weekly	0.52	
Vegetables in general consumed weekly	0.50	
Semi-skimmed milk and dairy products consumed daily	0.40	
Nuts consumed daily or weekly	0.32	
Beans consumed daily or weekly	0.21	
Other legumes consumed daily or weekly	0.34	
Beverages with sweeteners consumed daily or weekly	0.11	
Beverages with sugar consumed daily or weekly	0.03	
"Fruit and vegetables" (0.42)		25.7
Pumpkin and cabbage consumed daily	0.64	
Processed red meats and eggs not consumed	0.60	
White cheese and semi-skimmed milk consumed daily	0.57	
Light green vegetables consumed daily	0.56	
Beans not consumed	0.55	
Popular fruit consumed daily	0.51	
Fast food consumed daily or weekly	0.42	
Pasta and instant pasta consumed daily	0.40	
Less popular fruit consumed daily	0.39	
Raw green vegetables consumed daily	0.32	
Refined cereals not consumed	0.28	
Chicken breast consumed daily	0.25	
Confectionery not consumed	0.24	
Coconut water consumed daily or weekly	0.18	
"Bakery products" (0.60)		24.4
Nuts and other grains not consumed	0.68	
Boiled or fried chicken consumed daily	0.67	
Lentils and other legumes not consumed	0.62	
Full-cream milk and dairy products consumed daily	0.60	
Fruit not consumed	0.59	
Vegetables not consumed	0.58	
Refined cereals consumed daily	0.55	
Potato and flours consumed daily	0.51	
"Low sugar/low fat" (0.34)		4.3
Sugar-free and soy-based beverages	0.52	
Oats consumed daily	0.36	
Skimmed milk consumed daily	0.32	
Skimmed milk consumed weekly	0.31	
Whole-grain rice consumed daily or weekly	0.28	
Less energy-dense confectionery consumed daily or weekly	0.22	



Table 4

Total population and distribution of dietary patterns by sociodemographic variables. *Brazilian Longitudinal Study of Adult Health (ELSA-Brasil)*, 2008-2010.

Variables	ELSA-Brasil population (%)	Dietary patterns (%)				p-value *
		Bakery products	Traditional	Fruit and vegetables	Low sugar/low fat	
Sex						< 0.001
Female	54.40	19.16	44.27	30.81	5.76	
Male	45.60	30.72	47.44	19.27	2.57	
Age group (years)						< 0.001
35-44	22.06	24.39	58.31	14.67	2.64	
45-54	39.31	25.75	48.80	21.78	3.68	
55-64	28.04	23.28	37.15	33.67	5.90	
65-74	10.59	22.68	30.56	40.83	5.92	
Education						< 0.001
Elementary incomplete	5.92	54.61	23.26	21.57	0.56	
Elementary complete	6.81	45.66	32.78	21.07	0.49	
Middle	34.64	32.57	45.33	20.68	1.42	
Higher	16.00	18.68	51.08	26.32	3.93	
Postgraduate	36.63	10.47	49.76	31.27	8.51	
Study Center						< 0.001
Bahia	13.43	27.18	38.07	30.40	4.36	
Espírito Santo	6.98	32.07	39.11	26.07	2.76	
Minas Gerais	20.62	23.59	50.56	22.63	3.22	
Rio de Janeiro	11.81	19.53	50.56	25.81	4.10	
São Paulo	33.51	27.70	43.61	25.05	3.64	
Rio Grande do Sul	13.65	15.30	50.28	25.91	8.52	

\* Chi-squared test.

which differs from the results found in the ELSA-Brasil study population. Although consumption of beans has been observed to decline progressively in the Brazilian population<sup>25</sup>, it is observed in 73% of homes, making them one of the traditional foods most consumed in Brazil<sup>26</sup>. Monteiro et al.<sup>27</sup> and Levy et al.<sup>28</sup> have shown that consumption of red meats and milks is increasing in Brazil, over recent decades, and that frequent consumption particularly of meats denotes high social prestige<sup>29</sup>. More recently, Marchioni et al.<sup>13</sup>, examining data on Brazilians' food purchases, found pork in the "traditional" pattern, which is similar to our findings. One notable inclusion in our "traditional" pattern is high energy density products (such as cakes and ice creams), unlike what might be expected of that pattern (e.g. fruit-based or homemade confectionery). That result also seems to reflect food practices belonging to a more contemporary "traditional" pattern among Brazilian workers, as these foods reflect an image of modernity<sup>30</sup>. It also aligns with findings in the literature as to the increasing consumption of ultra-processed, ready-to-eat products in Brazil<sup>31</sup>.

The second most frequent pattern, "fruit and vegetables", the only one characterized by daily consumption of these food groups, was not identified in previous population-based studies in Brazil. This might be explained by the fact that the ELSA-Brasil study assessed a population of eminently urban workers, who often eat out, with access to weigh-and-pay (a more recent meal pattern in Brazil's dietary culture) and greater daily access to vegetables<sup>28,32,33</sup>. This pattern, which could be considered the "healthiest", is differentiated from the others by more frequent consumption of foods in their natural state. Unexpectedly, this "fruit and vegetables" pattern includes fast-food consumed daily or weekly. The presence of fast-food in this group reinforces the theory according to which apparently "inconsistent" food choices are common and reflect dietary practices influenced by a complex web of factors situated at levels from the macro to the everyday micro level<sup>34</sup>. Choices are thus influenced by dietary culture, cost, availability and marketing, as well as by the palatability of the foods/products and so on<sup>13,35</sup>.

The “bakery products” pattern, often similar to the “fruit and vegetables” pattern, was the most consistent and robust of all the profiles (silhouette = 0.60). Individuals in this group do not consume foods that are protective of health, such as fruit, vegetables and other legumes. The group comprises lower-cost foods and ultra-processed items that are consumed in snacks, and an upward trend is now being observed in such consumption in Brazil<sup>31</sup>. This population may have more opportunity to consume vegetables when, for example, eating out at weigh-and-pay restaurants. On the other hand, living in large towns, it faces the problem of lack of time to prepare meals including vegetables at home, instead eating snacks and fast food. Pollan<sup>36</sup> finds that one of the reasons for fruit and vegetables not being consumed daily may be the high cost of such foods and the difficulty of preparing them, given the fast pace of life in large towns.

The least frequent (5%) was the “low sugar/low fat” pattern, which can be considered recent in Brazil. No previous study of Brazilian adults has identified a pattern exclusively with these characteristics. This pattern included foods that are rich in fiber (oats and whole grain rice consumed daily), low in fat (skimmed milk consumed daily or weekly) and sugar-free or low-sugar (sugar-free or soy-based beverages consumed daily or weekly). It featured eating habits that were healthier and also restrictive when occurring in isolation, which may originate from professional recommendations for the control of chronic diseases, such as eliminating sugar in cases of diabetes. These health conditions are highly prevalent in Brazil and the media have publicized many recommendations relating to these food items.

While the composition of patterns comprising both healthy and unhealthy foods may represent a challenge in understanding how dietary choices are combined, on the other hand, the associations observed between patterns and sociodemographic characteristics suggest that the patterns identified are consistent and give them “face validity”. The distribution of those patterns by sociodemographic characteristics of the ELSA-Brasil study population is similar to recent findings in the Brazilian literature. Although using different methods, Gimeno et al.<sup>37</sup> observed greater frequency of the “healthy” pattern among women and older adults, while Marchioni et al.<sup>13</sup> and Arruda et al.<sup>38</sup> observed higher frequencies of the traditional pattern among men and among individuals with less schooling.

The “traditional” and “bakery products” patterns were more frequent among men and the younger age groups, which are known to be less

concerned with health<sup>39,40,41</sup>. Meanwhile, the “fruit and vegetables” and “low sugar/low fat” patterns were more frequent among women, confirming the results of other studies in which consumption of healthy foods is reported more frequently by women and older adults<sup>38,42</sup>. Probably because of their greater concern with beauty, health and more frequent recourse to health services, these two sub-groups are more likely to be following specific recommendations for control of diabetes, dyslipidemias and weight control<sup>43,44,45</sup>. Also, older adults may display physiological intolerances, such as reduced digestive capacity, which lead to reduced consumption of red meats, beans and other legumes<sup>26</sup>.

Level of education was directly related to frequency of the “fruit and vegetables” and “low sugar/low fat” consumption pattern, confirming the findings of other studies<sup>46,47</sup> that individuals with more education display “healthier” consumption patterns. This association may be explained both by greater purchasing power and by the likelihood of their occupations’ favoring healthier lifestyles. What is notable is that the “bakery products” pattern (which excludes consumption of fruit and vegetables) accounts for nearly one quarter of the ELSA-Brasil population (civil servants in tenured employment), and more than 50% of the individuals with the lowest levels of education in that population. Accordingly, we believe that, together with the higher cost of fruit and vegetables, dietary culture exerts an important role in selection of these foods. Claro & Monteiro<sup>48</sup> write that little headway has been made in Brazil in applying public policies to reduce the cost of fruit and vegetables.

As it was not possible to compare the distribution of dietary patterns by study center for lack of previous studies at the same locations, we compared our results with data from the *Brazilian National Dietary Survey* (INA)<sup>49</sup>, with a view to identifying whether the foods present in the patterns in our study displayed similar frequency distributions by region of Brazil. We observed that the distribution of the patterns by study center coincided partly with this national dietary survey, demonstrating, to some extent, the permanence of regional dietary culture. For example, the traditional pattern was more frequent among participants in Rio Grande do Sul (South region), and in Rio de Janeiro and Minas Gerais (Southeast region). The INA also found that foods such as meats, processed meats and beans, which form part of this pattern, were most frequently consumed in Brazil’s South and Southeast regions. In Espírito Santo and São Paulo (Southeast region) and Bahia (Northeast region) a higher proportion of consumption was found in the “bakery

products" pattern, involving mainly refined cereals (bread, pastas, flour and potatoes) and full-cream milk and dairy products, which may relate to consumption of snacks that replace meals or even to their being less expensive foods. In addition, the use of flour in preparations typical of Espírito Santo and Bahia would also explain the presence of such foods in this pattern. The "diet/light" pattern, which was most frequent in Rio Grande do Sul, was also observed in the INA findings on consumption of skimmed milk and less energy-dense confectionery, which was greater in the South region <sup>49</sup>.

Errors inherent to the process of measuring food consumption that may have occurred include overestimating consumption of certain food groups. Although that is a possibility, this study had the advantage of using a pretested questionnaire, whose validity had been estimated and which was subjected to a strict quality control process <sup>19</sup>. Another limitation is the possibility of classification errors in the patterns, given that this technique classifies individuals into mutually exclusive patterns. However, our objective was to identify typical behaviors, which characterize the main aspects of behaviors typified in individuals, which is a potential use of the analysis employed <sup>22</sup>.

The strengths of this study reside in the explicit description of all the stages involved. Systematic reviews on the subject have criticized studies for the large numbers of steps that depend on researchers' choices and for a failure to state explicitly the criteria used at those stages <sup>5,50</sup>. On the other hand, little has been done in Brazil to problematize the choice of multivariate analysis as a method for defining dietary patterns, the exception being Castro et al. <sup>51</sup>. The techniques most often used (factorial analysis and principal component analysis) presuppose the use of continuous variables. Most studies, however, say little explicitly about the characteristics of the distributions calculated in the studies to derive the patterns. In our study, we opted to analyze consumption frequency categories,

instead of using the sum of weight in grams or energy consumed, on the assumption that frequency represents more robust information on the dietary habits of the population studied. The reason is it avoids the errors related to the process of converting to weight and estimating nutrients <sup>52</sup>.

In all, four dietary patterns were identified in the study population, the "traditional" pattern being most frequent. For the first time in a Brazilian study, a pattern was identified that comprised sugar-free and low-fat and low-sugar foods and beverages, seeming to demonstrate a new set of dietary practices among a Brazilian working population residing in large cities. These results demonstrate the complexity of understanding one of the most significant health exposures, especially regarding the impact on public policy guidelines and programmes. The relation to sociodemographic variables showed subgroups with higher proportions of healthier patterns (women, more educated individuals and older individuals) and less healthy patterns (men, younger individuals and individuals with less education), alerting to the need for measures to encourage and support healthy diet for these groups. It seems that robust measures, particularly by the state, are needed to help to build and spread a culture of healthy diets in Brazilian society, as has been done to develop an anti-smoking culture. Less privileged population groups, both in the general population and among working people, should be considered as priorities. The current dietary guidelines for the Brazilian population serve to improve the quality of diet, but broad measures (such as taxation and regulation of ultra-processed products; media campaigns; professional recycling and capacity-building) are still necessary. Progress must be made in this regard in order to interrupt the rising rates of illness and death from chronic diseases in Brazil. Lastly, prospective monitoring of this population will make it possible to evaluate how these patterns impact on the development of diabetes and cardiovascular diseases.

### Contributors

L. O. Cardoso participated on the study design, data analysis, interpretation and discussion of results and writing the article. M. S. Carvalho contributed on the study design, statistical modeling, interpretation and discussion of results, writing and revising the manuscript. O. G. Cruz participated on the data analysis, interpretation and discussion of results, revision of article. C. Melere collaborated on the data collection, writing and revising the article. V. C. Luft contributed on the interpretation of results; article writing and critical review. M. C. B. Molina, I. M. Benseñor and C. P. Faria participated on the data collection, interpretation and discussion of results, writing and revision of article. S. M. A. Matos contributed on the interpretation and discussion of results, writing and critical review of the manuscript. M. J. M. Fonseca and R. H. Griep participated on the research design, analysis and interpretation of data and critical review of the manuscript. D. Chor contributed on the study design, interpretation and discussion of results, writing and revising the article.

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## Resumo

*Foi analisado o consumo alimentar de 15.071 servidores públicos de seis cidades brasileiras participantes da linha de base do Estudo Longitudinal de Saúde do Adulto (ELSA-Brasil, 2008-2010), com o objetivo de identificar os padrões alimentares e sua relação com variáveis sociodemográficas. Foram aplicadas análise de correspondência múltipla e cluster. Os quatro padrões identificados e suas respectivas frequências foram: "tradicional" (48%); "frutas e hortaliças" (25%); "pastelaria" (24%); e "diet/light" (5%). Os padrões "tradicional" e "pastelaria" foram mais frequentes entre homens, indivíduos mais jovens e de menor escolaridade. Por outro lado, os padrões "frutas e hortaliças" e "diet/light" foram mais frequente entre mulheres, indivíduos mais velhos e de maior escolaridade. Nossos achados mostram a inclusão de novos itens no padrão "tradicional" e o aparecimento do padrão "low sugar/low fat" entre os hábitos alimentares de trabalhadores brasileiros, e sinalizam diferenças sociodemográficas e regionais.*

*Comportamento Alimentar; População Urbana; Análise Multivariada; Adulto*

## Resumen

*Se analizó el consumo alimenticio de 15.071 empleados públicos de seis ciudades brasileñas, participantes de la línea de base del Estudio Longitudinal de Salud del Adulto (ELSA-Brasil, 2008-2010), con el objetivo de identificar los patrones alimenticios y su relación con variables sociodemográficas. Se aplicó un análisis de correspondencia múltiple y clúster. Los cuatro patrones identificados y sus respectivas frecuencias fueron: "tradicional" (48%); "frutas y hortalizas" (25%); "pastelería" (24%); y "diet/light" (5%). Los patrones "tradicional" y "pastelería" fueron más frecuentes entre hombres, individuos más jóvenes y de menor escolaridad. Por otro lado, los patrones "frutas y hortalizas" y "diet/light" fueron más frecuentes entre mujeres, individuos más viejos y de mayor escolaridad. Nuestros hallazgos muestran la inclusión de nuevos ítems en el patrón "tradicional" y la aparición del patrón "low sugar/low fat" entre los hábitos alimenticios de trabajadores brasileños, y señalan diferencias sociodemográficas y regionales.*

*Conducta Alimentaria; Población Urbana; Análisis Multivariante; Adulto*

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